obstetric trauma surgery
art and science

obstetric fistula classification
for reconstructive surgery

kees waaldijk
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babbar ruga national fistual hospital
katsina
nigeria
obstetric trauma surgery
art and science
setting standards by evidence-based practice

obstetric fistula classification
including
postpartum incontinence
with operation technique principles

based on
findings and outcome
in
25,000 obstetric fistula/trauma reconstructive procedures

kees waaldijk
obstetric trauma surgery
art and science

series of textbooks each with a specific topic

setting evidence-based standards

this series has been developed for setting evidence-based standards in the training and management of the obstetric trauma in all its forms in the developing as well as in the industrialized world

the name of the series has been changed from obstetric fistula to obstetric trauma surgery since the fistula is only one aspect of the complex obstetric trauma

though a systematic approach is being followed this seems to be a utopia since the material is too extensive and it would take too long

each time a specific topic has been finalized it will be published as a separate entity; with later on an update if needed

then somewhere along the line a comprehensive summary will be produced in order to have a representative overview

the emphasis is placed on the functional anatomy of pelvis, pelvis floor and pelvis organs, the female urine and stool continence mechanisms, the mechanism of action and the principles of reconstructive and septic surgery

for training reasons it will follow a step-by-step approach and repetition; together with schematic drawings and photographs

the whole series is based on kees archives of obstetric trauma with so far 25,000 reconstructive and conservative procedures in 20,000 patients with a rare “complete” documentation of each procedure and results as to healing and continence by electronic reports with 150 parameters, over 100,000 pre/intra/postoperative digital photographs and a comprehensive database as personal experience over a 35-year period from 1984 up till now

as such it is considered to be a full scientific evidence-based report; though it has not followed the “you peer me, i peer you” doctrine

it is also not following the strict protocol of the international scientific journals or the so-called established theories; since only dead fish follow the flow of the river; and strict protocols kill any creativity; the message is not in the format

since it is the life work of the author it is written in his own words and in his own style

writing things down helps the author in organizing his own understanding and ideas
foreword

the variety of the complex obstetric trauma is so enormous that it is not possible to develop an ideal fool-proof classification of the obstetric fistula that will satisfy all since actually each fistula constitutes its own specific entity

still, it is important to have a kind of classification in order to devise operation principles, to compare different operation techniques and to analyze the results

the first assignment of the obstetric trauma surgeon is to close the fistula and the second is to proceed in such a way that also continence is ensured

this can only be achieved if the complex obstetric trauma as a whole is taken into account whereby the functional anatomy is reconstructed with in the process closure of the fistula

so though any classification is a compromise it must include the urine and/or stool continence mechanisms as a major decisive inherent component

as well there are fluid transitions from one type to the other

out of the series obstetric trauma surgery; art and science this textbook outlines the complex obstetric trauma and presents an evidence-based classification of the obstetric fistula which has been used by the author in a prospective way and has been backed up by extensive documentation

the classification is based on the quantitative and qualitative involvement/tissue loss of the urine and/or stool continence mechanisms in the female

then the postpartum urine leakage without fistula has to be addressed like intrinsic stress incontinence and overflow incontinence due to hypotonic bladder, both of which are due to obstetric trauma; and the combination of both obstetric fistula with stress/urge incontinence

however, this classification is used as a guideline for the operation principles for the different types; though it cannot beat common sense

besides a classification, the trauma has to be described and documented in detail and in an objective way as to size, location, relation to euo and cervix/vault, tissue quality etc so that anyone analyzing the records gets a clear picture and can make his own classification if he thinks his own is better

kees waaldijk md phd

february 2018
urine continence mechanism

continence/closing mechanism: frontal

continence/closing mechanism: sagittal
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### basic science

- **pelvis anatomy in the female**  
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### abbreviations etc
stool continence mechanism

continence/closing mechanism: sagittal
introduction

in order to devise a plan of action, to develop surgical principles, to evaluate different operation techniques and to analyze the results more or less objectively a classification is needed which makes sense

there are lots of classifications presented for the obstetric trauma/fistula mostly based on small numbers and on personal feelings without being backed up by evidence in a large number of patients

the classification should be objective with clear definitions and parameters and not too complicated

simple, rather easy, difficult are all subjective and have no place; and is exclusively used by surgical ngo dummies who think that by calling something simple it automatically becomes simple; for this one only has to look at the poor results

however, reconstructive obstetric trauma surgery is never simple since

the major problem is that the functional anatomy of pelvis, pelvis floor and pelvis organs is highly complicated; this has to be mastered fully

then it is not the fistula which has to be addressed but the complex obstetric trauma with the fistula as only one factor; though the fistula is the most pressing

besides closing the fistula it is the postrepair incontinence after successful closure which is the major challenge

therefore the urine and stool continence mechanisms in the female have to be mastered in detail since only successful reconstruction of the functional anatomy will ensure full continence

though actually it is not possible to provide a waterproof classification which is 100% accurate the classification presented here is one of the conclusions in a phd study at the university of utrecht in 1989 and has been used prospectively in some 25,000 obstetric fistula and obstetric trauma related procedures over some 35 years with a rare complete documentation; the more it is being used the more valuable it becomes with an evidence-based 97% closure rate and 94% continence rate of the closed fistulas

so far it is the only evidence-based classification

based on the quantitative and qualitative tissue loss of the pelvis structures with special emphasis on the continence mechanism

with consequences for the operation technique principles and prospective predictable results as to closure and continence

kees waaldijk md phd

February 2018
raster urine/stool fistulas

6 cm raster vvf

12 cm raster rvf
essentials

what is needed
postpartum urine/stool loss
functional pelvis anatomy
the obstetric trauma
urine fistulas
stool fistulas
what is needed before a start is made

one has to master the complicated functional anatomy of the pelvis, the pelvis organs and the pelvis floor

one has to understand the functional anatomy as interaction between the different structures in order

to understand the physiology of the urine and stool continence mechanisms in the female

one must be able to identify the individual structures of the functional anatomy in the living female

which is different from the post-mortem dead anatomy

one has to study and understand the mechanism of action of the obstetric trauma, what it does to the functional anatomy of the individual structures and master the enormous variety of lesions

one must be able to identify and assess the individual obstetric trauma defects in the living female

one must study, understand and master the mechanisms of action of urine and stool incontinence and of prolapse in the female

then one must make a plan of action how to reconstruct the functional anatomy as customized to the individual findings and needs

one must master the principles of general, gynecologic, urologic, colorectal and reconstructive surgery and since the vagina is never sterile also the principles of septic surgery

one must understand and respect the natural tissue forces inside the human body

one must master the physiologic healing processes in order to promote the enormous natural healing potential of the human body

preferably one undergoes a practical training with a step-by-step approach where the basic skills are demonstrated in order to learn these skills

though the skills can be demonstrated and be practiced step by step under strict supervision there is NO automatic transfer of these skills and the ultimate responsibility for any surgery rests upon the performing surgeon

the decisive factor in surgery is the surgeon
postpartum urine and/or stool and/or flatus loss

introduction

involuntary urine loss and/or stool/flatus loss post partum is a frequent occasion all over the world due to the obstetric trauma; with and without anatomic tissue loss

and the first priority is to find out if the leakage is due to a fistula or due to another cause like incontinence or neurogenic

and the second priority is to determine if this needs surgical reconstruction or if it can be managed conservatively or a combination of the two

postpartum urine loss
with anatomic tissue loss
the obstetric urine fistula

without anatomic tissue loss
postpartum incontinence
genuine incontinence due to median defects within the endopelvic diaphragm
overflow incontinence due to hypotonic bladder

or a combination of the two
combination obstetric fistula with stress/urge incontinence
due to small/minute fistulas whereby the fistula functions as ectopic pacemaker
or as combined with a ureter fistula; a frequent objective finding

postrepair urine incontinence
fistula healed with incontinence

postrepair postdelivery incontinence
fistula healed with full continence but incontinence after subsequent delivery

postpartum stool/flatus loss
with anatomic tissue loss
the obstetric stool fistula

without anatomic tissue loss
stool/flatus incontinence
trauma to continence support like incomplete rupture/episiotomy
neurogenic like pudendal nerve trauma

postrepair stool and/or flatus incontinence
after sphincter ani rupture reconstruction
post urinary diversion incontinence; nightly soiling
true pelvis cavity
a confined space for the distal outlet organs of the urinary tract anteriorly, the genital tract in the middle and the digestive tract posteriorly with hydrostatic and compression pressure; normally in a continent way and divided into

- **anterior pre_subperitoneal compartment**
  for the distal end parts of the urinary tract: pelvic ureters, bladder and urethra
- **median subperitoneal compartment**
  for the (also distal end parts of) genital tract: uterus, adnexa, cervix and vagina
- **posterior retro_subperitoneal compartment**
  for the distal end parts of the digestive tract: rectum, anorectum and sphincter ani

enclosed by
- **parietal pelvis fascia** covering pelvis wall/floor muscles
- **parietal peritoneum**
  as connected to each other by
  - **teila urogenitalis** with corpus intrapelvinum and endopelvic diaphragm

**corpus intrapelvinum as dynamic matrix**
connective tissue organ of pelvis consists of a cohesive mixture of collagen for strength, elastin for passive elasticity and plasticity and mostly smooth muscle fibers for dynamic active non-fatigue tonus in a loose, dense or condensed form as a dynamic matrix into which the organs and their supply are embedded and suspended/connected to the pelvis wall and each other by highly specialized structures protecting the organs and their supply against trauma and stabilizing/securing them in their variable anatomic position as coordinated by the autonomic nervous system considered to be a fluidum since no sharp demarcations between the archaic matrix and its specialized structures

**endopelvic diaphragm**
highly specialized structure of corpus intrapelvinum from symphysis anteriorly to sacrum posteriorly as connected to its bilateral arcus tendienus fasciae with cervix as centrum tendineum intrapelvinum since all musculofascia structures are connected to it as first line of counteracting intraabdominal hydrostatic pressure and supporting the urogenital continence mechanisms in their anatomic position and preventing herniation of the urinary tract, genital tract, intraperitoneal contents and distal digestive tract into the zero-pressure vagina

**pelvis floor as one functional unit as part of abdominopelvic wall**
levator ani muscles connected firmly to the perineum outlet diaphragm via perineal body and external sphincter ani muscle supporting and reinforcing each other levator ani muscles as “pelvis diaphragm” highly overrated with direct action on stool continence mechanism and only indirect action on urine continence mechanism perineum outlet diaphragm into which the end outlet organs with their striated sphincter mechanisms are anchored and supporting directly and the urine and stool continence mechanisms
female urine continence mechanism  over in total 4-5 cm
bladder neck, uv-junction and whole urethra supported by the endopelvic diaphragm
there is an internal smooth muscle sphincter and an external striated rhabdosphincter with washer effect by the mucosa and submucous vascular plexus
continence potential over its whole length

female genital continence mechanism  over in total 3-4 cm
with cervix as internal smooth muscle sphincter as anchored into endopelvic diaphragm

female stool continence mechanism  over in total 4-5 cm
anorectum and external sphincter ani anchored within perineum outlet diaphragm
there is an internal smooth muscle sphincter and an external striated sphincter ani muscle with washer effect by mucosa and submucous vascular plexus

urine stress incontinence mechanism  genuine and post fistula repair
the anterior urethra wall is always fixed to the symphysis and cannot rotate backwards away from the symphysis whilst the posterior urethra wall is mobile as supported by the endopelvic diaphragm
once this support becomes weak the posterior urethra wall rotates backwards causing funneling = vesicalization of the proximal and mid or whole urethra with a decrease in resistance so that the intrinsic closing forces can no longer counteract the intravesical expulsion forces
or by defects within the anchoring into perineum outlet diaphragm; isolated or combined

pelvis floor muscle exercises
have a positive effect upon the urine and continence mechanism since the perineum outlet diaphragm contributes to the urine and stool continence mechanism by further stabilizing the outlet parts
the levator ani muscles contribute directly to the stool continence mechanism to which they are anatomically connected but only indirectly to the urine continence mechanism with no anatomic connection whatsoever with simultaneous reflex contraction of the external striated muscle sphincters with increase in tonus of smooth muscle fibers of the endopelvic diaphragm by reflex action by the sympathetic part of the autonomic nervous system

obstetric trauma
due to hydrostatic pressure, dilatation of birth canal, (in)direct cutting thru, shearing and compression; and in prolonged obstructed labor due to pressure necrosis resulting in an enormous variety of defects from minimal to extensive

pelvis organ prolapse
herniation of adjacent high(er)-pressure organs into the zero-pressure vagina and then further prolapse thru the vagina dragging vagina wall with them as intussusception due to defects within the separating and supporting endopelvic diaphragm structures of the corpus intrapelvinum between these organs and the vagina levator ani muscles and perineum outlet diaphragm do not play a role in this process since there is no anatomic contact between those organs and these structures

reconstructive surgery
the science is to identify the specific defects whilst the art is to reconstruct the functional anatomy using the available autologous structures
obstetric trauma

introduction

obstetrics constitutes always a major challenge to all pelvis organs with their different structures/support and to the pelvis floor structures and the actual trauma can be divided into two groups: lesions without and lesions with anatomic tissue loss therefore in the first group once the lesions have been repaired and the normal anatomy restored full function can be expected whilst in the second group even though “normal” anatomy may be restored full function can be compromised since there is a variable amount of tissue loss

analysis mechanism of action

there are several mechanisms by which the intrapelvic organs may be affected which will influence the functional pelvis anatomy in one way or the other

first by hormonal flooding

second by continuously increasing hydrostatic pressure due to pregnant uterus

third by dilatation of the cervix with opening up of the endopelvic diaphragm

fourth by direct or indirect cutting thru of the head thru the cervix, thru the gap between the puborectalis ledges and thru the opening within the perineum outlet diaphragm

fifth by shearing forces during actual childbirth when the head passes thru the cervix, thru the vagina, thru the gap between the levator ani ledges and thru the opening in the perineum outlet diaphragm

sixth by compression of the soft tissues between the hard fetal skull and the bony maternal pelvis

group I lesions without anatomic tissue loss

hormonal flooding

all the tissues will first “hypertrophy” to withstand the increased hydrostatic pressure and later on will soften as preparation for childbirth and will involute during the puerperium

hydrostatic pressure

since the fetus and the uterus will grow slowly there is a continuously increasing hydrostatic pressure which may traumatize the endopelvic diaphragm despite “hypertrophy”; in the involution phase defects may be resolved spontaneously or small defects remain whilst with subsequent pregnancies/deliveries these remaining defects may become larger up to a point where the support of the urinary continence mechanism becomes defective and/or the securing/stabilization of the organs becomes defective
dilatation of cervix with opening of endopelvic diaphragm
during the first stage of labor the cervix will efface and with it the endopelvic diaphragm
will open up with possible trauma to the anchoring of the cervix into this diaphragm
when the head passes thru this opening it may further stretch/traumatize the tissues
either bluntly or sharply

cut-thru trauma
when the passing of the head thru the birth canal goes too quick or when the birth canal
is not fully dilated and the tissues have no time to stretch the head may cut thru the
tissues either bluntly or sharply as
   blunt cut-thru
in combination with stretching the bilateral ledges of the pubrectalis muscles may be
traumatized
in combination with stretching the perineum outlet diaphragm may be traumatized
resulting in a wide introitus
   sharp cut-thru
when the cervix is not fully dilated the head may further traumatize the cervix and its
anchoring into the endopelvic diaphragm
when the perineum outlet is too stiff the head may cut thru the perineum, sphincter ani
and rectum resulting in the complex sphincter ani rupture

shifting/shearing
when the head of the infant passes thru the birth canal always shearing will take place in
minor or major form
between the head and the vagina wall
between the vagina wall and the endopelvic diaphragm,
between the endopelvic diaphragm and its attachment to the pubis bone and obturator
internus muscle fascia and
between the arcus tendineus of the levator ani muscles and the obturator internus
muscle fascia

**group II lesions with anatomic tissue loss**

compression trauma
when the head passes thru the vagina there will be compression of the soft tissues
between the hard fetal skull and the maternal bony pelvis
normally this is not a problem during physiologic childbirth but when obstructed labor
develops which is not relieved in time pressure necrosis will develop in an endless
variety; from minimal to extensive anatomic tissue loss

discussion
there are always tissue changes and tissue trauma during pregnancy and childbirth
even in physiologic pregnancy/labor
normally these changes/trauma will be resolved during the involution period of the
puerperium though small defects may remain
repeat pregnancies/deliveries will repeatedly add to these small defects and may result
in real pathologic defects
however, when labor becomes obstructed and this is not relieved in time pressure
necrosis will develop resulting in an endless variety of anatomic tissue loss with devas-
tating consequences for the woman affected
essentials vvf classification

as based on tissue loss, continence mechanism, operation technique and outcome

introduction

based on a retrospective analysis in 775 consecutive patients a scientific classification was developed and recommended in a phd thesis in 1989, university of utrecht this classification has been used prospectively and refined by the author in over 25,000 personal fistula and obstetric trauma related operations during a 35-year period of (surgical) management of the obstetric fistula mainly in nigeria, but also in burkina faso, ethiopia, kenya, niger, uganda, tanzania and pakistan from 1984 up till today

classification

the following classification is presented according to the anatomic/physiologic location with consequences for operation technique and prognosis; see table I

type I fistulas not involving the continence/closing mechanism

type II fistulas involving the continence/closing mechanism

type III miscellaneous

and of course postpartum urine incontinence

table I classification of fistulas according to anatomic/physiologic location

type I fistulas not involving the continence/closing mechanism

type II fistulas involving the continence/closing mechanism

A without (sub)total urethra involvement

   a without circumferential defect

   b with circumferential defect

B with (sub)total urethra involvement

   a without circumferential defect

   b with circumferential defect

type III miscellaneous, e.g. ureter fistulas and other exceptional fistulas

fluid transition from type I into type II fistulas is at 4-5 cm whilst transition from type IIA into type IIB fistulas is at 0.5-1 cm from the external urethra opening
a grading of involvement of the urine continence mechanism of the different types is presented in table II

**table II**
involvement of continence mechanism according to type

<table>
<thead>
<tr>
<th>type</th>
<th>involvement of continence mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>type I</td>
<td>none</td>
</tr>
<tr>
<td>type IIa</td>
<td>minor to moderate</td>
</tr>
<tr>
<td>type IIb</td>
<td>moderate to major</td>
</tr>
<tr>
<td>type III</td>
<td>major</td>
</tr>
<tr>
<td>type III</td>
<td>extensive</td>
</tr>
<tr>
<td>type III</td>
<td>none</td>
</tr>
</tbody>
</table>

**operation principles**

the operation principles for each type are presented in table III

**table III**
operation principles for each type

<table>
<thead>
<tr>
<th>type</th>
<th>bladder/urethra direction of closure</th>
<th>endopelvic diaphragm direction</th>
<th>ant vagina wall closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>type I</td>
<td>any according to common sense</td>
<td>no special measures</td>
<td>adaptation</td>
</tr>
<tr>
<td>type IIa</td>
<td>transverse</td>
<td>transverse repair (+ fixation)</td>
<td>transverse adaptation</td>
</tr>
<tr>
<td>type IIb</td>
<td>circumferential end-to-end</td>
<td>refixation</td>
<td>transverse adaptation</td>
</tr>
<tr>
<td>type IIBa</td>
<td>longitudinal (+ transverse)</td>
<td>fixation</td>
<td>flap</td>
</tr>
<tr>
<td>type IIBb</td>
<td>longitudinal + circumferential</td>
<td>refixation</td>
<td>flap</td>
</tr>
<tr>
<td>type III</td>
<td>special class of its own that needs their own specific approach</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
results

In 1,716 consecutively operated patients, a final check-up after first and/or final attempt was performed 5-6 months postoperatively.

Then the final results were analyzed whereby the incontinence rate was calculated as part of the healed fistulas and not as part of the total number of patients, see table IV.

table IV
results as to fistula type in 1,716 patients (1992-2001)

<table>
<thead>
<tr>
<th>type</th>
<th>number</th>
<th>healed first attempt</th>
<th>final healing</th>
<th>incontinent</th>
</tr>
</thead>
<tbody>
<tr>
<td>type I</td>
<td>243</td>
<td>238 (97.9%)</td>
<td>242 (99.6%)</td>
<td>1 (0.4%)</td>
</tr>
<tr>
<td>type IIAa</td>
<td>888</td>
<td>868 (97.4%)</td>
<td>888 (100%)</td>
<td>11 (1.2%)</td>
</tr>
<tr>
<td>type IIAb</td>
<td>366</td>
<td>333 (91.0%)</td>
<td>353 (96.4%)</td>
<td>30 (8.5%)</td>
</tr>
<tr>
<td>type IIBa</td>
<td>87</td>
<td>80 (96.4%)</td>
<td>86 (98.9%)</td>
<td>14 (16.3%)</td>
</tr>
<tr>
<td>type IIIBb</td>
<td>132</td>
<td>114 (86.4%)</td>
<td>121 (91.7%)</td>
<td>59 (48.8%)</td>
</tr>
</tbody>
</table>

discussion

This classification is based on the qualitative and quantitative amount of tissue loss of the urine continence mechanism in the female.

So far it is the only classification with a solid scientific background.

Clear operation technique principles for each type and prediction of outcome in terms of closure and continence.

The other classifications are either based on subjective opinion of the surgeon like simple, complex, easy, difficult etc etc or are a modification of what has been presented by the author in this book.

Of course within each type tens, hundreds or thousands of subsubtypes can be made but that would make the sense of classification unworkable.

At least for the author the more he uses this classification the more it becomes of value.

These are only guidelines and the approach has to be customized since each fistula constitutes its own unique entity.

