obstetric trauma surgery
art and science

kees neovagina reconstruction

ba hanya = gynatresia

kees waaldijk
obstetric trauma surgery
art and science

setting standards by evidence-based practice

kees neovagina reconstruction
rectouterine or rectovesical pouch

step-by-step

in line with the functional pelvis anatomy

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 organ(s), 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 30-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
**ba hanya** (= gynatresia) due to obstetric trauma is common and poses a major problem to the woman and the obstetric trauma surgeon

this term is chosen since this is how the patients describe this condition; and everyone understands it immediately without further explanation

and means literally: no road or road block; preventing vaginal sexual intercourse and pregnancy

the propagated operation technic so far is the sigmoid neovagina whereby an isolated vascularized sigmoid loop is placed in between the cervix/bladder and the rectum with an end-to-end sigmoidosigmoidostomy

however, it is associated with high rate of major intra- and postoperative complications and requires long general anesthesia, blood bank and an intensive care unit

whilst the cosmetic and functional results are not optimal; abnormal looking narrow vulva, reddish bowel mucosa and (smelling) bowel mucus discharge

recently, the author developed a safe reconstruction of a *kees neovagina* without major intraoperative complications and without a single postoperative complication in the 45 reconstructions so far performed and is totally in line with the functional pelvis anatomy with (re)positioning of cervix into the neovagina and

with good cosmetic and functional results; normal looking vulva, normal vagina mucosa, normal vagina flora and no discharge

which can be performed per “vaginam” in all our centers, under spinal anesthesia only, no need for special expensive instruments, no need for blood transfusion, no need for special intensive care unit; and so under the same conditions under which the obstetric trauma surgery is executed

since operation time ranged from 45-100 min; on the average some 60 min; and blood loss ranged from 50-100 ml, so ≤ 100 ml

after which the woman can have vaginal sexual intercourse and may become pregnant again; however, subsequent deliveries should be by elective cesarean section

this textbook is just another one out of the series *obstetric trauma surgery; art and science*

in order for the author to publish this technic whilst claiming his full intellectual property rights

the author

15th august 2017
median subperitoneal compartment

genital tract

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ba hanya = gynatresia
introduction

ba hanya = gynatresia

the obstetric trauma comes in an enormous variety and one major problem is the (sub)total loss of the vagina or obstetric gynatresia or as the woman herself calls it ba hanya

the normal vagina length/depth is in the range of 10-12 cm whilst for sexual vaginal intercourse at least some 8 cm are needed

ba hanya or gynatresia due to the obstetric trauma is associated with extensive necrotic tissue loss of the proximal vagina and severe fibrosis/scarring resulting in a funnel-shape fibrotic distal vagina of < 4 cm length

whereby (what is left of) the cervix is embedded in this fibrosis and may be occluded with frequently amenorrhea since cervix opening is blocked

and associated with inoperable urine/stool fistulas since no tissue left for reconstructive surgery

the woman comes with the complaint of ba hanya (no road; road block); however, upon further asking their main complaint is no live child

this is serious since in africa a woman without a live child is a disgrace to herself, to her husband, to her family and to her community

so they need a vagina for menstruation, for vaginal sexual intercourse and to become pregnant; and many prefer to have a hanya instead of closure of the fistula(s)

however, that is easier said than done since where to get healthy tissue to reconstruct a robust neovagina of sufficient length/depth and width and how to safely dissect the cervix, rectum, bladder out of the severe fibrosis, deblock the cervix and then position the (opened) cervix into this neovagina

the author thinks he found a safe real reconstructive solution totally in line with the functional pelvis anatomy
ba hanya = gynatresia
kees neovagina reconstruction

as solution for ba hanya

step-by-step pure vagina operation technic

under spinal anesthesia

introduction

the (surgical) management for ba hanya is complicated and requires high surgical skills by the obstetric trauma surgeon

conservative treatment is by pressure using different devices, but this requires patience and patient compliance and does not work in our setting

there are several technics using skin flaps but these are not very satisfactory, also since patient compliance is from poor to nonexisting

then the propagated technic is the sigmoid neovagina whereby a vascularized sigmoid loop is used to fill up the space between the bladder/cervix and the rectum with an end-to-end sigmoidosigmoidostomy with double approach abdomen and vagina

