Update

Surgical mesh reconstruction for post hysterectomy vaginal vault prolapse. Part II: Treatment and complications

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Abstract: The post hysterectomy vaginal vault prolapse (PHVVP) occurs with up to 50% of parous women. It was reported to cause a variety of urinary, bowel and sexual symptoms and to necessitate surgical correction in 11% of the female population. Up to 30% of all females suffer from pelvic floor relaxation progressed to a level which has a negative impact upon their quality of life. Hysterectomy results probably with damages to the integrity and blood supply of the endopelvic fascia as well as to the innervation of the pelvic floor musculature. This might potentially contribute to later POP manifestation. Post hysterectomy vaginal vault prolapse challenges commonly the pelvic floor healthcare practitioner, requiring thorough understanding of the pathology and adequate skills for treating it. Various aspects of PHVVP reconstructive surgery a well as operations for the cure of co-existing morbidities as urinary incontinence, vaginal wall prolapse etc. are discussed in depth.

Key words: Post hysterectomy vaginal wall prolapse management.

1. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE: THERAPEUTIC GOALS

One should bear in mind the different surgeon's and patient's expectations and desires related to POP therapy. While the practitioner might be satisfied with goon anatomical restoration, the patient looks for the functional recreation mainly. There is a need for a holistic approach towards the patient's anatomical abnormalities and the related functional impairments, including urine and fecal control and sexual intercourse. Patient's un-realistic expectations with the therapeutic process should be identified and adjusted to the known operative curative properties regarding urinary and fecal incontinence, bladder over activity symptoms, sexual functions as well as body image. Co-existing occult urinary female stress incontinence should be diagnosed prior to surgery and dealt with an anti-incontinence concomitant procedure.

2. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE: HERNIATION CONCEPT

POP is actually bulging of viscera through weakened pelvic floor and vaginal walls. Terms used to describe the pelvic organ prolapse in general, and particularly post hysterectomy vaginal vault prolapse could be easily replaced by simply stating the specific herniation process. Cystocele and urethrocele are then herniation of the anterior compartment of the pelvic floor. Uterine, uterine cervix and PHVVP prolapse are all central pelvic floor herniation and enterocele, rectocele and perineal body tear are herniation of the posterior compartment of the pelvic floor. Endorsement of this approach improves the understanding of the underlying process and points to the appropriate therapeutic tools elected for cure, based on the knowledge accumulated regarding hernia repair at other regions of the human body.[1]

3. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE RECONSTRUCTION: ARCHITECTURAL DESIGN

Comprehensive pelvic floor anatomic-functional approach should be based upon solid long lasting suspension of the vaginal vault apex to well established pelvic sustained structures. Among such are the ATFP (Arcus Tendineus Fascia Pelvis) and the sacro-spinous ligament. The first lays along the lateral border of the levator ani muscles, from the inferior pubic ramus and the obturator membrane anteriorly to the ischial spine posteriorly and the second connects the iscial spine to the sacrum. Another anchoring option is the pre-sacral fascia, which longitudely covers the sacral vertebra and provides a solid structure which might serve as a suspensory point to secure the vaginal apex to. Attaching the vaginal vault to one of these ligaments will yield a long lasting apical support, permitting restoration of the impaired pelvic floor and organs functions. Some advocates the pre-sacral fascia, as it is easily reached it is reached easily via the peritoneal cavity, either by laparotomy or by laparoscopy, while others are against because of relatively high rates of intra and post operative bleeding potential, prolapse recurrence and difficult vaginal access. The ATFP, being relatively easily accessed via vagina is elected by some for vaginal vault support, and others will go for the SS ligament, saying this is the most stable pelvic structure, hence providing the best and longest standing support. Deep pelvic dissection, wider than for the ATFP, is necessary for reaching the SS. The cardinal and the utero-sacral ligaments are other potentially usable supportive pelvic anchoring points, yet not easily identified and often obscure. Unfortunately, there is no comparative data to guide any evidence based decision making regarding the preferred pelvic supportive connective tissue, rather than experts opinions.

4. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE: NON-MESH REPAIR

The PHVVP non mesh repair operations are mainly done via vaginal approach as the abdominal rout might frequently requires mesh to bridge the gape between the vaginal apex and the anchoring point at the pre-vertebral fascia. For sexually non active women, whenever the vaginal sexual functions might be sacrificed, colpectomy or vaginal obliteration (Le Fort operation) is a therapeutic option. These relatively safe and simple operations are carried out vaginally, yet prolapse recurrence rate was not established. The vaginal capacity is significantly and irreversibly reduced with these operations. If sexual intercourse function should be preserved, the vaginal capacity is to be maintained. Then are the commonly performed vaginal vault prolapse non-mesh repair done by apical suspension to the SS ligament. The sacro-spineous fixation operation requires deep para-rectal pelvic dissection and is eventually related to significant intra-operative bleeding. This operation was reported to be complicated by post-operative dispareunia, buttock pain, urinary and fecal incontinence, cystocele and rectocele formation, altered defecation and constipation, bladder injuries,

urinary retention and infections. The most troubling disadvantage reported to be attached to this operations is an acceptably high recurrence rate. Neither simple colporrhaphy, with or without plication of the utero-sacral ligaments, nor sacro-spineous and sacral colpopexies, seem to be the preferred procedures for repairing vaginal prolapse. Some authors observed that these surgical modalities are associated with an to up 58% recurrence rate in terms of objective POP scoring and prolapse related subjective symptoms while others reported on a recurrent surgery rate for pelvic floor reconstruction of 30%. True surgery related QoL improvement was never well addressed with these operations.[2-8]

5. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE SURGICAL SUSPENSION WITH MESH IMPLANTS FOR RECURRENCE RATE REDUCTION: JUSTIFICATION AND REASONABILITY

Given that recurrence rate following traditional vaginal apex re-suspension it unacceptably high and that underlying causative genetic, traumatic and surgical co-factors contributes to progressive weakening of the endo-pelvic fascia, one would endorse a recurrence reducing surgical method. The mesh implant concept was previously proven as recurrence reduction method with abdominal wall hernia repair and was later implemented for the pelvic floor herniation repair as well.[9]

6. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE SURGICAL SUSPENSION WITH MESH IMPLANTS SPECIAL PERSPECTIVES

Unlike with abdominal wall hernia vertical mesh repair, the vaginally horizontal implanted meshes are under relatively high level of physical pressure. This makes the vaginally implanted meshes prone to further prolapse, unless well secured to solid pelvic structures as the SS, the pre-sacral fascia, the ATFP or the utero-sacral ligaments. The vaginally implanted meshes are covered by thin and fragile layer of mucosa in comparison with the thick abdominal wall coverage; hence erosion and mesh exposure are possible post operative complication. Anti erosive surgical steps are to be taken in order to minimize mucosal erosion and vaginal mesh protrusion hazard. Among these anti erosive steps are the well respected tension free principles for herniation repair, for both – vaginal wall tissue and mesh. Refrain from excessive vaginal mucosa trimming and dissecting below the sub-mucosal fascia to preserve blood supply and nerve endings might contribute to reduce the post-operative tissue tension as well, avoiding ischemia, mal healing and tissue necrosis, thus reducing the mesh exposure incidence. There is much importance of replacing significant and sufficient parts of the endo-pelvic fascia, beyond the borders of the defected endo-pelvic fascia and pelvic floor herniation process, with the artificial synthetic fascia which is the mesh. This is best done by well spreading the mesh from one pelvic side-wall to the other, from the urethra and bladder neck to the vaginal apex, through the posterior compartment all the way down to the perineal body. Then are the pelvic organs not supported with the defected endo-pelvic fascia any more but rather with the fascia replacing synthetic mesh. Wide dissection is generally required for achieving proper repair and meticulous support ensuring. Ligament through passing with the mesh arms is the preferred anchoring method, as it probably yields long lasting support in comparison with suture mesh fixation methods. The pre-operative surgical field sterilization achieved with abdominal operations could never be gained with vaginal surgery, as this will be never exceed the level of "clean-contaminated" sterilization degree, due to inability to totally disinfect the vagina. Hence, especially anti-infectious designed new mesh types were requested. Macro-porous and mono-filament meshes discourage bacterial growth and nesting and thus are best used for vaginal pelvic floor reconstruction.

7. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE SURGICAL SUSPENSION WITH MESH IMPLANTS FOR RECURRENCE RATE REDUCTION - EVOLUTION OF THE CONCEPT

Though the best approach for restoration of vaginal apical support among the commonly utilized abdominal and vaginal routes remains controversial, the utero-sacral, SS, ATFP and Sacral ligaments vault suspension are the most anatomical among the repairs. Hence, it is most unlikely that these ligament supports for the vaginal apical prolapse will create a predisposition to future anterior or posterior vaginal vault defects or compromise vaginal function. Given that vaginal vault herniation is the result of separation of the pubocervical fascia from the recto-vaginal and paracolpion facia, resulting in an apical enterocele, it should be corrected by meticulous herniorraphy including reattachment of the vaginal vault to one of the above mentioned ligaments. Early attempts to apply the well accepted approach of simple mesh implantation with abdominal wall herniorrhaphy for recurrence rate reduction to the POP repair surgery ended with disappointing results. The failure and mesh exposure rates were extremely high and these attempts were stopped. The reasons for failure were better understood later, as the intra-abdominal forces directed to the pelvic floor implanted mesh and the relatively poor mucosal coverage were acknowledged. These considerations encouraged the design of an innovative procedure for the correction of the apical vaginal support defect, through replacement of the utero-vaginal ligament encoding with a synthetic sling, positioned at the levator plate level space via vaginal approach to the para-rectal area, performed in a daycare setting. The novel Posterior Intra-Vaginal Sling (PIVS), entailing minimal invasiveness via a vaginal approach together with anatomical restoration of the uterosacral ligament suspension of the vaginal apex, performed in a daycare set-up. Magnetic resonance imaging showed that significant improvements in the restoration of the vaginal configuration were achieved in patients who underwent PIVS. The PIVS operation facilitates uterine conservation, even in the event of advanced uterine prolapse. The restoration of the uterosacral ligaments support enables the surgeon to re-suspend the uterine isthmus, hereby avoiding the necessity to perform vaginal hysterectomy for the treatment of uterine prolapse. Thereafter further developments occurred: the mesh against slings debate rose up; questioning whether the preferred way for POP repair is replacing the specific broken endo-pelvic ligaments with synthetic sling is adequate. Others felt that the whole endo-pelvic fascia should be replaced with large mesh from one side-wall to the other and from the pubic bone towards the sacrum is desired, similar to the way mesh implants are used with abdominal wall herniation repair and ending with large mesh size. The best mesh pelvic fixation points and fixation method are another field of uncertainty with POP vaginal mesh implantation: the SS, ATFP, pre-sacral and the sacro-uterine ligaments were all advocated as suitable for pelvic mesh anchoring with variety of fixation methods. Some feel very strongly that the only long lasting fixation method is passing wide mesh arms through the ligaments, others simply sutured the mesh to ligament and various stapling devices were introduced as well. All the above mentioned influence the needed width of pelvic dissection, hence the needed training and skills as well as the potential operative hazards.[10-15]

8. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE - PRINCIPLES OF MESH RECONSTRUCTION

The support facilitating and enhancing mesh should be secured to the vaginal apex on one edge and to the elected supportive structure – the SS, utero-sacral, pre-sacral or the ATFP ligaments on the other edge. The mesh should substitute the herniation causing weakened fascia that led to prolapse of the central, anterior and/or posterior pelvic floor compartments. Thus, the post hysterectomy vaginal vault prolapse, as well as the frequently co-existing cystocele and/or entero-rectocele are to be properly corrected simultaneously. In case of co-existing cystocele should the mesh provide support to the whole anterior pelvic floor compartment and be secured also to the anterior end of the ATFP, while with co-existing entero-rectocele should the mesh provide support to the posterior pelvic floor compartment and be secured also to the perineal body. These additive secures will serve to stabilize better the mesh and avoid displacement and recurrent prolapse.

9. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE - SURGICAL PEARLS

Tension free concept for the mesh placement and attachment as well as the mesh covering tissue should be kept in mind at all times when reconstruction of damaged pelvic floor is undertaken. This will reduce tissue ischemia, tissue necrosis, mal healing and later mesh exposure. Preservation of viable blood vessels and nerve endings by deep and full thickness infra-fascial lateral dissection of the vaginal wall will contribute for mesh exposure reduction. This is remarkably facilitated with hydro-dissection which is helpful for getting into the true vesico-vaginal and recto-vaginal spaces leads to lower erosion rates. A non-ischemic colpotomy closing suture knotting and minimization of the vaginal through cut are also valuable anti ischemic measures. Extensive mucosal trimming for tissue tailoring while normal dimensioned vaginal recreation might end with tensioned vagina, thus to further mesh exposure. Important is meticulous mesh flattening before vaginal cut assembling, to avoid post operative infra-mucosal mesh folding and pain, including dysmenorrheal. Mesh position securing, either by ligament passing mesh arms or with suturing, should ensure that the mesh is properly spread to replace the whole herniation causing defected endo-pelvic fascia.

10. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE VERSUS REPAIR OF VAGINAL VAULT PROLAPSE WHILE THE UTERUS IS IN SITU

The un-removed uterus offers the surgeon solid central pelvic encoring points such as the cervical ring or the uterus itself. These organs might then both be attached to various solid structures at the pelvic side-walls, as the SS, sacro-uterine, ATFP or the pre-sacral ligaments. Being connected to the cervico sacral, cardinal and cervico-pubic ligaments provides the spared cervical ring extra sustainability for the pelvic floor, arising out of recruitment these web architecture structures to the pelvic reconstruction. This perspective challenges the widely endorsed practice of reflective appointment for vaginal hysterectomy with any uterine prolapse diagnosis, trained at many centers and performed routinely around the globe. Solid data regarding the question whether should the prolapsed uterus be removed are not available currently. Yet, some level 2 evidence supports the preservation of the prolapsed uterus or the uterine cervix at least, potentially guiding a change with the common attitude of automatic indication towards vaginal hysterectomy whenever POPS is present. The direct disadvantages of hysterectomy regarding pelvic floor reconstruction are the damages to the endo-pelvic fascia integrity, vasculature, blood supply and innervation and the deprivation of the advantage of using the cervical rind and the web of connected ligaments for providing extra strength to the pelvic floor architecture. All these are extremely important for maintaining further pelvic floor sustainability and functions. Performing hysterectomy concomitantly with mesh pelvic floor reconstruction increases significantly the risk of post operative mesh vaginal exposure and the need for further operative intervention to cure this complication. Not rare is the occurrence of vaginal shortening after hysterectomy, to such degree that impairment of sexual intercourse. Except of the negative influence on the pelvic floor structure and functions, entails vaginal hysterectomy many operation related complication, some of are health and life threatening, and it might also physiologically mutilate the disregarded hysterectomised patient's body image and self esteem. Minimally invasive novel methods for the treatment of menorrhagia, endometrial polyps and uterine myomas as well as increasing public awareness against preventable hysterectomies lead towards preservation of the prolapsed uterus.[16-25]

11. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE REPAIR-VAGINAL VERSUS ABDOMINAL APPROACH

There are two surgical access routes for reconstructive pelvic surgery to correct POP: the abdominal approach (either by laparotomy or via laparoscopy) and the vaginal approach. Though the best approach for restoration of vaginal apical support among the commonly utilized abdominal and vaginal routes remains controversial; the pelvic ligament vault suspension is the most anatomical among the repairs. Hence, it is most likely that the utero-sacral, SS, ATFP and Sacral ligament support for the vaginal apical prolapse will yelled a long lasting vault suspension and restoration of the vaginal functions. For the last decade, various surgical modalities for curing POP through reconstruction of the pelvic floor have been advocated, mainly modification of the colpo-sacral and colpo-sacro-spinal fixations, using vaginal or abdominal approaches, via laparotomy or laparoscopy. These operations where associated with well documented complications such as mesh erosion, dispareunia, buttock pain, urinary and fecal incontinence, altered defecation and constipation, bladder injuries, urinary retention and infections, cystocele and rectocele formation and protrusion, and other disadvantages such as long operative time, slow return to normal living activities and great costs. Given that the vaginal vault herniation is the result of separation of the pubo-cervical fascia from the recto-vaginal and para-colpion fascia, resulting in an apical enterocele, it should be corrected by meticulous herniorrhaphy with reattachment of the vaginal vault to the utero-sacral ligaments. The vaginal approach for POP reconstructive operations is associated with fewer complications and results in a shorter rehabilitation period than the abdominal route, whereas hysterectomy is widely performed concomitantly whenever the uterus is significantly prolapsed. However, there is no clear evidence supporting the role of hysterectomy in improving surgery outcome. The new minimally invasive procedure for apical prolapse suspension, as the posterior intra-vaginal slingplasty (PIVS) for correction of advanced uterine prolapse, enables uterine preservation. The issue of vaginal hysterectomy within the context of POP was addressed earlier with regard to the potential additive curative effect in terms of reduction of the POP post-operative recurrence rate and the influence of future quality of life. No advantage was attached to hysterectomy in the