Not only the fistula has to be classified, but all the lesions/defects have to be objectively described/document in writing to be completely transparent.
urine continence mechanism

continence/closing mechanism: frontal

continence/closing mechanism: sagittal
essentials rvf classification
as based on tissue loss, continence mechanism and operation technique

introduction

in order to compare results and different operation techniques it is important to have a scientific classification which makes sense

classification

the following classification is presented according to the anatomic/physiologic location with consequences for operation technique but not for prognosis; see table I

- **type I**  fistulas not involving the continence/closing mechanism
- **type II**  fistulas involving the continence/closing mechanism
- **type III**  miscellaneous

and of course  postpartum stool/flatus incontinence

### Table I
classification of fistulas according to anatomic/physiologic location

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Not involving continence mechanism</td>
<td>Proximal fistulas</td>
</tr>
<tr>
<td>a</td>
<td>Without rectum stricture</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>With rectum stricture</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>With circumferential defect</td>
<td>Not common</td>
</tr>
<tr>
<td>Type II</td>
<td>Involving continence mechanism</td>
<td>Distal fistulas</td>
</tr>
<tr>
<td>a</td>
<td>Without sphincter ani involvement</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>With sphincter ani involvement</td>
<td></td>
</tr>
<tr>
<td>Type III</td>
<td>Miscellaneous, e.g. ileouterine fistulas after instrumental abortion</td>
<td></td>
</tr>
</tbody>
</table>
the operation principles for each type are presented in table II

**table II**
operation principles for each type

**rvf type Ia**
not involving continence/closing mechanism
transverse rectum closure with pvw adaptation; check for rectum stricture

**rvf type Ib**
not involving continence/closing mechanism; rectum stricture
first blunt/sharp disruption of rectum stricture then the same as type Ia

**rvf type Ic**
not involving continence/closing mechanism; circumferential defect
if possible and safe circumferential end-to-end rectorectostomy
if not possible or not safe 3/4 circumferential rectum repair
if difficult a combined abdominovaginal procedure may be required
these are the most difficult to repair with the worst prognosis

**rvf type IIa**
involving the continence/closing mechanism
transverse or longitudinal rectum closure depending on common sense

**rvf type IIb**
major involvement of continence/closing mechanism
longitudinal anorectum closure, end-to-end sphincter ani reconstruction and perineal body repair as major reconstructive surgery

**rvf type III**
may need an abdominal approach
action according to what is needed

**discussion**

these are only guidelines and the approach has to be customized since each fistula constitutes its own unique entity

there is no relation between fistula type and outcome; only that type lc fistulas are the most difficult with the worst outcome as to healing whilst

**nb**

though the rectovaginal fistulas look simple they are even more complicated to handle than vesicovaginal fistulas and the principles of septic surgery have to be applied since there is always some kind of stool/flatus contamination
stool continence mechanism

continence/closing mechanism: frontal

continence/closing mechanism: sagittal
classification of obstetric fistulas
+
management principles

classification urine fistulas
urine fistula management
fistulas for beginners
postpartum urine incontinence + management
postrepair urine incontinence + management
classification stool fistulas
stool fistula management
postpartum stool/flatus incontinence + management
discussion
introduction
In order to devise and execute the fistula repair according to the principles of reconstructive surgery and to compare the results and different operation techniques it is important to have a scientific classification which makes sense.

based on a retrospective analysis in 775 consecutive patients a scientific classification was developed and recommended in a **PhD thesis** in 1989, University of Utrecht.

this classification has been used prospectively and refined by the author in over 25,000 personal fistula repairs and related operations during a 35-year period of (surgical) management of the obstetric fistula mainly in Nigeria, but also in Burkina Faso, Ethiopia, Kenya, Niger, Tanzania, Uganda and Pakistan from 1983 up till today.

right from the beginning the whole management has been painstakingly documented by computerized operation reports including history and schematic drawings complete with intermediate and final postoperative check-ups as evidence-based results; to support the continuous prospective research.

classification
the following classification is presented according to the anatomic/physiologic location with consequences for operation technique and prognosis; see figs 1-2 and table I.

- **Type I**: fistulas not involving the continence/closing mechanism
- **Type II**: fistulas involving the continence/closing mechanism and
- **Type III**: miscellaneous

figures 1 and 2
table I

classification of fistulas according to anatomic/physiologic location

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type I</strong></td>
<td>fistulas not involving the continence/closing mechanism</td>
</tr>
<tr>
<td><strong>Type II</strong></td>
<td>fistulas involving the continence/closing mechanism</td>
</tr>
<tr>
<td>A</td>
<td>without (sub)total urethra involvement</td>
</tr>
<tr>
<td>a</td>
<td>without circumferential defect</td>
</tr>
<tr>
<td>b</td>
<td>with circumferential defect</td>
</tr>
<tr>
<td>B</td>
<td>with (sub)total urethra involvement</td>
</tr>
<tr>
<td>a</td>
<td>without circumferential defect</td>
</tr>
<tr>
<td>b</td>
<td>with circumferential defect</td>
</tr>
<tr>
<td><strong>Type III</strong></td>
<td>miscellaneous, e.g. ureter fistulas and other exceptional fistulas</td>
</tr>
</tbody>
</table>

This classification is based on the progressive quantitative and qualitative amount of tissue loss of the urine continence/closing mechanism. The transition from type I into type II fistulas is at 4-5 cm whilst the transition from type IIA into type IIB fistulas is at 0.5-1 cm from the external urethra opening.

In **Type I** fistulas there is only tissue loss of the bladder, pubocervical musculofascia (as part of endopelvic diaphragm = epd) and anterior vagina wall (= avw) and/or cervix and/or uterus with an intact continence/closing mechanism. There may be major tissue loss with also trauma to the sacrospinous ligament, (ischio)coccygeus muscles and piriformis muscles. However, the urethra, urethrovessical junction and anterior part of the pubocervical musculofascia together with its connection to the paraurethra pubis bones and the arcus tendineus fasciae are still intact.

In **Type IIAa** fistulas there is tissue loss of the bladder, urethrovessical junction/trigonal ring, detrusor loops, proximal-(mid) urethra, pubocervical musculofascia and anterior vagina wall (and cervix and/or uterus) with minor to moderate involvement of the continence/closing mechanism. There may be slight trauma to the arcus tendineus fasciae (atf), arcus tendineus of the levator ani muscle (atlam) and levator ani musculature. There may be a transverse defect in the musculofascia so that its direct connection to the paraurethra pubis bones and paraurethra atf is disrupted or weakened but the atf itself is more or less intact; and so is the atlam.

In **Type IIAb** fistulas there is circumferential tissue loss of bladder neck, urethrovessical junction/trigonal ring, detrusor loops, proximal-(mid) urethra and tissue loss of posterior pubourethral ligaments, pubocervical musculofascia, anterior vagina wall (and cervix and/or uterus), atf, atlam, pubococcygeus muscles and obturatorococcygeus muscles; also there may be even trauma to the obturator internus muscles, obturator membrane and coccygeus muscles with eventual loss of the pubis bone periost and the pubis symphysis cartilage with moderate to major involvement of the continence/closing mechanism. There is no functional tissue connection whatsoever between the traumatized urethra or what is left of it and the traumatized bladder (neck) whereby the urethra has retracted distally and the bladder proximally in opposite directions.
this distal and proximal retraction is limited by the fact that the anterior urethra is loosely fixed/adherent to the posterior symphysis and that the anterior bladder is loosely fixed adherent to the posterior symphysis and anterior abdominal wall; however, sometimes the bladder has slipped above the cephalad brim of the pubis symphysis the stabilizing support of the endopelvic diaphragm needed for the physiologic urethra continence/closing function has been lost since there is no connection whatsoever between what is left of the traumatized pubocervical musculofascia and the paraurethra pubis bones; viz. the anterior part of the pubocervical musculofascia together with the paraurethra part of the atf are completely lost for a good understanding it is the cephalad part of the levator ani muscle together with its origin atlam which is lost whilst the caudal part with its insertion into the levator plate and coccyx is still intact if there is major loss of the levator ani musculature the result is an empty pelvis with bare pubis bones; this is always combined with (sub)total loss of the atf and atlam from paraurethrally up to the ischium spine

in type IIBa fistulas there is major tissue loss of the urethra and tissue loss of the urethrovesical junction/trigonal ring, detrusor loops, bladder, pubocervical musculofascia and anterior vagina wall (and cervix and/or uterus) with major involvement of the continence/closing mechanism; though there is tissue loss of the anterior part of the pubocervical musculofascia the atf, atlam and levator ani musculature are intact though the connection of the musculo fascia onto the immediate paraurethra pubis bones may be lost

in type IIBb fistulas there is (sub)total circumferential tissue loss of the urethra, urethrovesical junction/trigonal ring, bladder neck, detrusor loops and tissue loss of the interm diate and posterior pubourethral ligaments, pubocervical musculofascia, anterior vagina wall (and cervix and/or uterus), atf, atlam, pubococcygeus/obturato coccygeus muscles; also there may be even trauma to the obturator internus muscles, obturator membrane and coccygeus muscles with eventual loss of pubis bone periost and pubis symphysis cartilage with extensive involvement of the continence/closing mechanism there is no functional tissue connection whatsoever between what is left of the severely traumatized urethra if anything is left at all and the bladder (neck) whilst the bladder has retracted proximally which is limited anteriorly by the loose fixation of the anterior bladder onto the posterior symphysis and anterior abdominal wall the anterior part of the pubocervical musculofascia has been lost completely together with bilateral loss of the paraurethra part of the atf; in extensive trauma there may even be complete bilateral loss of the atf from paraurethrally up to the ischium spine the cephalad part of the pubococcygeus muscle has been lost with (sub)tota loss of the paraurethra atlam; in extensive trauma also the cephalad part of the obturatococcygeus muscle is lost with complete atlam loss from paraurethrally up to the ischium spine normally there is very extensive tissue loss which makes the surgical management so complicated in these fistulas; frequently an empty pelvis is found with bare pubis bones and sometimes the fistula may be inoperable right from the beginning

though in type IIAa and type IIBa there is tissue loss of the pubocervical musculofascia and there may be trauma to the levator ani muscle, atf and atlam, in type IIAb and type IIBb there is total loss of the anterior part of the pubocervical musculofascia together with total bilateral loss of the paraurethra part of the atf and total bilateral loss of the cephalad part of the pubococcygeus muscle together with total bilateral loss of the para urethra part of the atlam; in extensive type IIAb and IIBb fistulas the atf and atlam are completely lost bilaterally up to the ischium spines; in both type IIAb and type II Ib the paravesical space has been opened partially or completely
in fistula formation (but especially circumferential) the urethra and bladder will retract in opposite directions due to natural tissue forces.

The type III fistulas are a class of its own, e.g., ureter fistulas or fistulas between the bladder and bowels or between the bladder and skin.

A grading of involvement of the urine continence mechanism of the different types is presented in Table II.

Table II
Involvement of continence mechanism according to type

<table>
<thead>
<tr>
<th>Type</th>
<th>Involvement of continence mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>None</td>
</tr>
<tr>
<td>Type IIa</td>
<td>Minor to moderate</td>
</tr>
<tr>
<td>Type IIb</td>
<td>Moderate to major</td>
</tr>
<tr>
<td>Type III</td>
<td>Major</td>
</tr>
<tr>
<td>Type IIb</td>
<td>Extensive</td>
</tr>
<tr>
<td>Type III</td>
<td>None</td>
</tr>
</tbody>
</table>

An additional subclassification is presented according to the fistula size: small, medium, large, and extensive, see Table III.

Table III
Subclassification of fistulas according to size

<table>
<thead>
<tr>
<th>Size</th>
<th>Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>&lt; 2 cm</td>
</tr>
<tr>
<td>Medium</td>
<td>2-3 cm</td>
</tr>
<tr>
<td>Large</td>
<td>4-5 cm</td>
</tr>
<tr>
<td>Extensive</td>
<td>≥ 6 cm</td>
</tr>
</tbody>
</table>
**operation principles**

The operation principles for each type are presented in table IV.

**Table IV**

**operation principles for each type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Bladder/Urethra direction of closure</th>
<th>Endopelvic diaphragm closure</th>
<th>Ant vagina wall closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Any according to common sense</td>
<td>No special measures</td>
<td>Adaptation</td>
</tr>
<tr>
<td>Type IIAa</td>
<td>Transverse</td>
<td>Transverse repair (+ fixation)</td>
<td>Transverse adaptation</td>
</tr>
<tr>
<td>Type IIAb</td>
<td>Circumferential end-to-end</td>
<td>Refixation</td>
<td>Transverse adaptation</td>
</tr>
<tr>
<td>Type II Ba</td>
<td>Longitudinal (+ transverse) urethra tissue</td>
<td>Fixation</td>
<td>Flap</td>
</tr>
<tr>
<td>Type II Bb</td>
<td>Longitudinal + circumferential nonurethra tissue</td>
<td>Refixation</td>
<td>Flap</td>
</tr>
</tbody>
</table>

**Type III**

Special class of its own that needs their own specific approach.

**Results**

In 1,716 consecutively operated patients, a final check-up after first and/or final attempt was performed 5-6 months postoperatively as presented in table V.

**Table V**

**Results as to fistula type in 1,716 patients (1992-2001)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Healed first attempt</th>
<th>Final healing</th>
<th>Incontinent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>243</td>
<td>238 (97.9%)</td>
<td>242 (99.6%)</td>
<td>1 (0.4%)</td>
</tr>
<tr>
<td>Type IIAa</td>
<td>888</td>
<td>868 (97.4%)</td>
<td>888 (100%)</td>
<td>11 (1.2%)</td>
</tr>
<tr>
<td>Type IIAb</td>
<td>366</td>
<td>333 (91.0%)</td>
<td>353 (96.4%)</td>
<td>30 (8.5%)</td>
</tr>
<tr>
<td>Type II Ba</td>
<td>87</td>
<td>80 (96.4%)</td>
<td>86 (98.9%)</td>
<td>14 (16.3%)</td>
</tr>
<tr>
<td>Type II Bb</td>
<td>132</td>
<td>114 (86.4%)</td>
<td>121 (91.7%)</td>
<td>59 (48.8%)</td>
</tr>
</tbody>
</table>
comments

this classification is based on the qualitative and quantitative amount of tissue loss of the urine continence mechanism in the female

so far it is the only classification with a

clear scientific background

clear operation technique principles for each type and

prediction of outcome in terms of closure and continence

the other classifications are either based on the subjective opinion of the surgeon like simple, complex, easy, difficult etc or are a modification of what has been presented by the author in this book

of course within each type tens, hundreds or thousands of subtypes can be made but that would make the sense of classification unworkable

these are only guidelines and the approach has to be customized since each fistula constitutes its own unique entity

not only the fistula has to be classified, but all the lesions/defects have to be objectively described/documentated in writing to be completely transparent

the classification as to type is far more important and decisive than the additional sub classification as to size; whilst most of type IIAb, type IIBa and type IIIBb fistulas are already large or extensive

with this classification it is possible to plan and execute the fistula repair according to the principles of reconstructive surgery and to compare the results and operation techniques in a scientific way

however, since the variety is so immense and there are no sharp demarcations but fluid transitions between the different types, this classification should be used as a comprehensive guideline since

each fistula constitutes a separate unique entity and needs its own specific customized approach, and that is exactly what makes obstetric fistula surgery so intriguing and challenging since there are no identical obstetric fistulas

vagina strictures, scarring, stenosis and/or previous repair(s)

are no part of a classification; it only may make the operation more complicated

and then there is postpartum urine incontinence without a fistula
type I fistulas

vesicovaginal fistula

vesicocervicovaginal fistula

vesicouterine fistula

vagina vault fistula

© kees
type II Ba fistulas
type IIb fistulas
fistula size

small fistula

medium fistula

large fistula

extensive fistula

small fistula

medium fistula

large fistula

extensive fistula
endopelvic diaphragm defects

- type I
- type IIa
- type IIb
- type IIc
- genuine incontinence
pre-, intra- and postoperative management of vvf

the fistula is closed during the surgical process of reconstructing
the functional pelvis anatomy

the better the organization of the preoperative preparation, of the operation theater and of the postoperative care the better the outcome of fistula surgery in terms of closure and continence and the better the chance of medical, physical, mental and social rehabilitation
however, it cannot be stressed enough that the weakest point of fistula surgery in the developing world is the poor nursing care

first visit of patient
  extensive history
  clinical check-up; with vaginal examination
  special attention to other lesions due to obstructed labor: ulcers, foot drop etc

preoperative preparation
  oral hematinics and high-protein diet; no antibiotics
  high oral fluid intake of at least 6-8 liters per day already preoperatively!
  full mobilization; if needed with stick

laboratory, blood bank and X-rays
  Hb/Ht and serum creatinine
  a blood bank is complicated
  X-rays are not indicated

examination
  normal vaginal examination at first visit and day before operation
  eua (examination under anesthesia) is utterly nonsense if it is not followed up immediately by surgery in the same session

timing of fistula management
  the management has to start the moment the leaking of urine is manifest
  if no healing by catheter then for early closure as soon as wounds are clean

equipment
  a well functioning hydraulic operating table with 45-50° inclination is a must

special surgical instruments
  self-retaining weighted auvard speculum, long vaginal instruments, sharply curved thorek scissors, sharp deschamps aneurysm needle

suturing materials
  polyglycolic acid and nylon; expensive atraumatic suturing materials are not required
anesthesia
spinal anesthesia with a long-acting agent, e.g. hyperbaric bupivacaine 0.5%

manpower
only the surgeon and one instrumentating operation theater nurse
one retractor inside the vagina is already a crowd

operation route
the vagina in type I through type IIb fistulas; exceptionally and for type III fistulas other routes may be necessary
the abdominal route is not advanced surgery but a lack of surgical skills

position on the operation table
exaggerated lithotomy position with the legs flexed and slightly abducted in the leg holders

accessibility
by median, uni- or bilateral episiotomies

examination under anesthesia
this is done by any surgeon for whatever surgery at the beginning of any operation; the fistula is classified and a final decision taken how to tackle this specific fistula

pubocervical musculofascia of endopelvic diaphragm
any defect has to be repaired meticulously and if necessary it has to be (re) fixed to the paraurethra pubis bone and arcus tendineus fasciae

the martius fibrofatty pad graft or any other kind of grafting
does not contribute either to closure or to continence

indwelling bladder catheter for minimum period of 2 weeks
foley catheter ch 18 or better nelaton ch 16

postoperative fluid intake
at least 6-8 liters per day in order to get good urine flow with urine output of minimally 4,000-6,000 ml per 24 hr

vagina pack
no routine vagina pack; good check on hemostasis

antibiotics
only on strict indications, e.g. pneumonia
the indiscriminate use of antibiotics only leads to multi-resistance

mobilization
full mobilization the morning following surgery

main postoperative problem when the fistula is closed
intrinsic stress and/or urge incontinence
so already at first attempt make sure the right technique is performed
postoperative intrinsic stress incontinence
  urethralization and musculofascia repair/refixation

postoperative urge incontinence
  only strict bladder drill

urethrovesical junction (or uv)-stricture with overflow
  daily gentle dilatation for 2 weeks; eventually combined with urethrotomy

social rehabilitation
  only by successful repair; then it takes place spontaneously

future subsequent pregnancies/deliveries
  regular antenatal care with delivery in hospital by elective cesarean section since labor assistance/monitoring is very poor in most instances

tissue quality
  at operation end the tissue quality is documented as good, medium or poor only for predicting prospective results; not for operation techniques

residual fistulas
  the same technique as if it were the first attempt

dye test with gentian violet
  whenever in doubt (fistula?, incontinence?, which type of incontinence?) instill 20-200 ml gentian violet into the bladder under the motto the dye no lie
  however, it is troublesome and unreliable in the immediate postoperative period

principles of surgical technique(s)

the vaginal approach is the route of choice with or without unilateral, median or bilateral episiotomies, spinal anesthesia is the anesthesia of choice and the (exaggerated) lithotomy position is the position of choice for type I thru type IIb fistulas; however, type III fistulas may need a different approach

the fistula is classified by careful inspection and systematic examination of the complex obstetric trauma under spinal anesthesia just before the surgery is started and a final decision taken how to handle that specific fistula

an incision is made at the fistula edge, if needed with bilateral transverse extension, in the large(r) fistulas an effort has to be made to identify and catheterize the ureters, a dissection of the bladder and/or urethra performed and the bladder/urethra closed without tension by one layer of inverting polyglycolic acid sutures taking good bites of the pubocervical musculofascia.

the principles of reconstructive surgery and common sense dictate the direction of closure: longitudinal, transverse or oblique; a foley ch 18 catheter is inserted and, after checking watertight closure, the anterior vagina wall is only adapted or half closed to allow free spontaneous evacuation of small blood clots, tissue debris and bacteria according to the principles of septic surgery
in **type I fistulas** this is the straightforward procedure, though in the vesicocervicovaginal fistulas and vesicouterovaginal fistulas the bladder has to be dissected from the cervix and/or uterus.

Once the fistula has healed the patient will be continent as well since the continence/closing mechanism is not involved, unless she was already incontinent before she developed the fistula.

It has the best chance of healing and continence.

In the **type II fistulas** also something has to be done about (reinforcing) the continence/closing mechanism, preferably during the repair or later if the patient develops post repair incontinence; by repairing all defects within the endopelvic diaphragm.

The circumferential fistulas need a circumferential dissection, advancement of the bladder and circumferential repair by an end-to-end vesicourethrostomy.

In **type IIAb fistulas** there is total disruption of the traumatized urethra from the bladder (neck) in order to perform a complete (circumferential) restoration of the urethrovesical junction, it is necessary to dissect the bladder circumferentially from the anterior vagina wall, pubis bones and posterior pubis symphysis and if necessary also from the anterior abdominal wall.

Then the bladder is advanced caudad and the anterior and anterolateral bladder walls are anchored onto the caudad posterior symphysis and distal anterior urethra by 3-5 polyglycolic acid sutures.

The operation is further completed as an end-to-end vesicourethrostomy followed by bilateral refixation of the pubocervical musculofascia/endopelvic diaphragm onto the paraurethra pubis bones and where the lost arcus tendineus fasciae used to be.

Since there is circumferential tissue loss, circumferential dissection and circumferential repair the closure rate and the continence rate are slightly worse than in type IIAb fistulas.

In **type IIB fistulas** (part of) the urethra has to be reconstructed (in addition to bladder closure in large fistulas), preferably during the first repair or if that is not possible as a second stage.

Since the most important part of the continence/closing mechanism is situated in the urethra the chance of becoming incontinent after successful closure is higher than in type IIA fistulas.
In type IIa fistulas, the urethra is reconstructed longitudinally by a single layer of interrupted polyglycolic acid; urethra tissue has retracted bilaterally and this (para)urethra tissue is used for the reconstruction.

Then, the pubocervical musculofascia has to be fixed to the paraurethra pubis bones and intact paraurethra arcus tendineus fasciae and the neourethra covered by a flap from the anterior vagina wall or from the labia.

Therefore, the closure rate is slightly worse than in type IIA fistulas; as well as the continence rate.

However, functional urethra tissue is used for the reconstruction.

In type IIb fistulas, there is often extensive tissue loss with (sub)total tissue loss of the urethra.

Therefore, the urethra is reconstructed from non-urethra tissue: either by paraurethra tissue (bulbocavernous muscle) if available, or by scar tissue or by bladder tissue; as well the bladder has to be dissected circumferentially and anchored to the caudad posterior pubis symphysis with an end-to-end anastomosis onto the neourethra; and then the pubocervical musculofascia has to be refixed to the paraurethra pubis bone and “arcus tendineus fasciae” and the whole repair covered by an advancement flap from the anterior vagina wall or labia.

Many times a two-stage approach is necessary.

As first stage the bladder is advanced and anchored caudally onto the pubis symphysis into supposed “external urethra opening” and if necessary as second stage the urethra is reconstructed; sometimes the first stage ensures already full urine continence; there is a fair chance of breakdown and 40-50% chance of developing intrinsic/stress incontinence if the repair has been successful.

NB With reference to postrepair stress incontinence it is of utmost importance to keep in mind that in type IIAb and type IIb the anterior part of the pubocervical musculofascia is completely lost together with the paraurethra part of the arcus tendineus fasciae and that the anterior part of the pubococcygeus muscle is lost together with the distal part or the whole arcus tendineus of levator ani muscle with possible tissue loss of obturatorococcygeus muscles; the musculofascia has to be repaired/refixed meticulously.

Type III fistulas are a class of its own and need their own specific approach, e.g., ureter implantation into the bladder.

In principle there is progressively more tissue loss in fistulas from small thru extensive; however, there are extensive fistulas which have become small due to scarring, and this should be taken into account; so there are extensive small fistulas; dissection becomes progressively more extensive, the operation progressively more complicated, and the results progressively worse from small thru extensive.