however it is complicated with high rate of intra- and postoperative complications and requires long term general anesthesia, blood bank, substitutes vagina mucosa by bowel mucosa with non-vagina flora and with (smelling) discharge; the cosmetic/functional results are not optimal

the davydov technic also requires a double approach vagina and abdominal endoscopy and needs also general anesthesia and expensive high-tech equipment; so this is out of the scope as well

since the ideal is to reconstruct a neovagina into which the cervix is ending (menstruation, vaginal sexual intercourse, pregnancy) more or less in line with the functional pelvis anatomy the author developed the following pure vagina technic

which can be performed in almost any center under spinal anesthesia using normal long vagina instruments with minimum blood loss and relatively short duration 45-100 min (which will be even far shorter once sufficient expertise has been gained)

with neovagina as lined by vagina mucosa as re-epithelized peritoneum with normal flora in line with the functional pelvis anatomy

so far no major intra- and postoperative complications were encountered with a good cosmetic and functional result
step-by-step reconstruction kees neovagina

**preparation, episiotomy, incision, dissection, freeing cervix**

a in the exaggerated lithotomy position

b suture the labia minora onto inner side of the upper legs/buttocks

c bilateral episiotomy (within skin lines) up to the “vault” for severing funnel shape stenosis and good exposure; of course many will boast this can be done without an episiotomy but that will restrict exposure and instrument manipulation with high chance of complications and poor result; and what about the existing stenosis

d indwelling foley bladder catheter for emptying bladder and as orientation during sharp dissection thru severe fibrosis/scar tissue

e transverse incision “vagina vault”; if cervix present as “posterior colpotomy”

f sharp dissection up to parietal peritoneum; the most difficult part due to fibrosis/scar tissue; whereby either the bladder or the rectum may be traumatized to be repaired immediately

g sharp transverse opening of abdomen as posterior colpotomy in between the cervix and the rectum

h sharp transverse widening of colpotomy up to pelvis wall in order to prevent stricture of neovagina ensuring a broad vagina; this is crucial

i identifying cervix, if present, deblocking cervix opening and (re)positioning cervix into neovagina

**end-to-end colpoperitoneostomy** no peritoneum dissection

j suturing the anterior colpotomy peritoneum bilaterally from cervix (so opening into neovagina) onto what is left of anterior vagina wall by interrupted polyglycolic acid; and in the midline onto posterior cervix lip so cervix canal open

k suturing the posterior colpotomy peritoneum onto what is left of posterior vagina wall by interrupted polyglycolic acid; nb the posterior colpotomy peritoneum is thick so it can be used to cover any repaired intraoperative rectum trauma and

l suturing peritoneum into deepest point of bilateral episiotomy/widened colpotomy to prevent re-stenosis and for a broad neovagina

**proximal neovagina closure with vault formation**

m identifying uterus and suturing posterolateral uterus muscularis/serosa bilaterally onto sacrouterine ligaments by polyglycolic acid closing the space between the uterus (up to 1-2 cm proximally from isthmus) and lateral pelvis wall
n  suturing posterior uterus muscularis/serosa at 1-2 cm proximally from isthmus onto anterior rectum muscularis/serosa at 12-14 cm from anus by polyglycolic acid closing the abdomen (extended rectouterine pouch) in such a way that the proximal anterior rectum wall will be the neovagina vault

o  start with median closure to determine neovagina length/depth and then continue closing from the lateral sides towards this midline suture or the other way

p  check deep hemostasis on anastomosis

q  remove the labia sutures and

r  hemostatic closure of episiotomies according to plastic surgery principles

s  check immediate postoperative result as to length/depth in cm and as to width


  postoperative care

t  leave indwelling foley catheter for couple of days

u  deep vagina vaseline pack up to neovagina vault for 5 days, then renew pack for 5 days up to 25-30 days and further keeping vagina open preferably by silicone vagina dilator with estriol cream and

v  to start sexual intercourse 4-5-6 weeks after operation; after removal of last pack; since that is the reason for the neovagina

if there is no cervix/uterus and in congenital mayer-rokitansky-küster-hauser syndrome the posterior bladder muscularis/serosa is used instead of the posterior uterus muscularis/serosa to close the proximal neovagina vault whilst episiotomies are not needed in mrkh
obstetric ba hanya (gynatresia)