NB If the fistula repair breaks down, this residual fistula has to be operated according to the same principles as if it were the first attempt.
the operation principles with respect to bladder/urethra, endopelvic diaphragm and anterior vagina wall for the different types have been summarized in table III and the results in table IV

### Table III

**Operation Principles**

<table>
<thead>
<tr>
<th>Type</th>
<th>Bladder/urethra Direction of Closure</th>
<th>Endopelvic Diaphragm</th>
<th>Ant vagina wall closure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type I</strong></td>
<td>any according to common sense</td>
<td>no special measures</td>
<td>adaptation</td>
</tr>
<tr>
<td><strong>Type IIAa</strong></td>
<td>transverse</td>
<td>transverse repair (+ fixation)</td>
<td>transverse adaptation</td>
</tr>
<tr>
<td><strong>Type IIAb</strong></td>
<td>circumferential end-to-end</td>
<td>refixation</td>
<td>transverse adaptation</td>
</tr>
<tr>
<td><strong>Type IIBa</strong></td>
<td>longitudinal (+ transverse) urethra tissue</td>
<td>fixation</td>
<td>flap</td>
</tr>
<tr>
<td><strong>Type IIBb</strong></td>
<td>longitudinal + circumferential nonurethra tissue</td>
<td>refixation</td>
<td>flap</td>
</tr>
</tbody>
</table>

### Table IV

**Results in 1,716 Consecutive Early Closure Patients (1992-2001)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Healed first attempt</th>
<th>Final healing</th>
<th>Incontinent</th>
</tr>
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<tbody>
<tr>
<td><strong>Type I</strong></td>
<td>243</td>
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<td><strong>Type IIBa</strong></td>
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<td>80 (96.4%)</td>
<td>86 (98.9%)</td>
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<tr>
<td><strong>Type IIBb</strong></td>
<td>132</td>
<td>114 (86.4%)</td>
<td>121 (91.7%)</td>
<td>59 (48.8%)</td>
</tr>
</tbody>
</table>

The results as to fistula healing at first attempt according to fistula type declined progressively from type I thru type IIBb fistulas; the same could be demonstrated for the fistula size from small thru extensive.

The continence rate of the healed fistulas declined progressively from type I thru type IIBb; the same could be demonstrated for fistula size from small thru extensive.
fistulas for beginners
objective characteristics by kees

introduction
due to vocal statements by verbal surgeons in the industrialized world and political statements by the major aid organizations, there is a lot of misunderstanding about obstetric fistula surgery and training such as the patient can be cured by a simple operation and beginners need rapid hands-on training for a short period.

however, there are no simple fistulas considering the complex trauma of the obstetric fistula and the enormous variety in tissue loss; it only may look simple in the hands of the few experienced fistula surgeons.

still one has to start somewhere and there are few vesicovaginal fistulas suitable for beginners as based on objective findings as to size, location, tissue quality, mobility of fistula/tissue/cervix, width of pubic arch, depth of vagina, concomitant rectovaginal fistula/sphincter ani rupture, previous repairs etc; all the characteristics of a small type IIAa fistula are outlined in order to help trainers and trainees.

objective criteria
based upon an extensive experience in more than 25,000 conservative and surgical procedures with excellent evidence-based results in closure of the fistula after one or more operations in more than 96% with severe incontinence in only 5-6% there are some fistulas which are suitable for beginners; the objective characteristics of which are outlined in table I with drawings in fig 1 and 2.

Table I
characteristics of fistulas for beginners

| 001  | size       | 0.2-1.5 cm |
| 002  | location   | midline    |
| 003  | distance from euo | 2-4 cm |
| 004  | classification | small type IIAa |
| 005  | ruga folds | intact     |
| 006  | mobility   | good mobility of fistula, tissues and cervix |
| 007  | pubic arch | ≥ 85°      |
| 008  | vagina depth | ≥ 10 cm |
| 009  | previous operation | no contraindication as long as no major scarring |
| 010  | rectovaginal fistula | no contraindication |
| 011  | no severe obesity | obesity makes any operation complicated |
possibilities
characteristics checklist

001 size
fistulas < 0.2 cm are difficult to handle and need special insight and operation principles

002 location
fistulas not in the midline are difficult to handle since instrument handling and tissue handling is complicated

003 distance from euo
any proximal fistula is difficult (instrument handling) and if it is too distal the delicate urethra (main continence structure) may be traumatized

004 classification
small type II\textsuperscript{Aa} fistulas where II means involving the urine continence mechanism, A no (sub)total urethra involvement and a no circumferential defect

005 ruga folds
when the ruga folds are not intact there is far more trauma than anticipated at first sight and one has to determine exactly the amount of tissue loss

006 mobility
if mobility is poor then mobilization of tissue and tension-free closure may be compromised or even impossible; even after closure there may be traction upon the repair, such as when a retracted cervix (after cesarean section) is pulling on the repair when the patient is coughing

007 pubic arch
if the pubic arch is < 85\textdegree then access may be poor which would make the operation more complicated

008 vagina depth
if the vagina depth is < 10 cm there is already substantial tissue loss

009 previous operation
if operated by expert surgeon there is almost no scar tissue, however, if operated by a surgeon without expertise there may be excessive scar tissue and mutilation

010 rectovaginal fistula
a rectovaginal fistula does not interfere with the operation technique or healing; a sphincter ani rupture makes the access even better however, beginners should not combine the vvf and rvf in one session but concentrate totally on one at a time

011 severe obesity
severe obesity makes any operation complicated; if so the patient should lose weight drastically first before she can be operated

after exact examination by this checklist, the surgeon should ask himself if he is able to continue or if it is better to refer the patient to a more experienced surgeon
preoperative preparation

the normal preoperative preparation should be followed like in any other operation; special for the vvf is abundant preoperative oral fluid intake until the spinal anesthesia which will clean the fistula, bladder and urine and hydrate the patient so that spinal anesthesia becomes safe, ureters can be identified and the occurrence of catheter blockage is minimal and to ensure patient compliance

operation technique

under spinal anesthesia and in the (exaggerated) lithotomy position a proper examination is performed whereby the above-named checklist is followed; then the surgeon should ask himself if he is able to handle this fistula competently a liberal use should be made of episiotomy to improve the access to the operation field an incision is made at the fistula edge with bilateral transverse extension; then minimal sharp dissection of the anterior vagina wall from the pubocervical musculofascia (with adherent bladder/urethra), identification of the pubocervical fascia, a transverse closure of the pubocervical fascia (with adherent bladder/urethra) is made by a single layer of inverting polyglycolic acid 00; the patient is asked to cough (with urine in the bladder) to check for urine leakage thru suture line or urine thru euo a foley catheter ch 18 is inserted and it is checked if urine flows thru the catheter which means 3 things; catheter is in the bladder, at least one ureter is functioning and the patient is not in shock the bladder capacity is estimated and the urethra length is measured in cm the anterior vagina wall is only adapted with 2-3x everting (non)absorbable sutures according to the principles of septic surgery the episiotomy is closed, and secure check made of the hemostasis; as routine a vagina pack is not inserted unless there should be diffuse oozing which cannot be controlled otherwise an (electronic) operation report is written immediately after finishing the repair comprising all the relevant parameters also including a drawing of the fistula

postoperative care

intensive care

is normally only for 12-24 hours with liberal use of analgesic drugs; no morphine or morphine derivatives since these interfere with breathing the following morning the patients have to be mobilized like after any other operation; besides good for their general health it is also good for prevention or treatment of contractures abundant fluid intake for as long as there is foley catheter inserted which is left in for a minimum period of 14 days; if nonabsorbable sutures have been used for adaptation of the anterior vagina wall these are removed 1 week after catheter removal upon catheter removal the patients is instructed to continue abundant oral fluid intake and to urinate frequently, to refrain from sex for 4-6 months, to come for regular follow-up up till 6 months postoperatively, to report when 3 month pregnant and to go immediately when labor pains start to a hospital at subsequent deliveries during the recovery phase all the patients are attending rehabilitation courses in special centers like literacy class, making soap, sewing etc
evidence based results

out of 10,529 patients operated during the period 1983-2010 in katsina, kano, zaria and nguru where there are reliable follow-up data, only 1,236 (12%) fulfilled the above-outlined criteria
the evidence-based postoperative results have been analyzed in table II

**table II**
**results in 1,236 patients operated during the period 1983-2010**

<table>
<thead>
<tr>
<th>Status</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>healed first attempt</td>
<td>1,221</td>
<td>98.8%</td>
</tr>
<tr>
<td>healed second attempt</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>whilst 4 did not report for another repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>postrepair continence surgery</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>all totally continent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>healed final outcome</td>
<td>1,230</td>
<td>99.5%</td>
</tr>
<tr>
<td>persistent incontinence only</td>
<td>7</td>
<td>0.5%</td>
</tr>
<tr>
<td>however, they did not report for incontinence surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mortality</td>
<td>2</td>
<td>&lt; 0.2%</td>
</tr>
<tr>
<td>native medicine 1; cerebrospinal meningitis 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**discussion**

as a start the beginner should stick to these principles in order to get good results, more experience and a systematic approach

once (s)he has performed some 20-25 repairs with good result (s)he now can expand her/his reconstructive surgery to other type IIa and type I fistulas

having performed some 50-60 repairs with good results (s)he now can start with small type IIAb fistulas

since type IIb and even more so type IIb fistulas are very complicated (s)he should start handling these types only if (s)he is very confident with type I, IIa and IIAb

**nb** if at any point during operation it becomes too complicated please terminate the operation and refer the patient; that is better than to continue and make irrepairable damage

remember, you are not the one who caused the fistula

first edition december 2010

final edition february 2018
postpartum urine incontinence
obstetric trauma with(out) anatomic tissue loss

introduction

there is also urine leakage due to obstetric trauma however without tissue loss and the obstetric trauma surgeon has to be familiar with this

then there is objective stress/urge incontinence combined with a small/minute fistula

so the first priority is to identify the cause of the urine incontinence

and the second is to promote spontaneous healing by indwelling bladder catheter or if that is not successful by meticulous repair of the defects, if possible; whilst high oral fluid intake is a must

postpartum intrinsic incontinence

as due to median defects within the endopelvic diaphragm or an overstretched loose endopelvic diaphragm so that the support of the posterior bladder/uv-junction/urethra is insufficient and these structures will rotate backward from the symphysis with funneling of proximal/mid or whole urethra and decrease in outflow resistance (equivalent to 4th power of radius of urethra diameter)

spontaneous healing is possible but the following is better
immediate catheter treatment for 4 weeks may promote spontaneous healing followed by pelvis floor exercises; if no cure obtained the responsible longitudinal median defect within the endopelvic diaphragm has to be repaired

postpartum hypotonic bladder with overflow incontinence

probably due to physical breakage/trauma of smooth muscle fibers of the detrusor muscle due to overstretching/filling of the bladder during delivery since urethra blocked by the infant head

spontaneous healing is possible via genuine intrinsic incontinence or intermittent self-catheterization; however the bladder remains full or is filling up again after each self-catheterization interfering with the physiologic healing processes

the following makes more sense
immediate bladder catheter for 4-6 weeks with complete decompression of the bladder at all times in order for the smooth muscle fibers to heal
uv-stricture with overflow incontinence and dysuria

this may be due to scarring after subfistula trauma; and since it may be the cause or the sequel a minute fistula has to be excluded by a dye test

and needs (repeat) gradual dilatation with indwelling catheter for 2 weeks and high oral fluid intake

if no cure obtained a surgical revision of the uv-junction is needed with excision of all scar tissue and re-anastomosis of bladder neck to proximal urethra or buccal mucosa plasty

neurologic incontinence

this is theoretically possible though difficult to diagnose and seems infrequent

obstetric fistulas combined with stress/urge incontinence

especially after fistula repair with minute/small residual fistulas, visible and nonvisible at direct inspection, whereby the scarring functions like ectopic pacemaker and prevents physiologic functioning of the continence mechanism

and a dye test is necessary to demonstrate or exclude the fistula

and

a frequent finding as combined with ureter fistulas type III

once the fistula has healed or the ureter has been successfully re-implanted, normally the incontinence will heal as well

postrepair post delivery incontinence

in patients who had a successful repair with full continence and who started to leak again without a fistula following a subsequent delivery; see next chapter

within the first 2 months after delivery the patients may benefit from indwelling catheter for 2-4 weeks and high oral fluid intake; however, most of them will not be cured

after a new or residual fistula has been excluded by a dye test incontinence surgery will be necessary whereby an effort has to be made to identify and then repair all the responsible defects within the endopelvic diaphragm and its suspension from/insertion into the pelvis wall
postrepair incontinence
fistula closed patient still leaking

postrepair urine incontinence is the major challenge in obstetric fistula surgery since most surgeons are only making an effort to close the fistula without paying attention to the obstetric trauma as a whole then there is incontinence after a subsequent delivery following successful repair with full continence

postrepair incontinence
a logical classification is according to the original fistula type

post I incontinence
post IIa incontinence
post IIb incontinence
post IIb incontinence
post III incontinence

cause: various defects within the endopelvic diaphragm and other lesions like (sub)total loss of the anatomic continence mechanism and/or bladder prevention and incontinence surgery should aim at meticulous reconstruction of the functional pelvis anatomy by repairing all the defects within the endopelvic diaphragm if possible; either first at fistula repair or later on at incontinence surgery

postrepair postdelivery incontinence
also here a logical classification is according to the original fistula type

post I postdelivery incontinence
post IIa postdelivery incontinence
post IIb postdelivery incontinence
post IIb postdelivery incontinence
post III postdelivery incontinence

cause: new defects within the endopelvic diaphragm prevention only by good obstetric care incontinence surgery by first identifying and then meticulous repair of all the defects within the endopelvic diaphragm in order to reconstruct the functional pelvis anatomy if possible
kees classification of stool fistulas

as based on tissue loss, continence mechanism and operation technique
without consequences for prognosis

introduction
In order to devise and execute the fistula repair according to the principles of reconstructive surgery and to compare the results and different operation techniques it is important to have a scientific classification which makes sense.

the author devised a classification for the obstetric stool fistulas conform the guidelines of the urine fistula classification.

this classification has been used prospectively and refined by the author in over 25,000 personal fistula repairs and related operations during a 35-year period of (surgical) management of the obstetric fistula mainly in Nigeria, but also in Burkina Faso, Ethiopia, Kenya, Niger, Pakistan, Uganda and Tanzania from 1983 up till today.

right from the beginning the whole management has been painstakingly documented by computerized operation reports including history and schematic drawings complete with intermediate and final postoperative check-ups as evidence-based results; to support the continuous prospective research.

classification

the following classification is presented according to the anatomic/physiologic location with consequences for operation technique only; see figs 1-2 and table I.

- **type I**: fistulas not involving the continence/closing mechanism
- **type II**: fistulas involving the continence/closing mechanism
- **type III**: miscellaneous

figures 1 and 2
table I

classification of fistulas according to anatomic/physiologic location

**type I** not involving continence mechanism
- a) without rectum stricture
- b) with rectum stricture
- c) with circumferential defect

**type II** involving continence mechanism
- a) without sphincter ani involvement
- b) with sphincter ani involvement

**type III** miscellaneous, e.g. ileouterine fistulas after instrumental abortion

and then there is **postpartum stool/flatus incontinence** without a fistula

this classification is based on the progressive quantitative and qualitative amount of tissue loss and on involvement of the stool continence/closing mechanism

the transition from type I into type II fistulas is at 4-5 cm from the anus whilst for type I fistulas a rectum stricture or circumferential defect has to be looked for

a grading of involvement of the stool continence mechanism of the different types is presented in table II

**table II**
involvement of continence mechanism according to type

<table>
<thead>
<tr>
<th>type</th>
<th>involvement of continence mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>type Ia</td>
<td>none</td>
</tr>
<tr>
<td>type Ib</td>
<td>none</td>
</tr>
<tr>
<td>type Ic</td>
<td>none</td>
</tr>
<tr>
<td>type Ila</td>
<td>from minimum up to major</td>
</tr>
<tr>
<td>type IIB</td>
<td>extensive</td>
</tr>
<tr>
<td>type III</td>
<td>none</td>
</tr>
</tbody>
</table>
operation principles

the operation principles for each type are presented in table III

table III
operation principles for each type

<table>
<thead>
<tr>
<th>type</th>
<th>rectum closure direction</th>
<th>special measures</th>
<th>post vagina wall only adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>type Ia</td>
<td>transverse</td>
<td>(+ colpotomy)</td>
<td>transverse</td>
</tr>
<tr>
<td>type Ib</td>
<td>transverse</td>
<td>+ disruption stricture</td>
<td>transverse</td>
</tr>
<tr>
<td>type Ic</td>
<td>circumferential end-to-end</td>
<td>(+ disruption stricture)</td>
<td>transverse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>highly complicated</td>
<td></td>
</tr>
<tr>
<td>type IIA</td>
<td>common sense transverse or longitudinal</td>
<td>(+ perineal body)</td>
<td>half open</td>
</tr>
<tr>
<td>type IIb</td>
<td>longitudinal</td>
<td>+ sphincter ani</td>
<td>left open</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ perineal body</td>
<td>intentionally</td>
</tr>
<tr>
<td>type III</td>
<td>special class of its own that needs their own specific approach</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

though the classification as to type is the most important, an additional subclassification can be made to the size: small, medium, large and extensive, see table III

table III
subclassification of fistulas according to size

- small < 2 cm
- medium 2-3 cm
- large  4-5 cm
- extensive ≥ 6 cm

results

postrepair incontinence is not a major problem, though it may occur in type IIb fistulas, whilst the type Ic fistulas have the worst results as to closure and may need a combined abdominovaginal approach; further, no clear relation to type
**comments**

this classification is based on the qualitative and quantitative amount of tissue loss and on the involvement of the stool continence mechanism in the female so far it is the only classification with a **solid scientific background**

**clear operation technique principles** for each type and however, no **prediction of outcome** in terms of closure

not only the fistula has to be classified, but all the lesions/defects have to be objectively described/documenting in writing to be completely transparent

the classification as to type is far more important and decisive than the additional sub classification as to size

with this classification it is possible to plan and execute the fistula repair according to the principles of reconstructive surgery and to compare the results and operation techniques in a scientific way

however, since the variety is so immense and there are no sharp demarcations but fluid transitions between the different types, this classification should be used as a comprehensive guideline since each fistula constitutes a separate unique entity and needs its own specific customized approach, and that is exactly what makes obstetric fistula surgery so intriguing and challenging since there are no identical obstetric fistulas

**vagina strictures, scarring, stenosis and/or previous repair(s)**
are no part of a classification; it only may make the operation more complicated

and then there is **postpartum stool incontinence** without a fistula

**nb**

though the rectovaginal fistulas may look simple they are even more complicated to handle than vesicovaginal fistulas and the principles of septic surgery have to be applied since there is always some kind of **stool/flatus contamination**
type II fistulas

type Ila

type Ila

type IIb

type IIb

type IIb

type IIb
fistula size
surgical principles for rectovaginal fistulas

the better the organization of the preoperative preparation, of the operation theater and of the postoperative care the better the outcome of fistula surgery in terms of closure and continence and the better the chance of medical, physical, mental and social rehabilitation
however, it cannot be stressed enough that the weakest point of fistula surgery in the developing world is the poor nursing care

general operation principles
the vaginal approach is the route of choice with/without episiotomies, spinal anesthesia is the anesthesia of choice and the (exaggerated) lithotomy position is the position of choice; type Ic and type III fistulas may need a different approach

the operation principles for each type are presented in tables I + II

table I
operation principles

rvf type Ia
not involving continence/closing mechanism
transverse rectum closure with pvw adaptation; check for rectum stricture

rvf type Ib
not involving continence/closing mechanism; rectum stricture
first blunt/sharp disruption of rectum stricture then the same as type Ia

rvf type Ic
not involving continence/closing mechanism; circumferential defect
if possible and safe circumferential end-to-end rectorectostomy
if not possible or not safe 3/4 circumferential rectum repair
if difficult a combined abdominovaginal procedure may be required
these are the most difficult to repair with the worst prognosis

rvf type IIa
involving the continence/closing mechanism
transverse or longitudinal rectum closure depending on common sense

rvf type IIb
major involvement of continence/closing mechanism
longitudinal anorectum closure, end-to-end sphincter ani reconstruction and perineal body repair for step-by-step reconstruction see text book

rvf type III
may need an abdominal approach
action according to what is needed
# Table II

## Operation Principles for Each Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Rectum Closure Direction</th>
<th>Special Measures</th>
<th>Post Vagina Wall Only Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type Ia</td>
<td>Transverse (+ Colpotomy)</td>
<td>Transverse</td>
<td>Transverse</td>
</tr>
<tr>
<td>Type Ib</td>
<td>Transverse + Disruption</td>
<td>Transverse</td>
<td>Transverse</td>
</tr>
<tr>
<td>Type Ic</td>
<td>Circumferential End-to-End (+ Disruption Stricture)</td>
<td>Transverse</td>
<td>Highly Complicated</td>
</tr>
<tr>
<td>Type IIa</td>
<td>Common Sense Transverse or Longitudinal (+ Perineal Body)</td>
<td>Half Open</td>
<td></td>
</tr>
<tr>
<td>Type IIb</td>
<td>Longitudinal + Sphincter Ani + Perineal Body</td>
<td>Left Open</td>
<td>Intentionally</td>
</tr>
</tbody>
</table>

## Comments

These are only guidelines and the approach has to be customized since each fistula constitutes its own unique entity.

There is no relation between fistula type and outcome; only that Type Ic fistulas are the most difficult with the worst outcome as to healing whilst Type IIb fistulas need thorough theoretic/practical knowledge of the stool continence mechanism, otherwise the results will be poor.
postpartum obstetric stool/flatus incontinence
without sphincter ani rupture
as based on
over 800 patients

introduction

many patients complain of stool/flatus incontinence immediately after childbirth and the first thing is to establish whether it is for surgical reconstruction or not and whether it will heal spontaneously or not
here only the nonsurgical conditions will be mentioned

obstetric incontinence due to trauma of support

open perineum rupture, open episiotomy with stool and/or flatus incontinence
though it probably will heal spontaneously something can be done but only if the wound is clean; if not clean speed it up by sitzbaths
as soon as wound is clean one or two deep adaptation sutures in one go thru skin and underlying tissue are performed as half-open closure according to septic surgery principles; leave the rest open

obstetric incontinence due to posterior vagina wall necrosis

distal or total posterior vagina wall necrosis; or already in healing phase
patients present with stool/flatus incontinence immediately post partum and distal posterior vagina necrosis without a fistula
the mechanism is that the inert nonfunctioning dead necrotic tissue with innervation loss is interfering with the smooth functioning of the stool continence mechanism; there are two possibilities either full thickness or not full thickness necrosis; this cannot be established immediately after childbirth only retrospectively

necrosis is full thickness
the necrosis is full thickness and the patient will develop rupture/fistula within a couple of days and then it becomes a surgical condition; see previous chapter

necrosis is not full thickness; or already in the healing phase
the necrosis is not full thickness which makes spontaneous healing likely, unless additional trauma by big stool bolus or iatrogenic by noncareful instrumental or other procedure; or if seen later it is already in the healing phase
so the first rule is do not interfere with the physiologic healing process; besides visual inspection no manual or instrumental examination; just wait and speed up the healing by immediate sitzbaths and supportive measures
however, until complete healing and regeneration has taken place this will interfere with the stool continence mechanism; also fibers of the autonomic nervous system have to find their way and grow into the regenerated tissue
the whole healing process may take 2-3 months though normally it goes rather quick
obstetric neurogenic stool/flatus incontinence

no visible trauma to anus, perineum, posterior vagina wall
considering the different innervation of the internal sphincter and external sphincter
there are a number of possibilities though for both local trauma and plexus trauma either
isolated or combined or all combined are possible

the sympathetic and parasympathetic nervous system is innervating the internal smooth
muscle sphincter; for its function no clinical test is available

the pudendal nerve is innervating the external striated sphincter ani muscle; to test its
function the anal reflex is used

the intensity of the trauma may be slight, moderate or extensive resulting in slight,
moderate or even total loss of function

the good thing is that normally there is spontaneous healing with full recovery; first the
patient becomes continent for stool and later on also for flatus

for scientific reasons the following possibilities may be the cause; either isolated or in
any kind of combination

  internal sphincter paresis
local trauma to autonomic nervous system at internal sphincter level
trauma to nerve during its course
pelvic plexus trauma

  external sphincter paresis
local trauma to pudendal nerve at sphincter level
trauma to pudendal nerve during its course
sacral plexus trauma

  combination of internal sphincter/external sphincter paresis
in whatever combination

nonobstetric neurogenic incontinence

actually this topic does not belong in this manuscript but a short outline will be given to
complete the overall view; there are many possibilities and careful history taking and
examination is necessary since patients are not coming out by themselves
these conditions are not being documented or managed by the author

spina bifida: overt or occult
if this is the cause normally the patient is already stool/flatus incontinent since she was
borne; but not all affected persons are incontinent
one patient with visible sacral meningocele claimed to be totally stool/flatus continent
until she delivered
so inspect the backside and look for scars of previous operation as well

  senile incontinence
unfortunately this happens rather frequently
though in the developing world there is no treatment for this type of incontinence these
patients may still benefit from strict personal hygiene and
**strict proper stool training**

set a time for active defecation (if the need is felt or not) in the morning after breakfast (gastroanal reflex) and continue this practice every day so that and the mind (brain) and the body is programmed and after some time and continuing this training defecation will be regulated more or less

one father who consulted me for/with his 8-yr-old son with spina bifida and stool/flatus incontinence reported 3-4 mth later to me personally that the problem had been solved

discussion

the variety of postpartum stool/flatus incontinence is large and the first thing which has to be established is whether this constitutes a surgical or a nonsurgical condition

if incontinence due to posterior vagina wall necrosis wait for breakdown or complete spontaneous healing; no manual or instrumental examination

the more specific the history taking the more frequent one finds obstetric neurogenic stool/flatus incontinence; the real incidence is not known though it must be high

normally this condition heals spontaneously and completely within 2-3 months and even far quicker

if it does not heal spontaneously a careful examination is performed to find out what is wrong and then action taken accordingly; ?rhaphy of whole continence mechanism? as last resort

in patients with nonobstetric neurogenic stool/flatus incontinence strict personal hygiene with stool training may be of benefit
obstetric fistula classification

discussion

considering the complexity of the obstetric trauma from one cell to subtotal loss of pelvis structures it is not possible to come up with a classification which will satisfy all

this classification is based on the qualitative and quantitative amount of tissue loss of the urine/stool continence mechanism in the female

so far it is the only classification with a
solid scientific background

clear operation technique principles for each type and
prediction of outcome in terms of closure and continence

it requires thorough theoretical knowledge of and ample practical experience in the complex trauma of the obstetric fistula, an exact knowledge of the (intra)pelvic anatomy and profound understanding of all the factors involved in the female continence/closing mechanisms

the other classifications are either based on subjective opinion of the surgeon like easy, simple, difficult etc or are a modification of what has been presented by the author in this book

of course within each type tens, hundreds or thousands of subtypes can be made but that would make the sense of classification unworkable

not only the fistula has to be classified, but all the lesions/defects have to be objectively described documented in writing to be completely transparent

with this classification it is possible to plan and execute the fistula repair according to the principles of reconstructive surgery and to compare the results and operation techniques in a scientific way

however, since the variety is so immense and there are no sharp demarcations but fluid transitions between the different types, this classification should be used as a comprehensive guideline since actually

each fistula constitutes a separate unique entity and needs its own specific customized approach, and that is exactly what makes obstetric fistula surgery so intriguing and challenging since there are no identical obstetric fistulas

vagina strictures, scarring, stenosis and/or previous repair(s) are no part of a classification; it only may make the operation more complicated

then there is postpartum urine incontinence without a fistula and postpartum stool incontinence without a fistula
though this classification has been presented earlier, it is the first time that all different anatomic structures involved are individually specified.

it is also the first time that a surgical plan of action with specific principles for each type is presented together with the results as to healing and to continence for each specific type in a large number of consecutive patients.

a special effort has to be made to identify circumferential defects.

since obstetric fistula surgery is reconstructive surgery in order to overcome highly variable amounts of anatomic tissue loss, the more accurate the quantitative and qualitative amount of tissue loss is assessed at the beginning of the operation the more effective surgery can be executed.

the classification as to fistula type is the most important since each type has its own specific surgical principles for repair with definite consequences for healing and continence.

the subclassification as to fistula size should be considered as additional/overlapping since it has no consequences for a specific surgical technique, only for extent of operation, healing and continence, and a majority of type IIAb, IIa, and IIb fistulas are already large or extensive.

though there is a direct relation between fistula type and operation principles, healing and continence depend upon other factors as well such as tissue quality, bladder capacity, urethra length etc.

therefore since 2005 at the end of the fistula repair healing and continence are predicted in percentage and this is written down in the operation report for even better evaluation.

previous repair(s) do not influence the outcome as to closure though they may influence the outcome as to continence since more scar tissue.

far more important are the original characteristics/qualities of the fistula which in the first place may be responsible for the breakdown, and who operated and how she was operated.

a concomitant rectovaginal fistula, scar tissue, vagina stricture, vagina stenosis/shortening, trauma to the piriformis muscle or trauma to the sacrospinous or sacrotuberous ligaments do not influence the classification, the operation technique or the outcome; at least not in the author’s experience since the principles of reconstructive surgery and of septic surgery are strictly adhered too.

since the endopelvic diaphragm plays a crucial role in maintaining continence by securing and stabilizing the posterior urethra in its anatomic position, it is of utmost importance to repair any defect in it and if necessary to (re)fix it bilaterally to the paraurethra pubis bone and arcus tendineus fasciae.

**type III urine and stool fistulas** are a class of its own with a different surgical approach though normally with excellent results as to closure and continence.
vaginal versus abdominal approach

performing a fistula repair thru the abdomen or thru the bladder is like performing a tonsillectomy thru the neck

some people claim that an abdominal repair is advanced level surgery; though actually it comes from a lack of anatomic knowledge, lack of vaginal surgical skills and lack of common sense so where is the advanced level

a repair thru the abdomen requires going thru the skin, subcutis, muscle fascia, muscle, muscle fascia, peritoneum, in between the bladder and cervix if present and then one is exactly where one is without any dissection in one go per vaginam what an additional surgical trauma and then the actual repair starts whilst after fistula repair the abdomen still has to be closed and general anesthesia

a repair thru the bladder requires going thru the skin, subcutis, muscle fascia, muscle, muscle fascia and anterior bladder wall and then one is exactly where one is without any dissection in one go per vaginam what an additional surgical trauma and then the actual repair starts whilst after fistula repair the abdomen still has to be closed and general anesthesia

the big lie of simple fistulas

as well, considering the extent and variety of the complex trauma of the obstetric fistula it is good to realise that there are no simple fistulas or simple repairs; it only may look “simple” in the hands of the few expert fistula surgeons

actually, the author has never seen a simple fistula; or performed a simple fistula repair or any other simple surgical procedure during the course of his 50 years in surgery

simple fistulas only exist in the simple minds of the project managers of the large aid organizations to secure funds by deliberately lying to the public

however, calling it simple does not make it simple

whilst only surgical dummies will follow since they have simply not been following up their own simple performance and will stay simple for the rest of their simple lives

what about quality surgery

do not waste time, energy and money on things which make no sense such as eu, first treating the urine dermatitis, intravenous pyelography, urine examination, waiting 3 months after delivery before surgery etc.

concentrate on the most important thing: close the fistula
basic science

pelvis anatomy
functional pelvis anatomy
connective tissue body of pelvis
endopelvic diaphragm
urine continence mechanism
urine incontinence mechanism
stool continence mechanism
remarks about pelvis organ prolapse
introduction

mastering the pelvis anatomy is not an easy task since the anatomy is complicated but it is the first step for any surgeon in whatever field since reconstruction of the functional anatomy will ensure normal physiology

here only a short comprehensive outline is given as a start/incentive to more extensive self-study; it is based on existing anatomic textbooks with some personal comments

only the lesser or true pelvis is considered within the context of the abdominopelvic cavity

bony pelvis

consists of 3 paired bones and 2 single bones connected to each other via joints and ligaments

paired pubis bones
  with body and superior/inferior rami as joined anteriorly in the midline by the symphysis pubis

paired ischium bones

paired ilium bones

single sacrum bone

single coccyx bone

the 3 paired bones pubis, ilium and ischium are fused together by ossification

it forms a cavity for the distal outlet end organs of the urinary tract, the genital tract and the digestive tract; normally in a continent way

it is also part of the musculoskeletal locomotion system with insertions for abdominal muscles and hip muscles

ligaments stabilizing bony pelvis

symphysis cartilage
joining pubis bones anteriorly in the median; whilst whole complex also referred to as symphysis

arcuate ligament
between inferior pubis bones just caudad from symphysis cartilage

sacroiliac ligaments, dorsal and ventral
between ilium bones and sacrum
**sacrotuberous ligaments**
broad base from dorsal posterior ilium spine, dorsal lateral parts of sacrum, upper lateral part of coccyx to medial ischium tuberosity

**sacrospinous ligaments**
in front of sacrotuberous ligaments, triangular in shape with a broad base from lateral lower parts of sacrum, lateral upper part of coccyx to ischium spine; (ischio)coccygeus muscles fused with its lower pelvic aspects

**pelvis divided into greater pelvis and lesser or true pelvis**

for anatomic and functional reasons the pelvis is divided into a greater and a lesser or true pelvis as divided by the linea terminalis which also forms the inlet opening into the true pelvis

**greater pelvis**

consists of bones anteriorly, posteriorly and bilaterally and abdominal muscles anteriorly and forms the lower part of the abdominal cavity and is separated by the linea terminalis from the lesser or true pelvis, the topic of this book

though normally occupied by the intraperitoneal organs, also intrapelvic organs may protrude into it

**true pelvis**

consists of a combination of bones, ligaments and muscles lining the bones or filling up the gaps in between bones with a funnel-like shape which is short and straight anteriorly (symphysis) and longer and concave-curved posteriorly (sacrum promontory to tip of coccyx bone)

though normally occupied by the intrapelvic organs, also some intraperitoneal organs like small bowel and sigmoid colon may protrude into it

there is a pelvis inlet into the true pelvis and a pelvis outlet and several other bilateral openings like obturator foramen and (greater and lesser) sciatic foramina

**functional pelvis cavity**

the functional pelvis cavity is the space in between the parietal pelvis fascia and the parietal peritoneum connected to each other by the tela urogenitalis into which the pelvis organs with their arterial blood supply, venous drainage, lymphatic drainage and innervation are embedded; see next chapter
pelvis inlet = apertura pelvis superior

round or oval shape as the upper (bony) ring in one plane through anteriorly superior symphysis edge, laterally upper edge of superior pubis bones and linea arcuata and posteriorly the promontory; the bony ring is interrupted anteriorly by the symphysis cartilage joint and posterobilaterally by the sacroiliac joints

inclination 55-60° with horizontal from superior symphysis edge anteriorly to promontory posteriorly in the upright position

pelvis outlet = apertura pelvis inferior  surface some 75-80 sq cm

diamond shape from inferior symphysis edge along ischiopubic rami to bilateral ischium tuberosities to tip of coccyx bone; the anterior triangle for the urogenital tract between symphysis and tuberosities in one plane and the posterior triangle for the digestive tract between tuberosities, sacrotuberous ligaments and tip of coccyx in another one plane

however there still remain some bony gaps posterobilaterally which are filled up by the coccygeus muscles, sacrospinous and sacrotuberous ligaments and piriformis muscles

anterior triangle in one plane with -10 to -15° inclination as to horizontal from symphysis to ischium tuberosities in the upright position

posterior triangle in one plane with 65 to 70° inclination as to horizontal from ischium tuberosities to tip of coccyx in the upright position

the direct inclination between inferior symphysis and tip of coccyx is 10-15°

anteroposterior diameter recta from inferior symphysis to tip of coccyx is 9-9.5 cm; can enlarge to 11 cm during childbirth; with transverse intertuberosity diameter of 10-11 cm

pelvis floor = part of the abdominopelvic wall

the pelvis outlet is more or less closed off by the pelvis floor structures; however with 3 openings for urethra, vagina and rectum; and consists of

levator ani muscles  gap between puborectalis ledges some 25-30 sq cm

the superior layer of the pelvis floor; as formed by puborectalis (as sling around the anorectum), pubococcygeus and obturatococcygeus muscles and in total like a shallow bowl with its deepest point at the anus

with an anterior sagittal median hernia-prone opening of 7-8 x 3.5-4 cm (some 25-30 sq cm) between the two puborectalis ledges

perineum outlet diaphragm

the inferior layer of the pelvis floor with perineal body as its center; formed by perineal membrane, perineal body, transversus perinei muscles, bulbospongiosus muscles, ischiocavernosus muscles, crura of clitoris, anococcygeal ligament/levator plate, coccygeus muscles, sacrospinous ligament and sacrotuberous ligament
the outgoing distal end organs of the urinary tract, genital tract and digestive tract with their continence mechanisms are firmly anchored into the pierced thru punched out openings in the outlet diaphragm and constitute part of it

so the pelvis floor belongs to the abdominopelvic wall into which the outlet organs with their continence mechanism are anchored; nothing more and nothing less

inclination of 10-15° as to horizontal from inferior symphysis edge anteriorly to tip of coccyx posteriorly; in the upright position

the pelvis floor is covered on the outside by the pudendal organs: clitoris, vestibule and labia minora/majora

pelvis foramina

obturato foramen
between superior pubis, inferior pubis and ischium bones; it is closed by the obturator membrane with a small opening as a canal for blood and nerve supply to the obturator externus muscle

the sacrospinous ligament divides the space between the ischium notch/spine and sacrum/coccyx into foramina with the sacrotuberous ligament as boundary:

greater sciatic foramen
thru which piriformis muscle, superior and inferior gluteal vessels and nerves, internal pudendal vessels, pudendal nerve and sciatic nerve caudad from piriformis muscle, posterior femoral nerve and nerves to obturator and quadratus femoris muscles; is the cephalad = superior foramen

lesser sciatic foramen
thru which obturator internus muscle tendon, nerve to internal obturator muscle, internal pudendal vessels and pudendal nerve; is the caudad = inferior foramen

pelvis muscles

there are 2 intrapelvic muscles which function as exo-rotators/abductors of the hip

obturato internus muscle
originates from pelvic surface of obturator membrane and pubic and ischial margins of obturator foramen with its tendon thru the lesser sciatic foramen and inserts into medial surface of trochanter major

piriformis muscle
originates from pelvic surface of sacrum and ilium, passes thru greater sciatic foramen and inserts into upper border of trochanter major

and four extrapelvic muscles as exo-rotators of the hip: obturator externus muscle, gemellus superior muscle, gemellus inferior muscle and quadratus femoris muscle
then there are muscles which constitute the “anterior” and bilateroposterior part of the superior layer of pelvis floor as shallow bowl with anus as most caudad point

**levator ani muscles**
originating from pubis bone body and atlas and inserting into levator plate, coccyx and anococcygeal ligament; actually one flat muscle but normally divided into different parts

**pubococcygeus muscles**
from pubis bone body and atlas to levator plate and anococcygeal ligament

**puborectalis muscles**
medial part of pubococcygeus muscles fusing behind rectum and pulling it anteriorly

**obturatococcygeus muscles**
from atlas/obturator internus fascia to levator plate, coccyx and anococcygeal ligament

and **(ischio)coccygeus muscles**
from ischium spine and inferior edge of sacrospinous ligament to sacrum and coccyx

and muscles which form the anterior part of the perineum outlet diaphragm as the inferior layer of pelvis floor

**compressor urethrae muscle**
in the deep perineal space between perineal membrane and levator ani muscles but not mentioned in older textbooks

**urethrovaginalis muscle**
in the deep perineal space between perineal membrane and levator ani muscles but not mentioned in older textbooks

**bulbospongiosus muscles**
in the superficial perineal space from symphysis and clitoris and radiating into perineal body; closes the vagina introitus and stabilizes the (anterior) anus

**ischiocavernosus muscles**
in the superficial perineal space from ischium tuberosity into clitoris

**transversus perinei muscles**
from ischium tuberosity and radiating into perineal body for stabilization of anterior anus

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**pelvis connective tissue**

**corpus intrapelvinum**

the organs of the pelvis together with their arterial blood supply, venous drainage, lymphatic drainage and innervation are embedded into and suspended/connected to the pelvis wall and to each other via a complicated system of connective tissue, called connective tissue body of pelvis = corpus intrapelvinum; see special chapter

it consists of a cohesive mixture of collagen for strength, elastin for passive elasticity and plasticity and smooth muscle tissue for active tonus and relaxation; under control of the autonomic nervous system

in a loose, dense or condensed form and may be highly specialized according to the needs as fascia, ligament or plica such as

**parietal pelvis fascia**
the general layer that lines the inner aspects of the pelvis cavity wall/floor; together with the periost
visceral fascia
from tela urogenitalis for packing/encapsulating the organs as fascia of the organs and
for ensheathing the blood vessels, lymphatic vessels and nerves

obturateur membrane
the obturateur membrane closes the obturateur foramen and forms the origin of the
obturateur externus muscle on the outside and the origin of the obturateur internus muscle
on the inside

obturateur fascia
fascia covering obturateur internus muscle; from/into which atf and atlam originate/insert

arcus tendineus of levator ani muscle = atlam
as line of fusion from 1.5-2 cm laterally from midline from posterior pubis bone body
over obturator internus muscle fascia to ischium spine; as origin of levator ani muscle

levator ani fascia
fascia covering levator ani muscle

arcus tendineus fasciae = atf
as line of fusion bilaterally from posterior pubis bone body 0.5-1 cm from midline pubis
symphysis to ischium spine; as anterolateral attachment of endopelvic diaphragm to
pelvis wall
it is connected to the obturateur fascia and to the arcus tendineus of levator ani muscle
via a narrow triangular fascia sheath
inclination of 115-120° as to horizontal from anterior to posterior in upright position

pubocervical muscolofascia = vesicovaginal muscolofascia
in between the posterior bladder wall and anterior vagina wall as the anterior part of the
endopelvic diaphragm; see special chapter

arcus tendineus of rectovaginal fascia = atrf
as line of fusion from the lateral side of perineal body over levator ani fascia to ischium
spine and fuses with the posterior part of the arcus tendineus fasciae

rectovaginal fascia = prerectal fascia
in between the posterior vagina wall and anterior rectum wall and fixed anteriorly to the
perineal body, (bi)laterally to arcus tendineus of the rectovaginal fascia and posteriorly
to the cervix and the sacrouterine ligaments

vesicoummbilical fascia
in between bilateral vesicoumbilical ligaments from bladder to umbilicus

perineum membrane
semicircular from symphysis and arcuate ligament in between both ischiopubic rami of
pubis bones up (in)to perineal body and transversus perinei muscles with small opening
for the urethra and wide opening for the vagina
this membrane separates the deep perineal space, between the membrane and levator
ani muscle fascia, from the superficial perineal space, between the membrane and the
subcutaneous fascia
perineal body = centrum tendineum perinei
wedge-like connective tissue structure in between the vagina and the anus; into which
the perineum membrane, bulbospongiosus muscles and transversus perinei muscles
radiate; as centrum tendineum perinei
it stabilizes the (anterior) anus in its anatomic position since it is firmly attached to the
external sphincter ani muscle

medial vesicoumbilical ligament
obliterated urachus
from median bladder to umbilicus
restricting the upward movement of the bladder