fibrosis/scar tissue
plane of dissection

after dissection + freeing/deblocking of cervix
end-to-end colpoperitoneostomy
anterior anastomosis points

end-to-end colpoperitoneostomy
anterior anastomosis
end-to-end colpoperitoneostomy
posterior anastomosis points

end-to-end colpoperitoneostomy
anastomosis completed

© Kees
point of suturing posterior uterus muscularis/serosa onto anterior rectum muscularis/serosa

reconstruction completed
normal vagina

kees neovagina
extended rectouterine pouch
pt 676 zaria          vvf 799
pt 675 ba hanya + fistula; neovagina + fistula repair vvf 798

sik (kaduna city)  female  35 yr  15.01.17

surgeon:  kees waaldijk
assistant:  kabir lawal

diagnosis:  PIII (1 alive), 0.2 cm 0 urethrovesicovaginal fistula with circumferential defect type IIAb at L lungu, leaking urine for 15 yr which started immediately following obstructed last labor of 3 days, in hospital sb male, married 22 yr ago post(menarche 1 mth earlier), not living with husband, still menstruation, bilateral drop foot for 3 mth R (grade 5) and L (grade 5), rvf no, no yankan gishiri, yes eclampsia; normal ap diameter/pubic arch 85°, ar pos, bilateral atrl/atl + pc_ilc_iscm loss, cervix fixed, semicircular pc fascia defect, total vagina atresia, no operation, stress ++
euo/f 2 cm, fl"c" 1 cm, ab/au xx cm, i/v 2 cm  cm

operation:  kees neovagina + uvvf-repair
duration:  45 min  healing 85% continence 75%
anesthesia:  spinal by staff

bilateral epi, transverse incision thru "vault", sharp dissection, fibrosis ++, sharp opening abdomen by posterior colpotomy, sharp transverse widening colpotomy, transverse incision thru fistula, minimal dissection, transverse fascia repair/fixation onto atrl at L, no urine thru suture line/euo on rest/cough/pressure, creating neovagina with cx inside by suturing posterior uterus muscularis/serosa onto sacrouterine ligaments/anterior rectum muscularis/serosa by serafit, suturing anterior colpotomy peritoneum onto what is left of avw by serafit, triple fixation of Foley ch 18, suturing posterior colpotomy peritoneum onto what is left of pvw, epi closure; free urine flow, euo/bw 12 cm, good anterior elevation, euo/b 1.5 cm

normal bladder capacity (longitudinal diameter 12-1.5 = 10.5 cm  good fascia plate
poor position of uv-junction fixed against caudad third symphysis

normal-width 1.5 cm medium–quality urethra_euo in anatomic pos
neovagina 8-9 cm long  deep packing with vaseline gauze
21.02.17  not leaking at all  cath removed  bladder dill
22.02.17  not leaking at all  vagina ok
23.03 +15.05.17  vagina 8 cm deep/long and broad, not leaking at all  nicely healed

0.2 cm + ba hanya
after dissection

end-to-end “colpo” peritoneostomy
anastomosis points
anastomosis completed

fixation points
posterior bladder muscularis/serosa
onto anterior rectum muscularis/serosa
reconstruction completed

kees neovagina
extended rectovesical pouch
mayer-rokitansky-küster-hauser ba hanya; neovagina reconstruction

nik (katsina)  female  18 yr  19.01.17

surgeon: kees waaldijk
assistant: kabir lawal

diagnosis: P0, ba hanya ko kadan, mayer-rokitansky-küster-hauser mrkh syndrome, married 5 yr ago pre(menarche), living with husband, no menstruation; normal ap diameter/wide pubic arch 90°, ar post female phenotype breast well developed, female external genitals

ba hanya ko kadan i/v 0 cm  158 cm  60 kg

operation: kees neovagina reconstruction

duration: 45 min  healing 95%  continence 95%
anesthesia: spinal by anesthetic staff