(bi)lateral vesicoumbilical ligaments
obliterated umbilical arteries
from bilateral internal iliac artery to umbilicus
restricting the upward and sideward movement of the bladder

pubovesical ligaments = pubovesical muscles
condensation of pubocervical musculofascia as attachment to pubis bone
stabilizing the posterior bladder neck

posterior pubourethral ligaments = pubourethral muscles
condensation of pubocervical musculofascia as attachment to pubis bone body
stabilizing the posterior proximal/mid urethra wall

anterior and intermediate pubourethral ligaments
condensation of perineum outlet diaphragm
anchoring distal urethra and external urethra opening

broad ligament = parametrium from lateral uterus to pelvis wall comprising

round ligament (muscle)
smooth muscle structure from anterolateral uterus horn thru inguinal canal and radiating
into labium majus and mons pubis
stabilizing uterus in anteflexion/version

infundibulopelvic ligaments = suspensory ligament of ovary
from ovary to pelvis wall
suspends ovary

ligamentum ovarii proprium = proper ovary ligament
from ovary to lateral uterus
connects ovary to uterus

cardinal ligaments
from ilium/ischium bones to (bi)lateral cervix in a frontal plane cephalad to the ischium
spines
suspending/connecting the cervix and endopelvic diaphragm bilaterally to the pelvis wall

sacrouterine ligaments = rectouterinus muscles
from cervix to rectum and sacrum
attached to (ischio)coccygeus fascia and piriformis fascia via fascia sheath
pelvis organs

the organs with their arterial blood supply, venous drainage, lymphatic drainage and innervation are embedded into and connected to the pelvis wall and each other by the corpus intrapelvinum as part of the tela urogenitalis
in contrast with the intraperitoneal organs which have a single posterior vascular supply and innervation, the pelvis organs have a bilateral vascular supply and innervation whilst the rectum has even a single dorsal combined with bilateral vascular supply and innervation

ureter

though the ureter is completely embedded into the tela urogenitalis it can be divided into a proximal retroperitoneal abdominal part and a distal subperitoneal pelvic part
suspended/connected to lateral pelvis wall by parametrium and paracystium as part of tela urogenitalis
blood supply
small vessels from all arteries it crosses
innervation
by autonomic nervous system

bladder = vesica = cystis

suspended/connected anteriorly onto the abdominal wall by the medial and lateral vesicoumbilical ligaments and to the symphysis by loose connective tissue and thin fluid film and by the pubovesical ligaments and to the lateral pelvis wall by the paracystium; all as part of the tela urogenitalis
blood supply
upper part: usually by 2 or 3 superior vesical arteries from upper part of umbilical artery
lower part/neck: by inferior vesical artery and neck also by vaginal arteries
innervation
many nerve fibers from vesical (and prostatic) plexus as forward extension of inferior hypogastric plexuses from autonomic nervous system

female urethra

suspended/connected to the symphysis by loose connective tissue and thin fluid film and by the pubourethral ligaments as part of the endopelvic diaphragm and distally anchored into perineum outlet diaphragm
blood supply
upper part: inferior vesical artery
middle part: inferior vesical artery and uterine artery
lower part: internal pudendal artery
innervation
upper part: vesical and uterovaginal plexuses of autonomic nervous system
lower part: pudendal nerve

uterus = metra, tubes and ovaries

though they are situated intraperitoneally they belong to the pelvis organs
they are suspended/connected to the lateral pelvis wall by the parametrium as part of the tela urogenitalis
blood supply
uterine artery
innervation
autonomic sympathetic and parasympathetic system
cervix = centrum tendineum intrapelvinum
entering thru the apical pubocervical musculofascia and proximal anterior vagina wall; stabilized in its anatomic position by the endopelvic diaphragm and cardinal ligaments; it is also the centrum tendineum intrapelvinum
blood supply
branches of uterine artery
innervation
autonomic sympathetic and parasympathetic system

vagina = colpos
suspended/connected to the (bi)lateral pelvis walls by the paracolpium as part of the tela urogenitalis and distally anchored into perineum outlet diaphragm
the anterior vagina wall is loosely adherent to pubocervical musculofascia/endopelvic diaphragm and as such indirectly fixed to the pelvis wall
the posterior vagina wall is adherent to prerectal fascia and perineal body and as such indirectly fixed to the pelvis wall
blood supply
upper part: branches of uterine artery
vaginal artery as 2 or 3 branches from internal iliac artery may anastomose in median plane to form longitudinal trunks as anterior and posterior azygos arteries of vagina
lower part: branches from artery of bulb of vestibule
innervation
by uterovaginal plexus of autonomic nervous system except for its lowermost part by pudendal nerve
therefore there is little sensitivity except for its lowermost part

rectum = proctos
is adherent to the sacrum and rests upon the levator ani plate, anococcygeal ligament, and coccyx and connected (bi)laterally to the pelvis wall by the paraproctium as part of the tela urogenitalis
reflection of peritoneum at anterior rectum at 5-6 cm from anus; distal part of rectum not covered by peritoneum
blood supply
most important unpaired superior rectal artery as continuation of inferior mesenteric artery
then paired middle rectal artery, inferior rectal artery and median sacral artery
extensive anastomosis between the arteries; so if inferior mesenteric artery ligated, the middle and inferior rectal artery can supply the entire rectum
innervation
autonomous sympathetic and parasympathetic system: from pelvic plexus and from mesenteric plexus

anorectum with sphincter ani complex
the anorectum is fixed in its position by anococcygeal ligament, levator plate, pubococcygeus muscles, puborectalis muscles, perineal body (centrum tendineum perinei), bulbospongiosus muscles and transversus perinei muscles; and it is anchored into the perineum outlet diaphragm
blood supply
unpaired superior hemorrhoidal artery = superior rectal artery (from inferior mesenteric artery) and paired middle hemorrhoidal artery = middle rectal artery and paired inferior hemorrhoidal artery = inferior rectal artery (both from internal pudendal artery)
innervation
inferior rectal nerve from pudendal nerve also for external sphincter whilst
the internal sphincter is under autonomic parasympathetic and sympathetic control

pudendal organs

introitus or vulva or vestibule

labia majora/minora
blood supply
anterior labial branches from external pudendal artery and posterior labial branches
from internal pudendal artery
innervation
anterior labial nerve (ilioinguinal nerve) and posterior labial nerve from pudendal nerve

clitoris
blood supply
clitoridial artery from internal pudendal artery
innervation
pudendal nerve and ilioinguinal nerve

pelvis blood supply

internal iliac (hypogastric) artery
from common iliac artery
supplies most of the pelvis

internal pudendal artery
from internal iliac artery
inferior rectal artery
posterior scrotal (labial) branches
perineal artery
artery of penis bulb
artery of bulb of vestibule
urethral artery
deep artery of penis or clitoris
dorsal artery of penis or clitoris

visceral branches from internal iliac artery
umbilical artery
superior vesical artery
ductus deferens artery homologous to uterine artery
inferior vesical artery

uterine artery
from internal iliac artery

vaginal artery
from internal iliac artery; sometimes in combination with uterine artery
superior rectal artery; unpaired
as continuation of inferior mesenteric artery: most important

middle rectal artery
either directly from internal iliac artery or from beginning of pudendal artery
with collaterals to

inferior rectal artery
from internal pudendal artery

pelvis nerves

nerve supply = innervation
from the sacral and coccygeal spinal nerves and from the pelvic part of the autonomic nervous system from sympathetic trunk and aortic plexus

sacral plexus (L4 to S5)
12 named branches:
7 distributed to the buttock and lower limb:
superior gluteal nerve (L5 to S1)
inferior gluteal nerve (L5 to S2)
nerve to quadratus femoris muscle (L4 to S1)
nerve to obturator internus muscle (L5 to S2)
posterior femoral cutaneous nerve (S1 to S3)
perforating cutaneous (inferior medial clunial) nerve (S2, S3)

sciatic nerve (L4 to S3), largest nerve in the body, leaves pelvis thru greater sciatic foramen below the piriformis muscle; the two parts may leave separately, peroneal portion pierces the piriformis or even above piriformis and the tibial portion passes below it and the two parts remain separate throughout their course
5 distributed to the pelvis
nerve to piriformis muscle (S1, S2)
nerves to levator ani and coccygeus muscle (S3, S4)
nerve to externus sphincter ani muscle (perineal branch of S4)
pelvic splanchnic nerves (S (2), 3, 4, (5))

and

pudendal nerve (S2, 3, 4)
exits pelvis thru greater sciatic foramen below piriformis muscle, crosses the back of the ischium spine, re-enters pelvis thru lesser sciatic foramen into ischorectal fossa, gives of inferior rectal nerve for sphincter ani externus muscle and skin around anus and anus mucosa up to pectinate line, enters/exits pudendal canal and gives of perineal nerve for the perineum outlet diaphragm and ends as dorsal penis/clitoris nerve

some important facts

upright position
the anterior superior iliac spines and pubis bone tubercles are in the same frontal plane in the upright position

the promontory, ischium spines, cervix, ischium tuberosities and perineal body are in the same frontal plane in the upright position
axis symphysis pubis
30-45° as to horizontal/ground from caudad=inferior to cephalad=superior in upright position; 5-6 cm broad

axis endopelvic diaphragm/pubocervical musculofascia
25-30° as to horizontal/ground from symphysis to sacrum in upright position

angle between arcus tendineus fasciae and symphysis
this is in the range of 110-125°

discussion

though this is a condensate from the existing textbooks the author added some things and phrased some things in a different way

the author uses the term obturato coccygeus muscle instead of iliococcygeus muscle since the muscle originates from/inserts into the obturator internus fascia via the atlam and not from/into the ilium bone in human beings; though in animals it does

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arcus tendineus levator ani muscle
atlam

arcus tendineus fasciae
atf

atf + atlam

origin pubococcygeus muscle
as part of levator ani

origin obturatococcygeus muscle
as part of levator ani

origin coccygeus muscle
introduction

The functional anatomy of the pelvis structures is a highly complicated interaction of the different pelvis organs as the distal outlet end parts of the urinary tract, the genital tract and the digestive tract; normally in a continent way.

The different organs with their arterial blood supply, venous drainage, lymphatic drainage and innervation are embedded into and protected by and encapsulated and/or ensheathed by a complex connective tissue body as corpus intrapelvinum as part of the tela urogenitalis.

The most difficult part to understand is the function of the corpus intrapelvinum which consists of a cohesive mixture of collagen, elastin and smooth muscle tissue in a loose, dense or condensed form depending upon the function needed under physiologic and pathologic stress.

Collagen for strength, elastin for passive elasticity and plasticity and smooth muscle for active tonus and relaxation all under autonomic innervation; see next chapter.

However, how hard the author studied he failed to comprehend the various theories since there was a discrepancy between what he found during his extensive obstetric trauma reconstructive surgery and all these theories.

The human anatomy does not change, except for under evolutionary impulses; but it seems another concept is needed for a comprehensive understanding.

Though it is based on existing anatomic textbooks, the following constitutes a personal interpretation by the author as a reconstructive surgeon.

function

This whole complex must take care of and is responsible for a more or less independent (and if needed combined) simultaneous functioning of the different organs and tracts from each other like:

- Rapid filling/storage of urine with rapid increase in bladder size and
- Urine continence until
- Voluntary micturition with instantaneous decrease in bladder size.
rapid filling/storage of liquid_solid stools/gas with rapid increase in rectum size and stool/flatus continence until voluntary defecation with instantaneous decrease in rectum size sexual intercourse with rapid increase/decrease in vagina size and shearing excretion of menstruation fluid coping with hormonal changes and ageing changes during the various periods of life slow increase in uterus size during pregnancy till enormous proportion and pregnancy continence and coping with hormonal flooding during pregnancy as slow preparation for : childbirth with enormous widening/opening of cervix, vagina and outlet diaphragm remodeling after childbirth during the involution phase of the puerperium withstand intraabdominopelvic hydrostatic (especially pregnancy) pressure and intraabdominopelvic compression pressure stabilizing/securing the different organs in their variable anatomic position under all possible body positions and under all normal filling stages prevention of urogenital prolapse prevention of prolapse of intraperitoneal contents and distal digestive tract

functional pelvis anatomy
the abdominopelvic space can be considered as a confined space with hydrostatic and compression pressure
the abdominopelvic cavity can be divided into three functional spaces: the intraperitoneal space for the digestive tract enclosed by the parietal peritoneum the retroperitoneal space for large vessels, pancreas, kidneys etc enclosed by parietal peritoneum anteriorly and spine with trunk muscles posteriorly the subperitoneal space of pelvis for the distal outlet organs of the urinary tract and the digestive tract and for the whole genital tract including its in- and outlet
true pelvis space

true pelvis cavity
a confined space for the distal outlet organs of the urinary tract anteriorly, the genital tract in the middle and the digestive tract posteriorly with hydrostatic and compression pressure; normally in a continent way and

enclosed by
  parietal pelvis fascia covering pelvis wall/floor muscles 
and
  parietal peritoneum as boundary of intraperitoneal cavity 
as connected to each other by
  tela urogenitalis/subserosa with corpus intrapelvinum and endopelvic diaphragm

divided into
  anterior pre_subperitoneal compartment
for the distal end parts of the urinary tract: pelvic ureters, bladder and urethra

  median subperitoneal compartment
for the (also distal end parts of) genital tract: uterus, adnexa, cervix and vagina

  posterior retro_subperitoneal compartment
for the distal end parts of the digestive tract: rectum, anorectum and sphincter ani

pelvis organs

in contrast with the intraperitoneal organs which have a single dorsal vascular supply and innervation, the pelvis organs have a bilateral blood supply and innervation whilst the rectum has a single dorsal blood supply and innervation combined with a bilateral blood supply and innervation

these organs belong to the pelvis cavity contents, are embedded into the connective tissue body of pelvis and do not belong to the pelvis floor which is just the pelvis wall and as such should not be addressed as being the same

corpus intrapelvinum as dynamic matrix

connective tissue organ of pelvis consists of a cohesive mixture of collagen for strength, elastin for passive elasticity and plasticity and mostly smooth muscle fibers for dynamic active non-fatigue tonus in a loose, dense or condensed form as a dynamic matrix into which the organs and their supply are embedded and suspended/connected to the pelvis wall and each other by highly specialized structures protecting the organs and their supply against trauma and stabilizing/securing them in their variable anatomic position
as coordinated by the autonomic nervous system
considered to be a fluidum since no sharp demarcation between the archaic matrix and its specialized structures
endopelvic diaphragm

highly specialized structure of corpus intrapelvinum from pubis bone bodies anteriorly to sacrum posteriorly as connected to its bilateral arcus tendineus fasciae with cervix as centrum tendineum intrapelvinum since all musculofascia structures are connected firmly to it and it is anchored within the endopelvic diaphragm as first line of counteracting intraabdominal hydrostatic pressure and supporting the pelvis organs with their supply and continence mechanisms in their anatomic position and preventing herniation of the distal urinary tract, genital tract, intraperitoneal contents and distal digestive tract into the zero-pressure vagina

defects within the endopelvic diaphragm are responsible for incontinence and pelvis organ prolapse

pelvis floor as one functional unit as part of abdominopelvic wall

superior upper layer
levator ani muscles as “pelvis diaphragm”; on its own this cannot be considered as a real diaphragm since there is a large anterior median gap of 7-8 x3.5-4 cm; this means that out of the total of 75-80 sq cm of the pelvis outlet some 25-30 sq cm are missing or roughly one third however, they are important since the vagina and rectum are indirectly connected to its fascia; as suspension/connection to the pelvis wall they play a direct role in the stool continence mechanism to which they are anatomically connected and only an indirect role in the urine continence mechanism to which they are not connected anatomically they support the perineum outlet diaphragm since there is a firm connection between the two in the region of the perineal body, anus with external sphincter ani muscle, levator plate, (ischio)coccygeus muscles and sacrospinous and anococcygeal ligaments

inferior lower layer
perineum outlet diaphragm into which the end outlet organs with their striated sphincter mechanisms are anchored and supporting directly and the urine and stool continence mechanisms; it includes levator plate/(ischio)coccygeus muscles this constitutes a real diaphragm between the abdominopelvic cavity and the outside as final barrier together with the end organs it forms part of the anatomic continence mechanisms of the urinary tract, the genital tract and the digestive tract since the final outlet organs are firmly anchored into it, first these can only prolapse to the outside by a kind of intussusception and second, contraction of the muscles and increase in its tonus during pelvis floor muscle exercises will contribute directly and positively to the continence mechanisms in quadrupeds the pelvis floor into which the distal outlets organs are anchored has the function of an abdominal side wall whilst the ventral anterior abdominal wall is the floor; by becoming bipeds this was rotated 90° backwards so the pelvis floor is part of the abdominopelvic wall, just as the anterior abdominal wall, nothing more and nothing less

defects within the pelvis floor are not the cause but the sequel of incontinence and pelvis organ prolapse
no role of **anterior vagina wall** as “hammock”

the anterior vagina wall cannot contribute to withstand intraabdominal pressure or to secure the pelvis organs in their variable anatomic position since the whole vagina (wall + its visceral fascia) is extremely distensible and as such lacks the stiffness characteristics required; as such it also cannot support the anatomic urine continence mechanism

it is hanging onto the endopelvic diaphragm in the upright position; and as such it is “dragging” this diaphragm down and cannot support this diaphragm to support the anatomic urine continence mechanism

normally there is no intravaginal filling content and as such the vagina is a low- or zero-pressure organ

therefore the vagina cannot prolapse into the other high(er)-pressure organs or cavities whilst the other organs can easily herniate into the zero-pressure vagina once there are defects within the musculofascia structures of the endopelvic diaphragm of the corpus intrapelvinum in between these organs and the vagina

the support to the posterior urethra is not by the anterior vagina wall like a hammock with 2-point fixation which would allow rather large forward and backward swing movements of the posterior urethra wall but

the support is by the endopelvic diaphragm with circumferential fixation like the skin of a drum or a trampoline allowing slight upward and downward movements depending upon the tonus and relaxation of the smooth muscle fibers of this diaphragm by reflex action as coordinated by the autonomic nervous system

**discussion**

there is an enormous amount of research done mostly based on postmortem dissection and indirect imaging; however, the author failed to understand the functional anatomy as described and the resulting theories could not be confirmed by him in the living patient

the author gives a very personal interpretation of the functional anatomy as based on findings and evidence-based results during and following his extensive obstetric trauma reconstructive surgery; this does not mean he is right since it is the view of a surgeon and not of an anatomist; but definitely **another concept is needed**

though the author was probably one of the first already in 1987 to use and then in 1994 to describe the function of the anterior vagina wall as a hanging mat (= hammock with 2-point bilateral fixation) this is not correct since the intact endopelvic diaphragm (with overall circumferential fixation onto the pelvis walls like the skin of a drum or trampoline) is securing the posterior urethra/uv-junction/bladder neck in their anatomic position allowing only slight cephalad/caudad movement

a hammock would allow far greater mobility of the (posterior) urethra especially from anterior to posterior with traction in the longitudinal urethra axis

the notion that the levator ani muscles are of paramount importance for the female urine continence mechanism and for (the prevention of) prolapse cannot be confirmed by the author; please look at the functional anatomic configuration
there is nowhere direct contact between the midline urethra/uv-junction/bladder neck (anatomic continence mechanism) and the lateral levator ani muscles

the urethra lies anteriorly at the midline against the symphysis and the nearest point the levator ani muscles come to the urethra is bilaterally 1.5-2 cm away at the most anterior part of the arcus tendineus of levator ani muscles (atlam); then the atlam runs immediately laterally and posteriorly to the ischium spine farther away from the midline and urethra; so contraction cannot have a direct effect upon the urethra

the only thing possible is that by contraction with compression of lateral/posterior vagina walls the anterior vagina wall with attached endopelvic diaphragm moves cephalad/ anteriorly bringing the posterior urethra wall nearer to the anterior urethra wall with an increase in outflow resistance and stronger intrinsic closing forces

the notion that the intact levator ani muscles prevent prolapse cannot be confirmed; to the author it looks far-fetched since there is nowhere direct contact between the pelvis organs and the pelvis floor/wall muscles

consider the tube-like configuration of the pelvis space and all the different intrapelvic structures between the pelvis floor (muscle fascia) and parietal peritoneum;

by what mechanism would the action of the levator ani muscles contribute and how can the pelvis floor structures as abdominopelvic wall prevent internal prolapse of pelvis organs

pelvis organ prolapse is herniation of the high-pressure organs thru defects within the endopelvic diaphragm into the zero-pressure vagina so that the urethra, bladder, cervix, intraperitoneal contents and rectum are no longer supported and start to descend

if there is pelvis organ prolapse, these slide unopposed “over” the levator ani muscles and other pelvis floor structures thru the vagina towards the outside

this process cannot be prevented or stopped by the levator ani muscles or other pelvis floor structures, either relaxed or contracted

based upon personal clinical and surgical research in the obstetric trauma the following proved to be something the author could understand

the pubocervical musculofascia/endopelvic diaphragm is separating the high pressure organs from the zero-pressure vagina and does not belong to the pelvis floor

the pubocervical musculofascia/endopelvic diaphragm plays an important role in stabilizing the pelvis organs in their position supporting the female continence mechanisms

transverse, quartercircular as combined with lateral, semicircular combined with lateral and longitudinal defects of the endopelvic diaphragm are found in the obstetric fistula; by repairing all these defects meticulously either first at repair or later at post repair incontinence surgery the continence was restored

median defects in the endopelvic diaphragm play an important role in the pathophysiology of genuine intrinsic stress incontinence: lateral defects were not found since the musculofascia fibers retract bilaterally towards the atf; by meticulous repair of these defects full continence was restored in over 98% of the patients
median defects in the endopelvic diaphragm play an important role in the pathophysiology of pelvis organ prolapse like cystocele and uterus/cervix prolapse; lateral defects are not involved since the musculofascia fibers retract bilaterally towards the atf

in both genuine incontinence and pelvis organ prolapse a predisposing factor is a wide pelvis with wide pubic arch since the span between the ischium spines is so wide that median defects within the endopelvic diaphragm may develop

the female urine and stool continence mechanisms will be presented in separate chapters

levator ani muscles

the levator ani muscles is one muscle originating from/inserting into pubis bone and obturator muscle fascia inserting into/originating from coccyx, levator plate/anococcygeal ligament and deep sphincter ani muscle

in reading the textbooks and articles it is stated that muscle fibers of the levator ani muscles and other pelvis floor muscles leave the main muscle and interfere with each other

though anatomically that may be correct, surgically speaking the author never found levator ani muscle fibers crossing the anterior anorectum/rectum or fibers crossing the posterior urethra

and since it is a striated muscle within a fascia the author thinks it strange that separate fibers can leave the muscle, pierce thru the fascia and then cross the midline underneath the urethra or cross the midline in front of the anus and unite

though there may be some connective tissue between the lateral vagina wall and the levator ani muscles, the notion that there is a pubovisceral muscle inserting into the urethra and vagina wall seems far-fetched or is this wishful thinking

attributing paramount functions to a structure that can only function as a wall/floor

due to its circumferential fixation the only thing it can do by contracting is to elevate the perineum outlet diaphragm with sphincter ani as pelvis floor with indirect pushing up/elevating the endopelvic diaphragm and so contributing to a better configuration of the urine continence mechanism in the female by bringing the mobile posterior urethra wall nearer to the immobile “fixed” anterior urethra wall

so the author fails to understand how the levator ani muscles can play a major role in prevention/development of pelvis organ prolapse and urine intrinsic incontinence
another concept as conclusion

the connective tissue body of pelvis as a whole
is responsible for
smooth functioning of the pelvis organs
embedding/protecting the organs with their supply
connecting the organs to the pelvis wall and each other

whilst

the endopelvic diaphragm
is responsible for
stabilizing/securing the pelvis organs
in their variable anatomic position
supporting the continence mechanisms

the pelvis floor structures as a wall are secondary
nothing more and nothing less
pelvis anatomy
introduction

the whole complex of intrapelvic connective tissue is called the corpus intrapelvinum or connective tissue body of pelvis; as matrix for the organs with their arterial blood supply, venous drainage, lymphatic drainage and innervation

it is also called endopelvic fascia or fascia endopelvina (conjugans), however, its main component consists of smooth muscle tissue/fibers; so the term fascia is misleading

though its basic anatomic structure and functions are easy to understand it is difficult to comprehend and visualize its exact anatomic extent with highly specialized functions according to the different physiologic needs

especially since there are no clear demarcations which make it difficult to demonstrate this body/organ with different structures by dissection and/or indirect imaging

however, it is only by studying its full anatomic extent and understanding its functions that progress will be made in reconstructive pelvis surgery

since weakness and defects in this important corpus intrapelvinum are responsible for the development of genuine intrinsic incontinence, urogenital prolapse, enterocele and rectocele

the amount of literature is enormous with confusing and contradicting terminology and various complicated theories

however, the anatomy and functional anatomy do not change and the author would like to give an outline as based on existing anatomic textbooks, especially

lehrbuch der topographischen anatomie as written by anton hafferl as second edition from 1957

by analyzing the topographic position in relation to the urinary and genital tract the paramount role of the levator ani muscles in these theories seems to be overvalued and highly questionable

the author thinks another concept is needed with regard to the functional anatomic urine (in)continence mechanism and pelvis organ anatomic position and prolapse

therefore he would like to introduce the concept of the endopelvic diaphragm as part of the corpus intrapelvinum as first line for counteracting the intraabdominal hydrostatic and compression pressure, as support of the urine continence mechanism and for securing the pelvis organs in their variable anatomic position; see next chapter
basics of serous membranes

the body cavities are enclosed by bones and muscles covering the bone and muscles bridging the gaps in between the bones

the **fascia interna** is the total fascia inner lining of the cavity

the **serosa** (peritoneum, pleura) is connected to this fascia by

the **tela subserosa**

depending upon the width in between the fascia and the serosa the tela subserosa may develop from minimal with its basic loose archaic texture to extensive with a cohesive mixture of collagen, elastin and smooth muscle tissue as connective tissue body/organ in a loose, dense or condensed form

the intracavity organs are embedded into the tela subserosa together with their blood supply, venous drainage, lymphatic drainage and innervation; whilst the tela subserosa also connects/suspends the organs to the cavity wall and each other

abdominopelvic cavity

the total fascia inner lining of the abdominopelvic cavity is called fascia abdominis interna; the serosa is called parietal peritoneum; the connective-tissue layer connecting the fascia abdominis interna to the parietal peritoneum is called the tela subserosa

the width between the internal fascia and peritoneum is small at the upper anterior abdominal wall from the umbilicus upwards and at the thoracoabdominal diaphragm and the fascia interna may “fuse” with the parietal peritoneum

however, the distance between the parietal peritoneum and posterior abdominal wall, anterior lower abdominal wall and pelvis wall becomes wider and wider resulting into extensive development of the tela subserosa as tela urogenitalis

pelvis cavity

the total fascia inner lining of the pelvis cavity is part of the fascia abdominis interna; and here it is called

the **fascia pelvis parietalis**

the **serosa** is called peritoneum parietale

the **tela urogenitalis** is that part of the tela subserosa which is filling up the large gap between the fascia pelvis parietalis and peritoneum parietale

the intrapelvic organs are embedded into the tela urogenitalis together with their arterial blood supply, venous drainage, lymphatic drainage and innervation; whilst the tela urogenitalis also connects/suspends the organs to the pelvis wall and each other
from the tela subserosa urogenitalis 3 structures develop

fascia visceralis
encapsulating the organs and ensheathing the blood/lymphatic vessels and nerves

corpus intrapelvinum
cohesive mixture of collagen, elastin and smooth muscle tissue/fibers in a loose, dense or condensed form; its main component is dynamic smooth muscle tissue/fibers

loose connective tissue
filling up the spaces not occupied by the corpus intrapelvinum

fascia visceralis
as part of the tela urogenitalis which encapsulates the organs and then is named after the organ like fascia visceralis vesicae = visceral bladder fascia; and which as well ensheaths the blood and lymphatic vessels and the nerves

the space in between the fascia visceralis and the organ wall is filled up by loose connective tissue allowing the organs like the bladder to expand and deflate rapidly by filling and emptying within a short time span

when the organ does not expand and deflate rapidly like the uterus which grows slowly during pregnancy the fascia visceralis “fuses” with the organ wall and grows slowly together with the uterus; after emptying by childbirth it involutes slowly together with the uterus during the puerperium

corpus intrapelvinum = connective tissue organ of pelvis
as part of the tela urogenitalis; it constitutes a multifunctional connective tissue organ/body and consists of a cohesive mixture of collagen, elastin and smooth muscle tissue fibers in loose, dense or condensed form according to whatever is needed

collagen for strength, elastin for passive elasticity and plasticity and smooth muscle fibers for active dynamic tonus and relaxation under autonomic nervous system coordination

the smooth muscle component is the main component; even if some parts of it are called fascia or ligament it is still prevalent

its extensive 3-dimensional mesh-like structure ensures a seamless combination of static and dynamic functions

as a whole together with components of the organ walls as embedded into it, the corpus intrapelvinum is the major force in resisting hydrostatic and compression intraabdominal pressure due to its non-fatigue tonus which can be increased by reflex action and as such contributes to compression pressure

the pelvis floor with its large hernia-prone openings is secondary in taking care of the rest pressure

it also protects the organs with their supply from physiologic trauma during walking, sexual intercourse and childbirth
the specialized parts of it are called fasciae, septa, ligaments, plicae which all together form the corpus intrapelvinum each with a specialized function for the organs with their supply and then combined for the whole biomechanicophysiology of the pelvis cavity

it has to be considered as one multifunctional organ where the basic archaic texture has developed into individual specialized structures according to the physiologic needs

the space between one organ and another or between an organ and the adjacent cavity wall is called a spatium filled up by connective tissue in a condensed form as septum/fascia or in a loose form or in a loose form with a thin fluid film

it embeds the organs and their arterial blood supply, venous drainage, lymphatic drainage and innervation; and stabilizes and secures the organs in their variable anatomic position depending upon the degree of filling of the organ itself or filling of the adjacent organ(s); in whatever body position

it suspends/connects the intrapelvic organs to the pelvis wall with so called pillars for arterial blood supply, venous drainage, lymphatic drainage and innervation

it is responsible for the blood flow inside the valve less intrapelvic veins towards the vena cava inferior

it allows the organs to expand rapidly by filling and deflate rapidly by emptying

it allows the organs to move smoothly and independently from or simultaneously with each other

depending upon the physiologic needs it condenses to dense fascia plates or septa in between the organs and ligaments from the organs to the (bi)lateral pelvis wall and also loose structures like plicae; since the ligaments are smooth muscle tissue they are called muscles as well

though it is one continuous 3-dimensional mesh-like body/organ it is subdivided into overlapping para-structures

paracystium
that part of corpus intrapelvinum into which the bladder is embedded with condensation as bladder pillar at posterior bladder base cephalad to the ischium spine containing the blood and lymphatic vessels and nerves, and the pelvic ureter; connecting/suspending the bladder to the pelvis wall

parametrium
that part of corpus intrapelvinum which embeds the uterus/cervix, tubes and ovaries with condensation as uterovaginal pillar at uterus isthmus in the frontal plane thru and cephalad to the ischium spine containing the blood and lymphatic vessels and nerves and the pelvic ureter; connecting/suspending these organs to the pelvis wall

paracolpium
that part of corpus intrapelvinum which embeds the vagina with condensation as uterovaginal pillar in the frontal plane thru and cephalad to the ischium spine containing the blood and lymphatic vessels and nerves; connecting/suspending the vagina to the pelvis wall
paraproctium
that part of corpus intrapelvinum which embeds the rectum with condensation as rectum pillar in the region of the ischium spine containing the blood and lymphatic vessels and nerves; connecting/suspending the rectum to the pelvis wall

and into the condensed parts in between the organs like septum; these are not separate parts but fit into the corpus intrapelvinum as part of the fascia between the organs like pubocervical musculofascia

septum vesicocervicale
in between posterior bladder and anterior cervix as vesicocervical fascia

septum vesicovaginale
in between posterior bladder and anterior vagina wall as pubocervical musculofascia

septum rectovaginale
in between anterior rectum and posterior vagina wall and is fixed to centrum tendineum perinei (perineal body) as rectovaginal fascia

the space between the septa and the visceral fascia of the organs is filled up by loose connective tissue allowing friction free movement of the organ wall against the septum; ideally this is the layer or space of interest for surgeons in bloodless dissection

spatium prevesicale
between bladder and symphysis in continuity bilaterally with

spatium paravesicale
between bladder and (bi)lateral pelvis wall
all filled up by loose connective tissue and thin adhesive fluid film allowing the bladder wall to slide against the pelvis wall and anterior abdominal wall without coming loose

spatium vesicocervicale
between bladder and cervix

spatium vesicovaginale
between bladder and vagina

spatium rectovaginale
between vagina and rectum and up to and into perineal body

spatium pararectale
(bi)laterally between rectum and pelvis wall in connection with

spatium retrorectale
between rectum and sacrum continues cephalad into the spatium retroperitoneale

it reacts to hormones and reconfigures and strengthens under physiologic stress
and is subdivided into other specialized condensed structures for further stabilizing the organs and connecting them to the pelvis wall like

**arcus tendineus fasciae = atf**

as line of fusion bilaterally from posterior pubis bone body 0.5-1 cm from midline pubis symphysis to ischium spine; as anterolateral attachment of endopelvic or intrapelvic diaphragm to pelvis wall

it is connected to the obturator fascia and to the arcus tendineus of levator ani muscle via a narrow triangular fascia sheath

inclination of 115-120° as to horizontal from anterior to posterior in upright position

**pubocervical musculofascia = vesicovaginal musculofascia**

in between the posterior bladder wall and anterior vagina wall as part of the intrapelvic or endopelvic diaphragm; see special chapter

**arcus tendineus of rectovaginal fascia = atrf**

as line of fusion from the lateral side of perineal body over levator ani fascia to ischium spine and fuses with the posterior part of the arcus tendineus fasciae

**rectovaginal musculofascia = prerectal fascia**

in between the posterior vagina wall and anterior rectum wall and fixed anteriorly to the perineal body, (bi)laterally to arcus tendineus of the rectovaginal fascia and posteriorly to the cervix and the sacrouterine ligaments

**vesicoumbilical fascia**

in between bilateral vesicoumbilical ligaments from bladder to umbilicus

**medial vesicoumbilical ligament**

obliterated urachus

from median bladder to umbilicus

restricting the upward movement of the bladder

**(bi)lateral vesicoumbilical ligaments**

obliterated umbilical arteries

from bilateral internal iliac artery to umbilicus

restricting the upward and sideward movement of the bladder

**pubovesical ligaments = pubovesical muscles**

condensation of pubocervical fascia

stabilizing the posterior bladder neck

**posterior pubourethral ligaments = pubourethral muscles**

condensation of pubocervical musculofascia as anterior attachment to pubis bones

stabilizing the posterior proximal/mid urethra wall

**broad ligament = parametrium** from lateral uterus to pelvis wall comprising

**round ligament (muscle)**

smooth muscle structure from anterolateral uterus horn thru inguinal canal and radiating into labium majus and mons pubis

stabilizing uterus in anteflexion/version
infundibulopelvic ligaments = suspensory ligament of ovary
from ovary to pelvis wall
suspends ovary

ligamentum ovarii proprium = proper ovary ligament
from ovary to lateral uterus
connects ovary to uterus

cardinal ligaments
from ilium/ischium bones to (bi)lateral cervix in a frontal plane cephalad to the ischium spines
suspending/connecting the cervix and endopelvic diaphragm bilaterally to the pelvis wall

sacrouterine ligaments = rectouterinus muscles
from cervix to rectum and sacrum
attached to (ischio)coccyeus fascia and piriformis fascia via fascia sheath

diaphragm
one highly specialized structure within the corpus intrapelvinum as a whole constitutes a
dynamic functional endopelvic diaphragm; see next chapter

loose connective tissue
as part of the tela urogenitalis in a loose archaic form filling up the spaces not occupied
by the corpus intrapelvinum; these spaces are of interest to the surgeon for a bloodless
dissection

this allows friction-free movement/sliding of the organ wall against the structures of the
 corpus intrapelvinum without becoming loose from each other

and together with a thin adhesive fluid film it allows the bladder wall to slide against the
anterior abdominal wall and anterior and lateral pelvis wall without becoming loose

and ensuring that the anterior urethra wall is always adherent to the posterior symphysis
and as such does not rotate; not even if the posterior urethra wall rotates backwards
away from the posterior symphysis due to defective connective tissue support and then
resulting into progressive funneling or vesicalization of the urethra starting proximally

innervation
like all other structures in the human body the corpus intrapelvinum is under control and
coordination by the autonomic nervous system; via a complicated reflex mechanism

the sympathetic system for stimulation by increasing the tonus of the smooth muscle
fibers and the parasympathetic system for relaxation of the smooth muscle fibers

since its main component is smooth muscle tissue/fibers the corpus intrapelvinum forms
a highly dynamic body/organ due to its non-fatigue tonus which can be increased or
relaxed immediately upon whatever is needed at a certain moment by reflex action
discussion

how to describe an important 3-dimensional mesh-like collagen, elastin and smooth muscle connective tissue organ without clear demarcations in its full anatomic extent and full dynamic multi-functionality

as based on findings during his obstetric trauma surgery and evidence based results it became clear that another concept was needed; as one major function of the corpus intrapelvinum

the problem is that since there are no clear demarcations between this body and the organs except for the visceral organ fascia and between the different structures of the corpus intrapelvinum it is difficult to demonstrate it as a whole and/or demonstrate its different structures by surgical dissection and/or indirect imaging

however, once one starts looking for this dynamic corpus and its different structures as a surgeon one will find it and its structures and then starts realizing its paramount importance for the functional pelvis anatomy

though the different structures have their own specific function their actual strength is that their function will be reinforced by the simultaneous function of the whole corpus intrapelvinum as one dynamic biomechanicophysiologic unit

embedding the organs and their arterial blood supply, venous drainage, lymphatic drainage and innervation and being

responsible for the independent physiologic functioning of the organs, for stabilizing/securing the organs in their variable anatomic position, for suspending/connecting the organs to the pelvis wall and to each other, for protecting the organs and their supply against physiologic trauma during walking, sexual intercourse and childbirth and for supporting the continence mechanisms of the urinary, genital and digestive tract

genuine intrinsic urine incontinence, urogenital prolapse like cystocele and uterus/cervix prolapse, intraperitoneal content prolapse like enteroccele and digestive prolapse like rectocele are all due to localized defects in the corpus pelvinum in isolated form or combined

though the author believes strongly in this concept, time and evidence-based results and challenges by other reconstructive surgeons will tell if he is right or wrong
endopelvic diaphragm

in the female

with cervix as its central point

introduction

the intrapelvic organ and organ support situation in the female differs radically from the situation in the male by the interposition of the large female genital tract in between the distal urinary tract anteriorly and the distal digestive tract posteriorly

all embedded into the corpus intrapelvinum of the tela urogenitalis, together with their vascular, lymphatic and nervous supply

though the situation of the superior layer of pelvis floor is more or less the same since the levator ani muscles are not affected; except for a wider pelvis

the perineum outlet diaphragm is severely weakened by the large vagina opening; so instead of two now a third and large opening has been pierced thru punched out

so the pelvis floor in the female is prone to dysfunctioning

there is increased hydrostatic intraabdominal pressure due to the weight of the female genital organs; especially during pregnancy

also the support of the anatomic female urine continence mechanism changed since in the male it is well supported by the prostate

as compensation in order to support the female bladder and urethra and the uterus and cervix and to withstand the intraabdominal pressure the corpus intrapelvinum formed a functional dynamic structure as the author would like to call the

endopelvic diaphragm

from the pubis bone bodies anteriorly to the sacrum posteriorly and circumferentially connected to the pelvis wall like the skin of a drum or trampoline with the cervix as its center; and fusing anteriorly with the perineum outlet diaphragm under an angle of 40-50°

in between the distal urinary tract, (proximal) genital tract, intraperitoneal contents and distal digestive tracts and the vagina

with a small opening anteriorly for the urethra and a larger one posteriorly for the rectum

since the cervix is firmly anchored into the central pierced thru punched out opening it becomes the centrum tendineum intrapelvinum as well; since all the (musculo)fascia structures are firmly anchored onto it
it consists of a mixture of connective tissue for strength, elastin for passive elasticity and plasticity and smooth muscle fibers for active dynamic non-fatigue tonus and relaxation under autonomic nervous innervation

it is the first line of counteracting the hydrostatic intraabdominal pressure and contributes to compression pressure by increase or decrease of its tonus; especially since its main component is smooth muscle fibers

whilst the rest pressure is dealt with by the pelvis floor structures, especially by the perineum outlet diaphragm

it supports the posterior urethra, uv-junction and bladder neck in their anatomic position and as such contributes to the anatomic urine continence mechanism

it prevents the posterior urethra, posterior bladder, cervix, intraperitoneal contents and anterior rectum from herniating into the vagina

it is divided into specialized parts as the pubovesical/posterior pubourethral ligaments, pubocervical musculofascia, arcus tendineus fasciae, cardinal and broad ligaments, rectovaginal fascia and sacrouterine ligaments with the cervix as centrum tendineum intrapelvinum since all its (musculo)fascia/ligament structures are firmly connected to it

**pubovesical/posterior pubourethral ligaments (= muscles)**

anchoring the most anterior part of the pubocervical musculofascia as part of the endopelvic diaphragm onto the pubis bone bodies and

securing the posterior proximal urethra, uv-junction and bladder neck in their anatomic position and so supporting the female urine continence mechanism

once they become defective intrinsic stress incontinence may develop

**pubocervical musculofascia**

like a triangle from the pubis bone body and bilateral atf to the cervix as the anterior part of the endopelvic diaphragm as part of the corpus intrapelvinum

this thick musculofascia is well developed and seems to consist of longitudinal smooth muscle fibers (from anterior towards posterior) and underneath the mid/distal urethra also transverse smooth muscle fibers (in between the median inferior surfaces of the pubis bones) interwoven by collagen and elastin

the longitudinal arrangement seems likely since longitudinal median defects are found intraoperatively at genuine incontinence, cystocele and cervix prolapse surgery

the anterior transverse arrangement seems likely since the median longitudinal defects stop at 1.5-2 cm to the external urethra opening

the intact pubocervical musculofascia secures and stabilizes the (posterior) bladder base/neck, uv-junction and urethra in their anatomic position and as such supports the female urine continence mechanism; it also stabilizes the cervix anteriorly and bilaterally

the intact pubocervical musculofascia prevents the pre/subperitoneal contents bladder base /uv-junction/urethra and the cervix from herniating into the vagina
the **axis** of the pubocervical musculofascia as to the horizontal/ground is 25-30° from symphysis to ischium spine in the upright position

the posterior wall of the urethra, uv-junction and the bladder trigonum are not expanding during the asymmetric filling of the bladder; therefore these structures are firmly fixed to the pubocervical musculofascia whilst

the anterior vagina wall is rapidly expanding and deflating with shearing during sexual intercourse and even more during childbirth and as such is loosely connected/fixed to the pubocervical musculofascia, except for in the region of the urethra where it is firmly fixed to it

**arcus tendineus fasciae = atf**
as bilateral fixation/insertion of the endopelvic diaphragm/pubocervical musculofascia whilst

the arcus tendineus fasciae is further connected to the lateral pelvis wall (arcus tendineus of levator ani muscle and oburator internus muscle fascia) via a narrow triangular fascia sheath

**cervix**
the cervix is considered to be the centrum tendineum intrapelvinum since all (musculo) fascia structures of the endopelvic diaphragm are firmly anchored onto it and the cervix itself is firmly anchored into the central pierced thru punched out opening within the endopelvic diaphragm

**cardinal ligaments and broad ligaments**
since their smooth muscle fibers radiate into the cervix they support the endopelvic diaphragm restricting its downward movement

**sacrouterine ligaments = rectouterinus muscles**
as posterior fixation of the endopelvic diaphragm onto the sacrum since they fix/connect the cervix posteriorly onto the rectum and sacrum

with lateral fixation to the pelvis wall, (coccygeus muscles, sacrospinous ligaments and priformis muscle) via fascia sheaths

they contract during childbirth keeping the cervix in its position by preventing upward movement

**(part of the) rectovaginal fascia**
In between the vagina and rectum and anchored onto the posterior cervix in between the sacrouterine ligaments as part of the endopelvic diaphragm

**weakest point in endopelvic diaphragm/pubocervical musculofascia**
considering the anterior cone-like triangular shape with the narrowest at the pubis bones and the broadest in between the ischium spines the weakest point is in the median at the anterior cervix

and the **broader the pelvis** (with broad span) the **more prone for median defects** and as such for stress incontinence, urethrocele, cystocele and cervix prolapse
mechanism of pathophysiologic action

the downward intraabdominal pressure upon the endopelvic diaphragm may lead to defects within this diaphragm

the downward pressure increases during the course of pregnancy with highest pressure at the median where the cervix is anchored into the endopelvic diaphragm

the broadest part of the endopelvic diaphragm is in between the ischium spines where it stabilizes and secures the cervix and

this is exactly where splitting/division of the longitudinal smooth muscle/collagen fibers at the median starts and then continues from proximally to distally

normally the most distal 1-2 cm stay intact since the short span is able to withstand the pressure and the smooth muscle/collagen fibers are also transverse (and longitudinal)

it is good to remember that during childbirth itself the pressure changes from downward caudad to upward cephalad and that semicircular compression and shearing occur at where the endopelvic diaphragm is attached to pubis bone and atf

so, other locations are possible as well

in prolonged obstructed labor pressure necrosis may develop and lead to anatomic tissue loss defects at any location within the endopelvic diaphragm

then there may be direct trauma (penetration, surgery) and trauma due to infection

defects within the endopelvic diaphragm

there are two types of defects viz defects without anatomic tissue loss like those due to intraabdominal pressure or shearing and defects with anatomic tissue loss varying from minimal to (sub)total loss like those due to pressure necrosis in prolonged obstructed labor or due to infection or due to surgery

defects without anatomic tissue loss

since it is the first line of withstanding intraabdominal hydrostatic pressure especially during pregnancy and also withstanding shearing forces during sexual intercourse and physiologic vaginal childbirth

it is clear that defects may develop weakening the endopelvic diaphragm in varying degrees from minor to extensive

it is good to realize that during pregnancy the direction of long-term pressure is from cephalad to caudad whilst during childbirth the short-term pressure is from caudad to cephalad upon this diaphragm

since it has multiple functions, like supporting the urine continence mechanism and securing the organs in their anatomic position, defects within the diaphragm will have different effects depending upon their location
the possibilities are as following: anterior, median, lateral, central and posterior; isolated or in any combination

**anterior defects**
with weakening of the urine continence support since the posterior urethra wall will “rotate backward” away from the symphysis causing vesicalization of the (proximal) urethra since fixed/adhesive anterior urethra wall by this mechanism genuine or postrepair intrinsic stress incontinence develops

**median longitudinal defects**
depending upon its location the posterior urethra, bladder base may herniate thru this defect into the zero-pressure vagina and eventually prolapse to the outside only if there is also concomitant weakening of the support or dorsal-directed pull on the posterior urethra wall towards the sacrum the urine continence mechanism may be involved

**central defect**
the cervix/uterus will herniate thru this defect into the vagina and then may prolapse unopposed to the outside thru the hernia-prone opening in the pelvis floor dragging the anterior vagina wall with it like intussusception only infrequently if there is concomitant weakening of the support or dorsal-directed pull on the posterior urethra wall towards the sacrum the urine continence mechanism may be involved normally there is full urine continence in total 3° uterus/cervix prolapse even with a urethra length of only 0.5-1 cm however, with increased longitudinal bladder diameter, shortened urethra and narrow external urethra opening

**posterior defect**
this will result in herniation of the intraperitoneal contents into the zero-pressure vagina

**lateral defects at atf**
this will result in loss of tonus of the intrapelvic urogenital diaphragm and an increase in the caudad/cephalad movements but not in herniation/prolapse of an organ thru this defect

**lateral defects of the fascia sheath in between the atf and atl am**
this will result in medial displacement of the atf with loss of tonus and hypermobility of the intrapelvic urogenital diaphragm but not in herniation/prolapse of an organ thru this defect

**other location**
due to penetrating trauma or forceps delivery or vacuum delivery

**defects with anatomic tissue loss**

it is good to realize that in any obstetric urine fistula there is anatomic tissue loss of the endopelvic diaphragm/pubocervical muscolofascia as well therefore in obstetric trauma surgery one should make an effort to identify the musculo fascia defects and repair them together with the fistula
the extent and location of pressure necrosis lesions in prolonged obstructed labor may be from minimal to extensive and from one location to the other in an endless variation which makes the obstetric trauma so intriguing

circular punched out defects
the same size as the fistula or (slightly) bigger than the fistula

transverse curved defects
bigger than the fistula whereby the fistula is somewhere within this defect

quartercircular defects
with partial or total anatomic loss of atf and atlam and possible partial loss of levator ani muscles, obturator muscles and obturator membrane
with fistula formation and possible opening of the paravesical spaces

semicircular defects
with partial or total anatomic tissue loss of atf and atlam; and with partial tissue loss of the levator ani muscles, obturator internus muscles and obturator membrane; eventually with bare bones
with fistula formation and opening of the paravesical spaces