transverse incision at “vault”, complicated sharp/blunt creation of tunnel /dissection up to parietal peritoneum, sharp transverse opening of abdomen by “posterior colpotomy”, no uterus but normal ovaria/tubes, creating neovagina by suturing posterior bladder muscularis/serosa onto peritoneum of “su ligaments” and onto muscularis/serosa of anterior rectum by interrupted serafit, transverse suturing of colpotomy peritoneum anteriorly onto “avw” and posteriorly onto “pvw” by interrupted serafit

neovagina 10-12 cm long and broad, no stricture; deep packing with vaseline gauze foley ch 18; free urine flow, euo/bw 12 cm, good anterior elevation, euo/b 2.8 cm normal bladder capacity (longitudinal diameter 12-2.8 = 9 cm) good “fascia” plate good position of uv-junction against middle third symphysis normal-width 3 cm good–quality urethra_euo in anatomic position

26.01.17 fine result, at least 12 cm no cooperation with packing
27.02.17  good result, vagina at least 12 cm and broad
27.0317  excellent result
22.05.17 myself no problem whatsoever vagina 12 cm and broad with normal vagina avw/pvw mucosa and normal vagina flora excellent result

ba hanya ko kadan
discussion

this no-nonsense procedure is straightforward, safe and gives good results and is the procedure of choice by the author and less traumatic and far faster/safer than any other procedure

and creates a robust neovagina comprising the vagina remnants and rectouterine pouch with anterior proximal rectum wall as vault

whereby the rectouterine pouch is isolated from the intraperitoneal cavity and becomes the proximal neovagina and the vagina remnants/vulva remain still the distal part

if there is no cervix/uterus and in mayer-rokitansky-küster-hauser syndrome there will also be a robust neovagina comprising the rudimentary “vagina” and rectovesical pouch with anterior proximal rectum wall as vault

whereby the rectovesical pouch is isolated from the intraperitoneal cavity and becomes the proximal neovagina and the rudimentary “vagina” remains the distal part

the bilateral episiotomy within the skin lines up to the vault is crucial in order to get good access to the operation field, for colpotomy widening up to bilateral pelvis wall, another crucial part, and for instrumentation

the most difficult part is the sharp dissection thru the severe fibrosis/scar tissue up to the parietal peritoneum whereby either the bladder or the rectum may be traumatized to be repaired immediately and then covered by the thick posterior colpotomy peritoneum

on sharp widening of the colpotomy up to ischium spines small arteries may be traumatized which so far could easily be clamped and then ligated under direct view since the bilateral episiotomies give good access to the operation field

this neovagina is more than only rectouterine or rectovesical pouch and reaches up to the sigmoid/rectum junction whereby the anterior proximal rectum wall will become the neovagina vault

the cosmetic result is excellent since the vulva with anterior and posterior vagina wall mucosa are part of the neovagina and the episiotomies will heal without a trace (since within the skin lines according to plastic surgery principles)

within 3 months the peritoneum lining of the neovagina will completely epithelize into normal vagina mucosa with normal non-smelling vagina flora without discharge

already at operation ending there is no visible distinction between the vagina mucosa remnants and the neovagina peritoneum lining

which is totally different from the reddish looking “vulva” of the sigmoid neovagina with bowel mucosa, bowel flora and smelling bowel mucus discharge

the critical point is the postoperative care during the first 4-6 weeks after reconstruction during which the neovagina has to be kept open by re-packing every 4-5 days
and then later preferably by silicone vagina dilator with estriol cream and/or by vaginal sexual intercourse to be started 4-5-6 weeks postoperatively; whilst a vibrator would be of great value

this requires **full compliance by the woman**

since the cervix is opening into the neovagina it is possible for the woman to menstruate and become pregnant; since the fixation is at 1-2 cm to isthmus the fundus can grow into the abdomen without compromising the neovagina and/or rectum

however once the patient becomes pregnant subsequent deliveries should not be per neovaginam but by an elective cesarean section to be planned far in advance

the neovagina is totally in line with the functional pelvis anatomy whereby the intrapelvic urogenitodigestive diaphragm is kept intact and even may be reinforced by part of the posterior uterus/isthmus supporting the urine continence mechanism and preventing urogenital and digestive prolapse

and the neovagina with repositioned cervix and uterus occupy the same median subperitoneal genital tract compartment of pelvis as the original vagina or a normal vagina