(sub)total pubocervical musculofascia loss
regularly (sub)total fascia loss with extensive fistula formation and anterior vagina wall loss and total loss of atf and atlam and (partial/extensive) loss of levator ani muscles, obturator internus muscles and obturator membranes is found with bare bones in a so-called empty pelvis

(sub)total endopelvic diaphragm loss
from time to time (sub)total loss of the whole diaphragm may be found with extensive soft tissue loss resulting in extensive urine/stool fistulas as cloaca; for these unfortunate women nothing can be done

however, anatomic tissue loss may also be found

due to surgery whereby tissue is excised

or due to necrotizing infections like postmeasles noma vaginae

reconstructive surgery

it is important first to identify the real (extent of the) defect(s) and then reconstruct the functional anatomy meticulously using autologous structures so that normal physiology will be ensured whilst

special attention has to be given to check that all (musculo)fascia structures are firmly (re)connected to the cervix as the centrum tendineum intrapelvinum
the endopelvic diaphragm as part of the corpus intrapelvinum is an important dynamic structure

it constitutes a real diaphragm with the cervix as its center with a small anterior median opening for the urethra and a larger posterior median opening for the rectum

separating the distal urinary tract, proximal genital tract, intraperitoneal contents and distal digestive tract (rectum) from the zero-pressure vagina

counteracting as first line the hydrostatic intraabdominal pressure (rise) due to the non-fatigue dynamic tonus of its smooth muscle component either by increase or relaxation under autonomic nervous coordination; whilst the rest pressure is then dealt with by the pelvis floor structures

contributing to intraabdominal compression pressure by increase in its tonus as reflex action by the sympathetic nervous system

contributing to securing and stabilizing the pelvis organs in their variable anatomic position and as such

supporting the anatomic urine and genital continence mechanisms

defects in this diaphragm are rather common and may be due to (increased) hydrostatic pressure, shearing by vaginal childbirth, pressure necrosis during prolonged obstructed labor, penetrating trauma and necrotizing infection; as also influenced by hormonal and ageing processes

depending upon (the large variety of) the anatomic location and extent of these defects the following is possible

intrinsic stress incontinence, ?cervix incompetence?, urethrocele, vesicocele, uterus/cervix prolapse, enterocele and rectocele; either isolated or in combination

there is a clear correlation between genuine intrinsic urine incontinence, cystocele and cervix prolapse with a wide pubic arch of ≥ 90° as indication of wide pelvis

simply since the wider the pelvis the broader the span by the diaphragm and the more chance the longitudinal fibers will split/divide in the midline; with its weakest point just anteriorly from the cervix where the span is the widest

though lateral defects due to hydrostatic and/or shearing atf level and lateral defects in the narrow triangular fascia sheath between atf and atlam are possible this will not lead to herniation of the posterior bladder wall thru these defects into the vagina

at least the author has not encountered this as the cause of cystocele; the only time the author encountered a lateral defect with cystocele formation was in a patient who developed a fourth obstetric fistula after successful repair of three previous obstetric fistulas including an extensive type IIIBb
in quartercircular and semicircular defects (always combined with lateral defects) with anatomic tissue loss of the endopelvic diaphragm and with fistula formation ensuring an empty bladder, another mechanism comes into play according to the natural tissue forces; besides the fact that the urethra and bladder will retract in opposite directions which is the opposite of what one would expect
due to the balloon-like structure of the bladder with anterior bladder wall adherent/sticking to the posterior symphysis this will result in anterior and cephalad pull onto the posterior bladder (neck) wall whereby the loose endopelvic diaphragm is pulled as well and will re-attach onto the pubis bones and bilateral pelvis wall at a more anterior and cephalad level due to the natural tissue forces
actually, the saucer-like shape of the empty bladder in the normal anatomic situation is caused by the fact that the fixation of the posterior bladder wall onto the endopelvic diaphragm prevents the natural tissue forces from adapting the posterior bladder wall onto the anterior bladder wall
endopelvic diaphragm
smooth muscle
autonomic innervation

perineum outlet diaphragm = pelvis floor
striated muscle
somatic innervation
anterior longitudinal median trauma

anterior trauma atf/atlam loss

transverse trauma

transverse trauma atf/atlam loss

quartercircular trauma

semicircular trauma
female urine continence mechanism

introduction

the functional anatomy of the female urine continence mechanism consists of a rather complicated multi-interaction of static (bone, connective tissue) and dynamic structures (muscles; mucosa, submucous vascular plexus) and nervous innervation

the anatomic female urine mechanism comprises the bladder neck with both detrusor loops, the uv-junction and the whole urethra from internal to external opening over a total length of 4-5 cm with continence potential over its whole length as influenced by physiologic stress

there is an internal smooth muscle sphincter and an external striated muscle rhabdo sphincter with washer effect by the mucosa and submucous vascular plexus

the distal urethra and external opening are anchored into the pierced thru punched out opening in the perineum outlet diaphragm

here only a short comprehensive outline is given as a start/incentive to more extensive self-study

functional anatomy

anatomic urine continence mechanism

bladder
a balloon like organ for continent filling and storing of urine
the ureters, trigone and posterior urethra smooth muscles have the same origin and these structures are not as distensible as the rest of the bladder
uv-junction and stiff trigone as fixed point from which the bladder fills asymmetrically and towards which it contracts during micturition
adherent and sticking anteriorly to symphysis and (bi)laterally to pelvis wall by loose connective tissue and thin fluid film which allows friction-free upward/downward shifting/sliding of anterior and (bi)lateral bladder walls during filling and micturition
firmly adherent posteriorly to the pubocervical musculofascia as anterior part of the endopelvic diaphragm
this configuration is responsible for the saucer-like shape when the bladder is empty; otherwise the posterior and anterior bladder walls would be adapted due to the natural tissue forces
anteriorly it rests upon the symphysis and posteriorly upon the pubocervical musculo fascia as part of the endopelvic diaphragm; in the upright position

bladder neck
two detrusor loops
trigonal ring
urethra
length 3.5-4 cm
with proximal internal and distal external opening
shape and diameter
lumen
urethra mucosa
submucous vascular plexus
longitudinal smooth muscle fibers
circular/oblique smooth muscle fibers
as internal smooth muscle sphincter
horseshoe-shaped striated muscle fibers; slow-twitch and fast-twitch
as external striated “rhabdosphincter”; since posteriorly it is open and
the endings are inserting into the pubocervical musculofascia; so sphincter-like
elastin and connective tissue of urethra wall

anatomic/physiologic support

pubis symphysis
anterior bladder wall, anterior urethrovesical junction, anterior urethra are adherent/
 sticking to the posterior and caudad symphysis and rest upon it in the upright position

pubourethral ligaments: static and dynamic
anterior and intermediate
as condensations of perineum outlet diaphragm and stabilizing the distal/mid urethra
and external opening in anatomic position; since firmly anchored into this diaphragm
posterior
as condensations of the pubocervical musculofascia as anterior part of the endopelvic
diaphragm and stabilizing the proximal/mid urethra in anatomic position

pubocervical musculofascia as anterior part of dynamic endopelvic diaphragm
in between posterior bladder/urethra wall and anterior vagina wall and from pubis bone
and arcus tendineus fasciae and
from pubis bone bodies anteriorly to cervix posteriorly and as
anterior part of the endopelvic diaphragm in combination with cervix, broad/cardinal
ligaments and parametrium and sacrouterine ligaments
for stabilizing and securing the (posterior) urethra/bladder neck and cervix in their
anatomic position

perineum outlet diaphragm inferior layer of pelvis floor
the distal urethra with external urethra opening are anchored into the perineum outlet
diaphragm
as such these structures are stabilized and secured in their anatomic position and they
become part of this diaphragm whilst
contraction with increase in its tonus will support the external rhabdosphincter

no direct role of levator ani muscles superior layer of pelvis floor
but only indirect role since no anatomic contact whatsoever between midline continence
mechanism and lateral muscles
and anatomic continence mechanism cephalad to levator ani muscles
however, combined with the perineum outlet diaphragm together they form the
pelvis floor as one functional unit as abdominopelvic wall
since these two structures are firmly connected to each other via perineal body, external sphincter ani complex and levator plate/anococcygeal ligament and so supporting and reinforcing each other

no support by anterior vagina wall
very distensible and as such lacking the stiffness required; also loosely attached to and hanging on the endopelvic diaphragma “dragging” it down instead of pushing it up in the upright position; whilst the vagina is a zero-pressure organ since no filling content

intact innervation of these components

autonomic sympathetic and parasympathetic nervous system for longitudinal and circular/oblique smooth muscles; the sympathetic fibers for stimulation and continence against the parasympathetic fibers for relaxation and micturition; from hypogastric and pelvic plexus and from s2, s3, s4
the pudendal nerve innervating the external striated “sphincter” and the perineum outlet diaphragm; from s2, s3, s4

function of anatomic structures

the two detrusor loops keep the bladder neck contracted during the filling phase and prevent it from opening up

trigonal ring keeps the urethrovesical junction contracted and prevents the internal urethra opening/proximal urethra from opening up during the filling phase

urethra length is normally 3.5-4 cm; the critical length for continence seems to be 1-1.5 cm; if it is shorter continence may be compromised

urethra shape is tube like and probably circular over its whole length since the internal opening and the external opening are circular in shape

urethra diameter plays a role since the more narrow the stronger the natural centripetal forces closing the urethra; physical law of poiseuille

urethra mucosa with submucous vascular plexus is responsible for a water-tight closure; washer effect

longitudinal smooth muscle layer plays a role in micturition since by contraction of its fibers the urethra becomes shorter and wider; under autonomic nervous system control

circular/oblique smooth muscle layer as internal sphincter is responsible for keeping the urethra closed due to the non-fatigue tonus of its fibers; also under autonomic nervous system control

horseshoe-shaped striated muscle layer as external “rhabdosphincter” gives additional strength due to the tonus of its slow-twitch fibers and if needed by short-time contraction of its fast-twitch fibers; under pudendal nerve control voluntarily but also by reflex action upon intraabdominal pressure rise like coughing or standing up
anterior, intermediate and posterior pubourethral ligaments secure the urethra in its anatomic position anteriorly against the posterior/caudad symphysis

pubocervical musculofascia as part of endopelvic diaphragm supports and secures the cervix, posterior bladder, posterior uv-junction and posterior urethra in their variable anatomic position since these structures are fixed to it and as such it supports the urine continence mechanism; if there is a defect in the diaphragm these structures herniate thru this defect whilst also genuine incontinence may develop

anterior bladder wall, urethrovesical junction, urethra are more or less adherent/sticking to the posterior/caudad symphysis and rest upon it in the upright position and are pressed against it; as such these structures can shift/slide friction-free against the symphysis but cannot rotate backwards away from the symphysis

posterior bladder wall, urethrovesical junction, urethra are adherent to the endopelvic diaphragm; as such these structure are mobile depending upon the movements of the fascia; if the support becomes defective they can rotate backwards away from the symphysis causing funnelling of the proximal or total urethra

anterior vagina wall is loosely adherent to the endopelvic diaphragm; with circular ruga folds of the vagina due to natural tissue forces; it lacks the stiffness characteristics required for support of the anatomic urine continence mechanism

pubococcygeus muscles as part of levator ani muscles on contraction will squeeze the posterior and bilateral vagina walls resulting indirectly into cephalad and anterior movement of anterior vagina wall with adherent endopelvic diaphragm for a better support of the posterior bladder neck, urethrovesical junction and urethra; and as such contribute to a better configuration of the anatomic continence mechanism

other pelvis floor structures of the perineum outlet diaphragm play a direct role in stabilizing the distal/mid female urethra in its anatomic position since these organs with the external “rhabdo”sphincter are anchored into the perineum outlet diaphragm

intact innervation of these components is needed for smooth coordination of all the physiologic processes

physiology of continence and micturition

the literature is so abundant and confusing and contradicting that it is not possible to study it all and produce an evidence-based true statement; see chapter: remarks on urine continence mechanism

basic continence principles

movement of contents within an organ is only possible from higher pressure levels towards lower pressure levels

so as long as the urethra closing pressure is higher than the intravesical excretory pressure there is continence
as soon as the intravesical pressure becomes higher than the urethra closing pressure urine will flow thru the urethra towards the outside; either as voluntary physiologic action like during micturition or involuntarily and then it is called incontinence

**urethra closure**

it is not clear whether urethra closure is **circular** (external and internal opening circular on direct inspection) or that it is by **coaptation**;

however, if it is by coaptation then coaptation of the **posterior** urethra wall **against** the **anterior** urethra wall since **immobile anterior** bladder neck/uv-junction/urethra are more or less fixed/adhesive to and pressed against symphysis whilst **mobile posterior** bladder neck/uv-junction/urethra are adherent to elastic endopelvic diaphragm

**biophysiochemistry**

the two detrusor loops and trigonal ring keep the urethrovesical junction closed during the filling phase of the bladder

the urethra is kept closed/adapted by centripetal forces and by the tonus of the internal sphincter and slow-twitch fibers of the external “sphincter”; whilst the urethra mucosa and submucous vascular plexus are responsible for a water-tight urine seal

during the compliant filling phase of the bladder these mechanisms maintain closure of urethrovesical junction and (proximal) urethra; when the bladder fills up more these forces increase via impulses from baroreceptors

(voluntary) increase of these forces is possible directly by contraction of the external urethra “rhabdosphincter” and (in)directly by contraction of the pelvis floor muscles; with increase in the tonus of the smooth muscles of the endopelvic diaphragm by reflex action of the sympathetic nervous system

at sudden intraabdominal pressure rise there is a reflex increase in tonus of the smooth muscle fibers of the endopelvic diaphragm and contraction of the external urethra “rhabdosphincter” which takes place a few milliseconds before there is an increase in intravesical pressure since first the thoracic diaphragm and the anterior abdominal musculature contract (with or without contraction of the pelvis floor) on cough and this causes intraabdominal pressure rise a few miliseconds later; this action may be enforced directly and indirectly by simultaneous reflex contraction of the pelvis floor muscles

if these **intrinsic** mechanisms are deficient, for whatever reason, stress incontinence develops in varying degrees

at the beginning of voluntary micturition the two detrusor loops relax whilst the longitudinal detrusor muscle contracts with additional relaxation of the detrusor loops, the fast-twitch and slow-twitch muscle fibers of the external urethra “rhabdosphincter” relax, the pelvis floor muscles relax, the tonus of the endopelvic diaphragm relaxes, the longitudinal smooth musculature of the urethra contracts whilst the circular smooth muscle fibers as internal sphincter relax resulting in urethra shortening with an increase in its diameter
so, the forces which close the urethra decrease whilst intravesical pressure increases and the urethra opens up from proximally, from the urethrovesical junction, towards distally, towards the external urethra opening, and stays open during micturition

at the end of spontaneous micturition the opposite takes place and the urethra stretches with a decrease in its diameter

so, the forces which close the urethra increase whilst intravesical pressure decreases and the urethra closes

**pressure transmission** on sudden intraabdominal pressure rise

there is pressure transmission on sudden (or slow) increase in intraabdominal pressure due to cough, standing up, straining etc

its net effect upon the cephalad/anterior and the caudal/posterior movement of the endopelvic diaphragm will determine if this has a positive, neutral or negative effect on keeping the urethra closed

on cough by contraction of thoracic diaphragm and abdominal musculature without simultaneous contraction by pelvis floor the pressure transmission will be coming from cephalad and anteriorly

and will reach the bladder first before pushing down on the endopelvic diaphragm despite reflex increase in its tonus; and only if defective this will result in backwards rotation of the posterior urethra wall away from the symphysis and will have a negative effect

on cough by contraction of thoracic diaphragm and abdominal musculature and with simultaneous contraction by pelvis floor the pressure transmission will be from cephalad, from anteriorly and from caudad simultaneously

since the distance from the pelvis floor to the endopelvic diaphragm is shorter than the distance from the thoracic diaphragm the caudal pressure will first reach the endopelvic diaphragm and move this anterior/cephalad before meeting the anterior and cephalad pressure; this will result in rotation of the posterior urethra wall forwards toward the symphysis and will have a positive effect

if the pelvis floor contracts earlier than the thoracic diaphragm and anterior abdominal musculature the positive effect will be strengthened

however, the ultimate effect, involuntary urine loss or continence, is with the intrinsic forces of the continence mechanism

**anatomic changes at urethrovesical junction and urethra**

**vesicalization**

funnelling of the internal urethra opening and proximal urethra may occur and this is called vesicalization by heinrich martius since this part of the urethra becomes part of the bladder (vesica); it may be partial or total
re-urethralization
by tightening the support the vesicalized urethra becomes again proximal urethra so this
is called by the author re-urethralization

urethralization
in post-fistula repair intrinsic incontinence with real circumferential loss of the proximal
urethra the remaining bladder neck can be narrowed by special operation technique and
function as the proximal urethra; this is called urethralization by the author

stress incontinence mechanism

the anterior urethra wall is adherent to the posterior symphysis by loose connective
tissue and a thin fluid film which allows the anterior urethra wall to shift against the
symphysis friction free, though little; however it cannot rotate backwards away from the
symphysis

the posterior urethra wall is firmly adherent to the pubocervical musculofascia with
pubourethral ligaments as part of the endopelvic diaphragm

if defects develop within this diaphragm the posterior urethra wall will rotate backwards
away from the symphysis causing partial (or total) funneling of the proximal (or total)
urethra since the anterior urethra wall stays sticking against the symphysis; this process
is called vesicalization since functionally the funneled part of the urethra becomes part
of the bladder (vesica)

besides backward rotation there is also backward shifting of the posterior urethra wall
against the anterior urethra wall into the direction of the sacrum; since the anterior
external opening is fixed and immobile

these two mechanisms of pathophysiologic action result into a wider (proximal) urethra
lumen and a more oval elliptical arrangement of the smooth muscle fibers and

interfere with the intrinsic forces keeping the urethra closed since more force is needed
to close the urethra; less resistance according to poiseuille law

once the intrinsic forces can no longer keep the urethra closed sufficiently this will lead
to genuine or post fistula repair intrinsic stress incontinence in various degrees

in total intrinsic stress incontinence there is continuous leaking of urine on lying/sitting/
standing/walking due to total loss of the intrinsic forces

intraoperatively under spinal anesthesia in these patients in the exaggerated lithotomy
position the level of urine within the urethra is noticed in concord with respiration, rising
on expiration and lowering on inspiration

a third mechanism may be a defect in the anchoring of the distal urethra (with external
urethra opening) into the perineum outlet diaphragm; with or without avulsion

this mechanism is probably responsible for the development of postpartum genuine
intrinsic stress urine incontinence with a hourglass or sandglass deformity of the
urethra which is rather common; though combined with a median longitudinal defect
within the endopelvic diaphragm
urge incontinence mechanism

In urge incontinence there are involuntary contractions of the detrusor muscle without reflex increase in the intrinsic closing forces setting involuntary micturition in motion whilst voluntary increase in the extrinsic forces is too weak and too short to stop the involuntary micturition.

The involuntary contractions are triggered by low-threshold pacemaker, irritation of the pacemaker (like in cystitis) or by an ?ectopic pacemaker?

discussion

The author outlines the various structures and factors which influence the functional anatomic urine continence mechanism in the female.

It is up to the reader to make his/her own conclusions.
mechanism of urine stress incontinence

genuine and post fistula repair

introduction

if one wants to perform reconstructive surgery one must know the anatomy and the mechanism of action of continence and of incontinence

here a short outline is given about the mechanism of urine stress incontinence either in genuine incontinence or post fistula repair stress incontinence

as based upon the systematic examination/assessment/documentation/analysis of various defects and tissue loss of the continence mechanism from one cell to total loss as a “natural experiment” within the complex obstetric trauma

stress incontinence is always an expression of defective intrinsic forces, in genuine incontinence without tissue loss and in post fistula repair with anatomic tissue loss

mechanism of urine stress incontinence

the immobile anterior urethra wall is adherent/sticking to the posterior symphysis by loose connective tissue and a thin fluid film which allows the anterior urethra wall to slide/shift against the symphysis friction free, though little; however it cannot rotate backwards away from the symphysis also since it is pressed against the symphysis by hydrostatic pressure

the mobile posterior urethra wall is firmly adherent to the pubocervical musculofascia as part of the endopelvic diaphragm

if defects develop within this diaphragm the posterior urethra wall will rotate backwards away from the symphysis causing partial (or total) funneling of the proximal (eventually whole) urethra since the anterior urethra wall stays sticking against the symphysis; this process is called vesicalization since functionally the funneled (part of the) urethra becomes part of the bladder (vesica)

besides backward rotation there is also backward shifting of the posterior urethra wall against the anterior urethra wall into the direction of the sacrum; since the anterior external urethra opening is fixed and immobile

these two mechanisms of pathophysiologic action result into a wider (proximal) urethra lumen and a more oval elliptical arrangement of the smooth muscle fibers and

interfere with the intrinsic forces keeping the urethra closed since more force is needed to close the urethra; combined with less resistance according to poiseuille law

once the intrinsic forces can no longer keep the urethra closed sufficiently this will lead to genuine intrinsic stress incontinence in various degrees
in total intrinsic stress incontinence there is continuous leaking of urine on lying/sitting/standing/walking due to total loss of the intrinsic forces

intraoperatively under spinal anesthesia in these patients in the exaggerated lithotomy position the level of urine within the urethra is noticed in concord with respiration, rising on expiration and lowering on inspiration

the external urethra opening is anchored into the perineum outlet diaphragm and anteriorly firmly connected to the symphysis whilst

the anterior urethra, anterior uv-junction and anterior bladder neck are connected/firmly adhesive to the posterior/inferior symphysis by loose connective tissue and thin fluid film and

the anterior bladder is connected/firmly adhesive to the posterior symphysis and the anterior abdominal wall by loose connective tissue and thin fluid film

in the upright position the anterior bladder neck, anterior uv-junction and anterior urethra wall are resting upon and pressed against the posterior symphysis

as such the anterior urethra, anterior uv-junction and anterior bladder can shift friction free against the posterior symphysis; but they cannot rotate backwards away from it due to the strong negative pressure exerted within the thin fluid film on pull/traction

there are two forces at work which exert traction upon the mobile posterior uv-junction and posterior urethra wall whereby the architecture of the urethra wall will be distorted

first the uv-junction and proximal urethra are pulled and pushed open and the urethra becomes functionally part of the bladder (vesicalization);

as long as the remaining intrinsic continence mechanism is strong enough the woman is still continent but once the intrinsic continence mechanism cannot cope any more with increased intravesical pressure there is urine loss;

though this is called genuine stress incontinence actually it is intrinsic incontinence

later there will be opening up of the whole urethra (total vesicalization);

the mobile posterior urethra wall is pulled away from the immobile anterior urethra wall opposite to the direction of coaptation;

besides this the posterior urethra wall is pulled towards the cervix/sacrum as well with posterior deformation of the external urethra opening so that the smooth muscle fibers become more oblique and continent closure is no longer possible and the woman looses urine more or less continuously whilst lying/sitting/standing/walking, with or without spontaneous miction

the first force is downward due to herniation of the posterior bladder/posterior bladder neck/posterior uv-junction/posterior proximal urethra thru the median defect in the endo pelvic diaphragm as seen in cystocele

or due to a loose endopelvic diaphragm since its connection to the pubis bone has been lost either directly as in circumferential fistulas or indirectly by a transverse defect
the second force is posterior into the direction of the cervix/sacrum due to pull by the herniated and/or sagging down posterior bladder wall

this second force can be the main mechanism of incontinence as seen when a longitudinal median scar from the external urethra opening to cervix (see mutilating incision) keeps on contracting throughout life since it is perpendicular to the ruga folds

it can also been seen after a cesarean section whereby the cervix is fixed intraabdominally and moves paradoxically cephalad on cough with posterior traction onto endopelvic diaphragm

it is seen frequently in ureter fistulas type III due to its posterior traction effect upon the endopelvic diaphragm; once there is vesicalization a downward force will come in as well

the third possibility is a trauma to the anchoring of the distal urethra and its external opening into the perineum outlet diaphragm; with or without an avulsion of the distal urethra and its external opening

defects within the endopelvic diaphragm

there are defects without tissue loss as in genuine incontinence and defects with anatomic tissue loss as in post fistula repair incontinence

in genuine incontinence without tissue loss

normally one will find a median longitudinal defect whereby the posterior urethra wall is no longer supported

however, transverse defects with indirect loose connection to the pubis bone and arcus tendineus fasciae = atf may also be found

and direct loose connection to the pubis bone

either isolated or combined; as well in combination with urogenital prolapse

in post fistula repair incontinence with anatomic tissue loss

the variety is great as is the variety in anatomic tissue loss

median longitudinal defects with loss of support of the posterior urethra wall

transverse defects with indirect loose connection to pubis bones/pelvis wall

quartercircular defects with (in)direct loose connection to pubis bones/pelvis wall and loss of atf

semicircular defects with (in)direct loose connection to pubis bones/pelvis wall and loss of atf and atlam and cephalad part of levator ani muscles etc