the davydov technic is: separate circumferential incision parietal pelvis peritoneum at level above the bladder, wide dissection and then pulling the mobilized parietal peritoneum flap(s) down over the posterior bladder (serosa) and the anterior rectum (serosa) thru the colpotomy up to vulva, circumferentially closing the parietal pelvis peritoneum at a more proximal level including the ovaries/tubes and so creating a weak parietal peritoneum neovagina with parietal peritoneum as vault with high chance of prolapse

and to the author’s knowledge, the davydov technic has only be used in the mayer-rokitansky-küster-hauser syndrome and other congenital vagina agenesis but not in the obstetric hany a where there is cervix/uterus with **severe fibrosis/scarring**
major principal differences with other technics

first pure “vagina” procedure

second no separate circumferential incision parietal pelvis peritoneum, wide mobilization and pull-thru; but as an (extended) rectouterine or rectovesical pouch

third sharp transverse dissection of colpotomy up to ischium spines in order to prevent stricture/stenosis of the neovagina and to create a broad vagina; this is crucial

fourth transverse suturing anterior colpotomy peritoneum bilaterally from the cervix (so opening into neovagina) onto what is left of anterior vagina wall (mucosa) in an end-to-end way; no dissection of peritoneum

fifth transverse suturing the thick posterior colpotomy peritoneum onto what is left of posterior vagina wall (mucosa) in an end-to-end way; no dissection of peritoneum

sixth separate bilateral suturing of posterolateral uterus muscularis/serosa onto sacro uterine ligaments

seventh proximal closure of neovagina by suturing uterus muscularis/serosa (obstetric ba hanya) or bladder muscularis/serosa (mrkh) onto lateral parietal peritoneum and anterior rectum muscularis/serosa creating a robust neovagina

eighth anterior proximal rectum wall as vault instead of (only) circumferentially closed parietal peritoneum

ninth neovagina lined by original vagina mucosa, original parietal peritoneum of pelvis and original visceral peritoneum of organs and so totally

tenth in line with the functional pelvis anatomy and

eleventh low chance of prolapse

twelfth after 3 months whole neovagina lined by normal vagina mucosa with non-smelling normal vagina flora without discharge; as opposite to sigmoid neovagina with bowel mucosa and smelling bowel mucus discharge

thirteenth after 2-3 months no longer chance of neovagina shortening/occluding

fourteenth once healed the kees neovagina occupies the same subperitoneal median genital tract compartment of the pelvis as the original vagina or as supposed to be; so totally in line with the functional pelvis anatomy

however, the author could not find step-by-step descriptions of the other technics, only some general principles; if they exist and if necessary the author will adapt his claims and comments accordingly
kees neovagina
experience so far in 45 patients
within 9-mth period november 2016 thru july 2017

characteristics

approach     vagina
anesthesia   only spinal anesthesia
instruments  normal long vagina instruments
personnel    surgeon + assisting theater nurse
operation time  on the average 60 min with a range of 45-100 min
blood loss on the average 50-70 ml with a range of 40-150 ml
in line with functional pelvis anatomy

no major intraoperative complication
bladder/rectum trauma in 8 patients which was repaired immediately and healed completely
not a single postoperative complication
inoperable ba hanya 1 patient with 6-8 cm long fibrosis traject which had to be terminated since it would have been unwise to continue
recurrence 2 patients due to problems with packing and no compliance

positive spin off

in some patients with postrepair incontinence due to traction by fibrosis/fixed cervix traction was neutralized
in some patients with inoperable urine/stool fistulas these fistulas became “operable”

conclusion

the kees neovagina reconstruction seems to be a safe solution for women with ba hanya (gynatresia) either due to obstetric trauma or otherwise; and has become the standard in our program and can be recommended to any one

however, though the preliminary results are excellent, the long-term results are not yet available since the author started only 9 months ago with this technic
mechanism of obstetric trauma

obstetrics constitutes always a major challenge to all pelvis organs with their different structures and 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 intrapelvic urogenitodigestive 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 hard bony maternal pelvis

seventh iatrogenic by intervention by health workers

eighth eclampsia

i 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

ii hydrostatic pressure
since the fetus and the uterus will grow slowly there is a continuously increasing hydrostatic pressure which may traumatize the intrapelvic urogenitodigestive diaphragm despite “hypertrophy”; in the involution phase defects may be resolved spontaneously or small defects remain
with subsequent pregnancies/deliveries these remaining defects may become larger up to a point where support of the urinary continence mechanism becomes defective and/or the securing/stabilization of the organs become defective

iii dilatation of cervix + opening of intrapelvic urogenitodigestive diaphragm
during the first stage of labor the cervix will efface and the urogenitodigestive diaphragm will open up with possible trauma to 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

iv 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 not 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 puborectalis 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 intrapelvic urogenitodigestive 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

v 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 intrapelvic urogenitodigestive diaphragm,
between the urogenitodigestive 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

vi compression trauma
when the head passes thru the vagina there will be compression of the soft tissues between the hard fetal skull and the hard 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, with fistula development

vii iatrogenic trauma
additional trauma by episiotomy, by vacuum, by forceps, by internal version and pedal extraction, by craniotomy or by cesarean section

viii eclampsia
may cause death, stroke, mental confusion, transitional blindness

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 by active inter vention pressure necrosis will develop resulting in an endless variety of anatomic tissue loss with devastating consequences for the woman affected

conclusion
the obstetric fistula is more than only a fistula and has to be handled within the context of the complex obstetric trauma
pressure gradient
total circumferential trauma
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**
and
- **parietal peritoneum**
as connected to each other by
- **tela urogenitalis**

**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 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

**intrapelvic urogenitodigestive 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 urogenital tract and intraperitoneal contents and of the distal digestive tract into the zero-pressure vagina

**pelvis floor as one functional unit**
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 intrapelvic urogenitodigestive 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 intrapelvic urogenitodigestive 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
distortion of smooth muscle arrangement of the urethra with weakening of the intrinsic
closing forces due to backward rotation/shifting of mobile posterior urethra wall away
from the immobile anterior urethra wall
by downward/caudad traction/push, by posterior traction towards sacrum due to defects
within the support by the intrapelvic urogenitodigestive diaphragm and 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 intrapelvic urogenitodigestive dia
phragm 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

urogenital and digestive 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 fascia structures of the corpus intra
pelvinum 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
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 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 iliac spine, dorsal lateral parts of sacrum, upper lateral part of coccyx to medial ischial 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 ischial 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 posterobilaterally and abdominal muscles anterobilaterally 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 (sacro 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
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 (bi)lateral ischial 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 and tip of coccyx in another one plane

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

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

posterior triangle in one plane with 65 to 70° inclination as to horizontal from ischial 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

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

the superior “antero”lateroposterior layer of the pelvis floor; as formed by the levator ani muscles with (ischio)coccygeus muscles/sacrospinous ligaments as a U sling around the anorectum and in total like a shallow bowl with its deepest point at the anus

with an anterior sagittal median hernia-prone opening within the “diaphragm” 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, external sphincter ani muscle, perineal body, transversus perinei muscles, bulbospongiosus muscles, ischiocavernosus muscles and anocecocygeal ligament; and bilateral crura of clitoris; combined with coccygeus muscles and levator plate
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

as such the organs cannot prolapse directly to the outside but only by kind of intussusception dragging the vagina (wall) with them

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

obturator 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, 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 internal obturator 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

obturator 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-shape “pelvis diaphragm” with anus as most caudal point

**levator ani muscles**
originating from pubis body and atlam and inferior edge of sacrospinous ligament and inserting into levator plate, coccyx and anococcygeal ligament; actually one flat muscle but normally divided into different parts

**pubococygeus muscles**
from pubis body and atlam to levator plate and anococcygeal ligament

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

**iliococygeus muscles**
from atlam to levator plate, coccyx and anococcygeal ligament

**pubo(cocygeus) muscles**
from ischium 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

**ischio(cavernosus muscles**
in the superficial perineal space from ischium tuberosity into clitoris

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

**pelvis connective tissue**

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

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
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

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

obturator fascia
fascia covering obturator internus muscle

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 ischial 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 ischial spine; as anterolateral attachment of intrapelvic urogenitodigestive 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 urogenitodigestive diaphragm; see special chapter

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

rectovaginal fascia = prerectal musculofascia
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/muscles

vesicoumbilical 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 as centrum tendineum perinei
wedge-like connective tissue structure in between the vagina and the anus; into which the perineum membrane, bulbospongious 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 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