(sub)total loss with major pelvis soft tissue loss

the more extensive the anatomic tissue loss the more chance of incontinence

all these defects may be combined with anchoring defects into the perineum outlet diaphragm

defects within the anchoring into the perineum outlet diaphragm

since the anterior external urethra is firmly fixed and as such the anterior urethra wall also secured defects will lead to shifting of the posterior urethra wall and external opening towards the sacrum with wide opening of the external urethra opening and hourglass or sandglass deformity of the urethra
this anchoring defect is normally combined with a median longitudinal defect within the endopelvic diaphragm

this is a rather frequent finding especially in fresh postpartum genuine incontinence

however, total avulsion of the distal urethra and external opening out of its anchoring is rare though it may occur

the author encountered this only 4 times, once due to direct trauma, once due to infection and twice due to obstructed labor

discussion and practical consequences

the obstetric fistula surgeon is in a unique position to study the female urine continence mechanism by direct observation of an endless variety of the natural experiment of the complex obstetric trauma in all its forms

the term intrinsic stress incontinence is preferred above stress incontinence since it is the intrinsic continence mechanism which is defective and has to be corrected

the art of reconstructive surgery is to first assess the trauma and then to reconstruct only the functional anatomy so that physiology will be restored under physiologic stress

since any patient with urine incontinence is unique, once the general principles have been outlined the operation technique has to be customized to correct the specific individual lesions; a standard trick may work but it is insight that counts

for intrinsic-stress incontinence a physiologic reconstructive operation technique has been developed which only corrects the defects in the endopelvic diaphragm with tightening if necessary

these principles may be of value to the industrialized world as well since most operation techniques are tricks and nonphysiologic

for all fistulas, type I; type IIAa, type IIAb, type IIBa and type IIBb operation principles have been developed to correct the respective defects in the endopelvic diaphragm and its fixation already during the repair to prevent postrepair incontinence
downward force

force towards cervix/sacrum

downward force
cystocele
median defect pc fascia

downward force
no connection pc fascia to atf

vesicalization proximal urethra
total vesicalization

© kees
female stool continence mechanism

functional anatomy

introduction

the functional anatomy of the female stool continence mechanism consists of a rather complicated multi-interaction of static (connective tissue) and dynamic structures (muscles; mucosa, submucous vascular plexus) and nervous innervation.

the anatomic stool continence mechanism is situated within the distal 4-5 cm of the anorectum, the external sphincter ani muscle and support.

there is an internal smooth muscle sphincter and an external striated muscle sphincter with washer effect by the mucosa and submucous vascular plexus.

the distal anorectum and external sphincter ani are anchored into the pierced thru punched out opening in the perineum outlet diaphragm.

here only a short comprehensive outline is given as a start/incentive to more extensive self-study.

functional anatomy

anatomic stool continence mechanism

anorectum-rectum junction

diameter

anorectal angle, normally 80°-100°

anorectum

length 4-5 cm

shape and diameter

lumen

anus mucosa

anal cushions = columnae anales

submucous vascular plexus

circular smooth muscle fibers = internal sphincter ani

longitudinal smooth muscle fibers

sphincter ani muscle

circular striated muscle fibers around distal anorectum/anus

consisting of mostly slow-twitch for tonus but also fast-twitch for emergency closure

divided into three parts:

subcutaneous

superficial

deep
anatomic/physiologic support

**rectovaginal or prerectal fascia** (of denonvillier)
supports the anterior anorectum

**perineum outlet diaphragm**
the anorectum with external sphincter ani complex are firmly anchored into the pierced thru punched out opening within the perineum outlet diaphragm

**perineal body (= centrum tendineum perinei) with transversus perinei and bulbo spongiosus muscles**
stabilizes the anus and sphincter ani anteriorly and laterally; in a way that is comparable to the role of the pubocervical fascia in stabilizing the posterior urethra

**anooccocygeal ligament**
stabilizes the anus posteriorly

**levator ani muscles + levator plate**
anterobilaterally from pubis bone and arcus tendineus levator ani as a sling around the lateral and posterior anorectum walls and external sphincter ani, and inserting into levator plate, anooccocygeal ligament and coccyx

especially the puborectalis muscles, median part of pubococcyeus muscles, play a role pulling the anorectum anteriorly; these muscles are responsible for the anorectal angle; its fibers fuse with the deep portion of the external sphincter ani muscle

**posterior vagina wall**
attached to perineal body and rectovaginal or pre(ano)rectal fascia and rectum serosa

**perianal skin with subcutaneous tissue and constrictor ani muscle**
stabilizes also the anus/sphincter ani muscle

intact innervation of these components

autonomic sympathetic and parasympathetic (vagus) nervous system for the circular smooth muscle as internal sphincter and longitudinal smooth muscle; the sympathetic fibers for stimulation and continence against the parasympathetic fibers for relaxation and defecation; from hypogastric and pelvic plexus
pudendal nerve innervating the external sphincter ani; from s2, s3, s4
levator ani nerve innervating levator ani muscles; from s3, s4

discussion

the stool continence mechanism must take care of
gas
for final sealing off the mucosa with mucosa cushions and the submucous vascular plexus are responsible
liquid stool
for final sealing off also the mucosa with mucosa cushions and the submucous vascular plexus are responsible

solid stool
this is the easiest since normally there is no stool inside the rectum

anorectal angle is determined by the puborectalis muscle and is normally 80°-100°; if it contracts the angle will become sharper; however, this seems to be of minor importance

anorectum mucosa with mucosa cushions and submucous vascular plexus are responsible for air- and water-tight closure; washer effect

water-tight closure is a problem since liquid stool inside the rectum is accompanied by a strong urge component with bowel contractions

linea dentata between squamous epithelium (proctodaeum origin) with sensibility for pain and touch since innervated by pudendal nerve and cubical epithelium (hindgut origin) without sensibility since innervated by autonomic nervous system

thickened circular smooth muscle = internal sphincter ani is the strongest factor and responsible for closure due to non-fatigue tonus; it is separated from the external sphincter by the longitudinal smooth muscle layer sheath

longitudinal smooth muscle is playing a role in defecation since it will shorten the anorectum if contracting; it separates the internal sphincter ani muscle from the external sphincter ani muscle

rectovaginal or prerectal fascia (denonvillier) bilaterally from an arcus tendineus attached to levator ani muscle fascia; this is attached to/supporting the anterior anorectum; if defective a rectocele will develop

external sphincter ani circular around the distal anorectum and consists of striated muscle fibers; the slow-twitch muscle fibers are contributing to its tonus whilst the fast-twitch fibers will contribute to short-duration closure of the anus; especially in the female it is thicker posteriorly than anteriorly

it consists of 3 parts: subcutaneous, superficial and deep; fibers of the puborectalis muscle fuse with the deep part bilaterally and posteriorly

it is separated from the internal sphincter by the longitudinal smooth muscle sheath of the anorectum

the external sphincter extends 0.5-1 cm distally from the internal sphincter (intersphincteric groove) and protrudes slightly from the surrounding skin

perineum outlet diaphragm
the anorectum with the external sphincter ani complex are firmly anchored into the pierced thru punched out opening within this diaphragm stabilizing/securing these structures in their anatomic position

active contraction of its striated muscle component and reflex contraction of its smooth muscle component will reinforce the stool continence mechanism
**perineal body**
wedge-like connective tissue structure into which the bulbospongiosus and transversus perinei muscles radiate; attached to anterior external sphincter ani

this structure stabilizes and secures the anterior sphincter ani/anorectum in its anatomic position and as such supports the stool continence mechanism

**transversus perinei muscles**
bilaterally from ischium tuberosity and uniting indirectly medially via the perineal body and prevent lateral shifting of perineal body/anus

**bulbospongiosus muscles**
bilaterally from paraclitoridally and uniting posteriorly medially via the perineal body and prevent posterior shifting of perineal body/anus

**levator ani muscles + levator plate**
a flat striated muscle sheath originating anterobilaterally from pubis bone and arcus tendineus of levator ani muscles (atflam) and like a sling around lateral vagina walls and laterally from and underneath sphincter ani/anorectum/rectum and fusing with each other and inserting posteriorly from sphincter ani/anorectum/rectum into levator ani plate, anococcygeal ligament and coccyx bone

though it is one muscle it can be divided into different parts based on their origin: pubococcygeus and obturatoccygeus muscles

the medial part of the pubococcygeus is called the puborectalis muscle; this portion fuses with the bilateral and posterior deep external sphincter ani muscle fibers; it is responsible for the anorectal angle and prevents posterior shifting of the anus

for some investigators the *(ischio)coccygeus muscle* is (synonymous with) the sacro-spinous ligament

due to its sling-like shape contraction of the levator ani muscles compresses the lateral and posterior anorectum and sharpens the anorectal angle and as such contributes to the stool continence mechanism

**posterior vagina wall**
covers and is attached to the perineal body and anorectum/prerectal fascia/rectum (serosa) and as such is fixed indirectly to the lateral pelvis walls

**anococcygeal ligament**
from coccyx bone to posterior sphincter ani/anus/anorectum and stabilizes/secures the external sphincter ani and anus in its posterior anatomic position and prevents anterior shifting of external sphincter ani/anus

**shafik mechanism**
surgically speaking this is difficult to check; as well this could only function if the levator ani muscles are posteriorly uniting around posterior anorectum (true), the anococcygeal ligament around anterior anorectum and/or external sphincter ani and/or perineal body (not true) and bulbospongiosus muscles unite posteriorly from anorectum (not true)

besides this, as long as an anatomically correct reconstruction is performed these structures will be restored as well whatever the arrangement
skin with subcutaneous tissue and corrugator ani muscle
the perianal skin and subcutaneous tissue in combination with corrugator ani muscle around the anus stabilizes the anus as well

intact innervation of these components
autonomic sympathetic and parasympathetic (vagus) nervous system for the ano rectum circular smooth muscle fibers as internal sphincter and longitudinal smooth muscle fibers and for (non)sensibility of anorectum cubic mucosa up to dentate line; from hypogastric and pelvic plexus

pudendal nerve innervating the external sphincter ani and for sensibility for touch/pain of perianal skin and squamous anorectum mucosa up to dentate line; from s2, s3, s4

levator ani nerve innervating levator ani muscles; from s3, s4

synergistic interaction between stool and urine continence mechanisms
though the two mechanisms may function independently from each other there is a lot of analogy and synergy; for instance first flatus and then micturition (le vent avant la pluie) and first micturition before defecation, combination of cystocele and rectocele, combination of sphincter ani rupture and genuine intrinsic urine incontinence etc

analogy between stool and urine continence mechanism
analogy of functional anatomy: mucosa, submucous vascular plexus, internal smooth-muscle sphincter, external striated-muscle sphincter and support

analogy of posterior support of urethra by pubocervical fascia and anterior support of sphincter ani/anorectum by perineal body with transversus perinei and bulbospongiosus muscles and by prerectal fascia

analogy of innervation (pudendal nerve + autonomic nervous system)
and analogy of blood supply (internal iliac artery); and for (ano)rectum also inferior mesenteric artery

direct against indirect action of levator ani muscles
tonus and contraction of levator ani muscles have a direct action upon the stool continence mechanism since lateral/posterior anorectum walls are being squeezed and fibers of puborectalis support deep part of sphincter ani muscle ani whilst the anorectal angle becomes sharper

tonus and contraction of levator ani muscles have no direct action upon the female urine continence mechanism since there is no direct contact whatsoever between the two; but there is indirect action since the endopelvic diaphragm as attached to anterior vagina wall is moving anteriorly and cephalad by compression of lateral/posterior vagina walls which improves the support

sphincter ani/perineal body complex
schematic drawings of the sphincter ani/perineal body complex with transversus perinei and bulbospongiosus muscles are presented on opposite page

last edition february 2018
remarks about pelvis organ prolapse

the author is privileged to study the experiments of nature about the prolapse mechanism in the female as presented by the complex obstetric trauma

his findings of anatomic tissue loss, his physiologic operation techniques to step-by-step reconstruct the functional anatomy, his evidence-based results and his theory are in sharp contrast with the current theory about prolapse in the female

functional pelvis anatomy

the pelvis organs with their supply structures are embedded into the connective tissue organ of pelvis = corpus intrapelvinum and suspended/connected to the pelvis wall and to each other by highly specialized structures of this connective tissue organ

however, there is no direct anatomic connection between the pelvis organs and the pelvis wall and/or floor

except for the fact that the continence mechanisms of the urinary tract, genital tract and digestive tract are anchored into the perineum outlet diaphragm as pelvis floor

the corpus intrapelvinum with its highly specialized structures is responsible for the variable anatomic position of the pelvis organs in all possible body positions and all physiologic filling phases of the pelvis organs

the perineum outlet diaphragm = pelvis floor is the ultimate barrier between the pelvis contents and the outside; the same function as the anterior abdominal wall; though with the anchored continence mechanisms as outlet

and in quadrupeds this structure is the side wall with anchored continence mechanisms and the anterior abdominal wall the floor of the abdominopelvic cavity

so the abdominopelvic side wall in quadrupeds became the floor in bipeds

one highly specialized structure of the corpus intrapelvinum is the dynamic endopelvic diaphragm with cervix as its center

which separates the high-pressure organs of the distal urinary tract, proximal genital tract and cervix, intraperitoneal contents and distal digestive tract from the zero- or low-pressure vagina

and if intact keeps the pelvis organs in their variable anatomic position and

as such supports the urinary, genital and digestive continence mechanisms and

prevents the high-pressure organs from entering the zero- or low-pressure organ the vagina
the levator ani muscles form part of the lateral walls of the pelvis and also belong to the pelvis floor = perineum outlet diaphragm as combined with perineal membrane, perineal body, transversus perinei muscles, bulbocavernosus and ischiocavernosus muscles and posteriorly sphincter ani complex and levator plate with anococcygeal ligament, (ischio)coccygeus muscles and sacrospinous ligaments

based on the functional anatomy, though contrary to popular belief, the pelvis floor structures as perineum outlet diaphragm can neither prevent nor stop the process of pelvis organ prolapse; and do not play a role of paramount importance

it is far more logical and surgically proven that defects within the endopelvic diaphragm are involved in the development of (urethro)cystocele and uterus/cervix prolapse, enterocele and rectocele as pelvis organ prolapse

real mechanism of action in prolapse

median defects of the fascia are involved in the development of (urethro)cystocele since the posterior bladder and/or urethra wall herniate thru the defect

transverse, quartercircular, semicircular and lateral defects are also possible but these lead not to cystocele; when these defects occur the loose endopelvic diaphragm seems to move anteriorly and cephalad due to retraction of the bladder towards fixed anterior bladder wall; due to the natural forces in a balloon like structure where one side is fixed

median/central defects of the endopelvic diaphragm in combination with loosening of scarouterine, broad and cardinal ligaments may lead to cervix/uterus prolapse and the cervix will herniate thru the median defect

median defects do occur since the span is too wide and the weakest point is the median where the longitudinal fibers may split/divide due to hydrostatic and intra peritoneal compression pressure; and the defect becomes larger and the fascia retracts bilaterally towards the arcus tendineus fasciae due to the elastin and muscle fibers and becomes thicker; since the span is the widest proximally in between the ischium spines that is where it starts and then moves distally whilst normally over the last distal 2 cm the fascia will stay intact since here the span is narrow and the fibers also transverse

the wider the pelvis the greater the chance that this will happen; therefore normally (urethro)cystocele and cervix prolapse are combined with a wide pelvis with pubic arch of ≥ 90° as found by the author during his surgery

pregnancy and childbirth may accelerate these processes though prolapse may be found in nulliparous patients as well

during the course of pregnancy there is increasing (due to increasing fetus weight) hydrostatic pressure upon the endopelvic diaphragm from cephalad to caudad; as well the diaphragm strengthens first and then softens up under hormonal influences

during actual childbirth the pressure upon the endopelvic diaphragm changes 180° and becomes from caudad to cephalad during a short period whilst the cervix and with it the diaphragm opens up
lateral defects of the endopelvic diaphragm are normally not involved in uterus/cervix prolapse; however, they may be found in extensive obstetric trauma in combination with other pressure necrotic lesions of broad, cardinal and sacrouterine ligaments even in patients with narrow pelvis with pubic arch of $\leq 80^\circ$ and then lead to cervix prolapse which is not so common

once the prolapse has started the organs may slide unopposed thru the vagina towards the outside thru the opening(s) in the pelvis floor as perineum outlet diaphragm

the emperor’s clothes

some of these things the author considers like the emperor’s clothes: nobody is willing or able to contradict the sayings of experts in order not to be ridiculed in public

also the author cannot follow the MRI images and ultrasound images where somewhere an arrow points to something vague

the author prefers to rely on his own eyes during the course of surgery

the author cannot skip the feeling that those theories have been developed to back up the artificial products of the multi-billion dollar medical industry

consequences for reconstructive surgery

in female genital prolapse the defective structures have to be identified exactly so that the available autologous structures are used in the real reconstruction of the functional pelvis anatomy

the corpus intrapelvinum is responsible for the suspension of pelvis organs

whilst

the pelvis floor can neither prevent nor stop pelvis organ prolapse

the anterior vagina wall lacks the stiffness and pressure dragging the diaphragm down instead of pushing it up
incision anterior vagina wall

physiologic incision

mutilating incision
## abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>vvf</td>
<td>vesicovaginal fistula</td>
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<tr>
<td>rvf</td>
<td>rectovaginal fistula</td>
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<tr>
<td>uvvf</td>
<td>urethrovaginal fistula</td>
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<tr>
<td>vcvf</td>
<td>vesicocervical fistula</td>
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<td>vuvf</td>
<td>vesicouterine fistula</td>
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<td>cx</td>
<td>cervix</td>
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<td>avw</td>
<td>anterior vagina wall</td>
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<td>pvw</td>
<td>posterior vagina wall</td>
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<td>pcf</td>
<td>pubocervical fascia</td>
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<td>atf</td>
<td>arcus tendineus fasciae</td>
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<tr>
<td>atlam</td>
<td>arcus tendineus of levator ani muscle</td>
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<td>lam</td>
<td>levator ani muscle</td>
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<tr>
<td>pcm</td>
<td>pubococcygeus muscle</td>
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<tr>
<td>ilcm</td>
<td>iliococcygeus muscle</td>
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<tr>
<td>iscm</td>
<td>(ischio)coccygeus muscle</td>
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<tr>
<td>iom</td>
<td>obturator internus muscle</td>
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<tr>
<td>pm</td>
<td>piriformis muscle</td>
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<td>sul</td>
<td>sacrouterine ligament</td>
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<td>bl</td>
<td>broad ligament</td>
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<td>cl</td>
<td>cardinal ligament</td>
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<td>ch</td>
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<td>parity</td>
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<td>cesarean section</td>
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<td>sth</td>
<td>subtotal hysterectomy</td>
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<td>tah</td>
<td>total abdominal hysterectomy</td>
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<tr>
<td>tvh</td>
<td>total vaginal hysterectomy</td>
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</tbody>
</table>
euo = external urethra opening
iuo = internal urethra opening
uv(-junction) = urethrovesical (junction)

euo/f = distance between euo and fistula
f/c = distance between fistula and cervix
f/v = distance between fistula and vagina vault;
euo/b = distance between euo and catheter balloon
euo/bw = distance between euo and bladder wall (fundus)
a/f = distance between anus and (rectovaginal) fistula
i/v = distance between introitus and vagina vault; vagina length

pa = pubic arch
ap = anterior to posterior pelvis diameter
ar = anal reflex

gm = gastrocnemius muscle
sm = soleus muscle
at = achilles tendon

min = minute
hr = hour
wk = week
mth = month
yr = year

R = right
L = left

bladder capacity by longitudinal diameter (euo/bw minus euo/b)
small < 4 cm
moderate 5-6 cm
normal 7-12 cm
transitional 13-14 cm
increased > 15 cm
normal measurements

vagina length 10-12 cm
euo/c 6-7-8 cm
anatomic urine continence mechanism 4-5 cm
anatomic stool continence mechanism 4-5 cm
urethra length 3.5-4 cm
longitudinal bladder diameter (euo/bw minus euo/b) 7-12 cm
anorectum 4-5 cm
symphysis 5-6 cm broad
axis inclination 30-45° as to horizontal in the upright position
pubic arch 85-90°
atf 7.5-8 cm
inclination 25-30° as to horizontal from pubis bone to ischium spine
atlam 7-7.5 cm
inclination 25-30° as to horizontal from pubis bone to ischium spine
angle between symphysis and atf/atlam 110-125°
inter ischium spine distance 10 cm
inter ischium tuberosity distance 10-11 cm
pelvis inlet plane inclination 55-60° to horizontal from superior symphysis edge to promontory in the upright position
pelvis outlet 10-15° to horizontal from inferior symphysis to tip of coccyx in the upright position
anterior triangle pelvis outlet from inferior symphysis to ischium tuberosity in one plane with -10 to -15° inclination to horizontal in upright position
posterior triangle pelvis outlet from ischium tuberosity to tip of coccyx in one plane with 65-70° inclination as to horizontal in upright position
pelvis outlet surface 75-80 sq cm
gap between puborectalis edges 25-30 sq cm
diameter recta from inferior symphysis up to tip of coccyx 9-9.5 cm; up to 10.5-11 cm during delivery
type IIAb fistulas