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

cardinal ligaments
from ilium/ischium bones to (bi)lateral cervix in a frontal plane cephalad to the ischial spines
suspending/connecting the cervix and intrapelvic urogenitodigestive 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

ureter
though the ureter is completely embedded into the tela subserosa 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

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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 connective tissue organ of pelvis (corpus intrapelvinum)
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 intrapelvic urogenitodigestive 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 corpus intrapelvinum
blood supply
uterine artery
innervation
autonomic sympathetic and parasympathetic system

**cervix** as center of the intrapelvic urogenitodigestive diaphragm
entering the vagina thru the proximal anterior vagina wall; and stabilized in its anatomic position by the intrapelvic urogenitodigestive 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 corpus intrapelvinum and distally anchored into perineum outlet diaphragm
the anterior vagina wall is loosely adherent to pubocervical musculofascia and as such indirectly fixed to the pelvis wall
the posterior vagina wall is adherent to prerectal musculofascia 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 sensation except for its lowermost part

rectum = proctos
is adherent to the sacrum and rests upon the levator ani plate, anooccygeal ligament, and coccyx and connected (bi)laterally to the pelvis wall by the paraproctium as part of the corpus intrapelvinum
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 autonomic nervous system

anorectum with sphincter ani complex
the anorectum is fixed in its position by anooccygeal 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 (from superior rectal 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
cloritdal 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 (S1, S2)
nerves to levator ani and coccygeus (S3, S4)
nerve to sphincter ani externus (perineal branch of S4)
pelvic splanchnic nerves (S (2), 3, 4, (5))
and
pudendal nerve (S2, 3, 4)
exts pelvis thru greater sciatic foramen below piriformis muscle, crosses the back of the ischial spine, re-enter pelvis thru lesser sciatic foramen into ischiorectal fossa, gives off inferior rectal nerve for sphincter ani externus muscle, perianal skin an anus mucosa up to pectinate line, enters/exists pudendal canal, gives off 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, ischial spines, cervix, ischial 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 intrapelvic urogenitodigestive diaphragm
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
fig 7  sacrospinous ligament

fig 8  sacrotuberous ligament

fig 9  sacrotuberous ligament
sacrospinous ligament
obturator foramen

fig 10  greater sciatic foramen

fig 11  lesser sciatic foramen

fig 12  pelvis foramina
fig 13  arcus tendineus levator ani muscle
atlam

fig 14  arcus tendineus fasciae
atf

fig 15  atf + atlam

fig 16  origin pubococcygeus muscle
as part of levator ani

fig 17  origin iliococcygeus muscle
as part of levator ani

fig 18  origin coccygeus muscle
fig 19  origin obturator internus muscle
fig 20  origin obturator internus muscle
fig 21  origin piriformis muscle
fig 22  origin piriformis muscle
fig 23  cervix
fig 24  cervix
fig 25  cardinal ligaments
fig 26  cervix + cardinal ligaments
fig 27  sacrouterine ligaments
fig 28  cervix + sul
fig 29  sacrotuberous ligaments
fig 30  sacrotuberous ligaments
fig 31  sacrospinous ligaments

fig 32  sacrospinous ligaments

fig 33  pubocervical fascia

fig 34  pubocervical fascia

fig 35  rectovaginal fascia

fig 36  rectovaginal fascia
pelvis anatomy
### abbreviations

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<td>total abdominal hysterectomy</td>
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<td>total vaginal hysterectomy</td>
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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 \( \leq 4 \text{ cm} \)
moderate \( 5-6 \text{ cm} \)
normal \( 7-12 \text{ cm} \)
transitional \( 13-15 \text{ cm} \)
increased \( \geq 16 \text{ cm} \)
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         resp 25-30° as to horizontal from pubis bone to ischium spine

angle between symphysis and atf/atlam    110-125°

inter spinal distance 8-9 cm

inter 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
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and as influenced by many others since the author started his medicine study in 1959 but especially by prof j m greep, prof t k a b eskes and dr med h stenkhoff
anterior pre/subperitoneal compartment
urinary tract

median subperitoneal compartment
genital tract

posterior sub/retroperitoneal compartment
digestive tract