surgical cure of POP. Replacement of the broken utero-sacral ligaments applying PIVS provides adequate uterine re-suspension, hereby permitting uterine preservation while treating advanced uterine prolapse.[26-30]

12. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE REPAIR - LAPAROSCOPIC APPROACH

Laparoscopic suspension of prolapsed uterus or prolapsed vaginal vault is feasible and has durable curative results, yet it requires advanced laparoscopic skills and an experienced laparoscopic center as sever damage might occur to the surrounding organs during operation. This is done by suturing mesh to the anterior and posterior aspects of the vaginal vault and securing it to the longitudinal sacral ligament at the level of sacral 2nd or 3rd spine. Post operative dispareunia is claimed to be reduced in comparison with vaginal reconstruction but this was not proved. the advanced laparoscopic surgical skills required for laparoscopic sacro-colpopexy include deep pelvic floor tissue dissection capability as well as familiarity with suturing and knot tying. Thus, this procedure is reserved only for the very well trained end experienced laparoscopists. However, when properly performed is the laparoscopic approach for sacrocolpopexy claimed to be as effective as the abdominal one, while the operative time is significantly longer and hospitalization, blood loss and rehabilitation period are much reduced. due to the necessitated meticulous and proper prior training remained the laparoscopic sacral colpopexy unpopular at many medical centers.[31-35]

13. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE - ISOLATED APICAL SUPPORT DEFECT MESH REPAIR

When the apical vaginal vault is prolapsed while the lower segment of the anterior and posterior vaginal walls are well suspended, apical correction only is needed. This might be achieved either via the abdominal cavity by laparotomy or by laparoscopy, or vaginally. The abdominal approach permits exposure of the pre-sacral longitudinal fascia for suspension of the prolapsed vaginal apes, yet frequently implanted mesh is required for bridging over the anatomical gap in-between the two structures. One mesh end is to be fixed to the pre-sacral exposed and bare 4 to 6 square cm. of fascia, avoiding the rectal vessels. The other mesh edge is fixed to the exposed vaginal apical wall. Often the bladder and the rectum must be dissected away from the vaginal apex for about 6 to 8 square cm. permitting adequate and sufficient mesh appliance in order to provide long standing support. Permanent sutures should be used for the mesh to soft tissue fixation. The suture must not be too tight to reduce the occurrence of tissue ischemia, necrosis and breakdown. Other possible fixation methods are staples, yet safety and durability were not reported. At the end the mesh is to be covered with peritoneum to avoid later intestinal damage. Vaginal apical suspension might also be achieved via vaginal approach, either using the ATFP or to the SS ligaments as anchoring points. The ligaments are reached via colpotomy, para-rectal or para vesical dissection and ischial space development. Displacement of the bladder, rectum and small bowels might be necessary for ligamentary palpation or visualization. Occasionally is the vaginal vault long enough for direct suturing to the suspensory ligament, yet – mesh implants are probably important for avoiding recurrence. Unless done bilaterally, which is a rather complicated operation, vaginal axis lateral deviation is induced, causing further potential dispareunia. The durability of this operation is not well established. Many advocates mesh implantation for sustained correction of vaginal vault prolapse, when performed via vagina. The mesh should be fixed either to the ATFP or to the SS ligaments on both lateral pelvic sides and to the vaginal apex medially.

14. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE - APICAL AND ANTERIOR VAGINAL WALL SUPPORT DEFECT MESH REPAIR

When the apical vaginal support defect is combined with anterior vaginal wall defect (cystocele), should the apical reconstruction (chapter 22) be followed with anterior vaginal wall reconstruction to complete the pelvic floor repair. This might be done by classical anterior Colporrhaphy most of the times, if only the potential supportive characteristics of the Vesico-vaginal endo-pelvic fascia are judged to be sufficient for long lasting prolapse correction. There are not any existing objective tools to guide such decision, hence must the surgeon base his preferred approach upon clinical impression related to the tissue nature and personal and family history. Elects the surgeon to perform a classical anterior Colporrhaphy, should he make a longitudinal medial anterior wall cut and free the vaginal wall from the bladder Detrusor muscle. Then should he place some transverse sutures to approximate both sides of the vesico-vaginal endo-pelvic fascia to recreate a dissent support for the bladder, trim the un-necessary mucosa to tailor a vaginal at normal capacity and length and close the surgical cut. Should the surgeon decide that the particular pelvic floor might be not appropriate for homologous repair, might a mesh implantation be desired. With such situation, might the surgeon consider adding mesh reinforcement for the anterior vaginal wall reconstruction to the apical support operation. The mesh should preferably cover the whole anterior wall fascial supportive defect, and be spread from one pelvic side wall to the other, from anterior to posterior, to replace literally the whole anterior compartment pelvic endo-pelvic fascia and prevent recurrent prolapse. Achieving proper mesh placement requires then a rather large paravesical dissection, along with the bony pelvis up to the iliac spins laterally and posteriorly and to the pubic bone upwards. The mesh should be flattened properly to prevent further lump formation and vaginal pain. The mesh and the overlying whole thickness and well blood supplied vaginal mucosa should be left totally tension free to avoid tissue ischemia, mal-healing and mesh exposure. The mesh should be well attached to solid intra-pelvic ligament to prevent support brake down. The mesh should be also secured to the fascial ring of the uterine cervix or to the vaginal apex at the insertion point of the former sacro-uterine ligaments to recruit the endo-pelvic ligaments for improved supportive results. Mesh fixation to the para-urethral tissue is desired as well to promise latter stabilization of the construction. Normally, mucosal trimming is avoided or limited with mesh implants to reduce the possible tissue tensioning and ischemia.

15. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE - APICAL AND POSTERIOR VAGINAL WALL SUPPORT DEFECT MESH REPAIR

When the apical vaginal support defect is combined with posterior vaginal wall defect (recto-enterocele), should the apical reconstruction (chapter 14) be followed with posterior vaginal wall reconstruction to complete the pelvic floor repair. This might be done by classical posterior Colporrhaphy, if only the potential supportive characteristics of the recto-vaginal endo-pelvic fascia are judged to be sufficient for long lasting prolapse correction. There are not any existing objective tools to guide such decision, hence must the surgeon base his preferred approach upon clinical

impression related to the tissue nature and personal and family history. Elects the surgeon to perform a posterior Colporrhaphy only, should he make a longitudinal medial posterior wall cut and free the vaginal wall from the rectum and enterocele herniation peritoneal sac. Then should he place a tobacco-pouch round suture to reduce the enterocele herniation and some transverse sutures to approximate both sides of the recto-vaginal endo-pelvic fascia to recreate a dissent support for the rectum. The distant levator muscles are to be approximated in a similar way to form a functional perineal body. The un-necessary mucosa is trimmed to tailor a vagina at normal capacity and length and then the surgical cut the closed. Should the surgeon decide that the particular pelvic floor might be not appropriate for homologous repair, might a mesh implantation be desired. When such occurs, should the surgeon add to the apical support operation posterior vaginal wall mesh reinforcement. The mesh should preferably cover the whole posterior wall fascial supportive defect, and be spread from one pelvic side wall to the other, from anterior to posterior, to replace literally the whole posterior compartment pelvic endo-pelvic fascia and prevent recurrent prolapse. Achieving proper mesh placement requires then a rather large para-rectal dissection, along with the bony pelvis up to the iliac spins laterally and posteriorly and to the perineal body anteriorly. The mesh should be flattened properly to prevent further lump formation and vaginal pain. The mesh and the overlying whole thickness and well blood supplied vaginal mucosa should be left totally tension free to avoid tissue ischemia, mal-healing and mesh exposure. The mesh should be well attached to solid intra-pelvic ligament to prevent support brake down. The mesh should be also secured to the fascial ring of the uterine cervix or to the vaginal apex at the insertion point of the former sacro-uterine ligaments to recruit the endo-pelvic ligaments for improved supportive results. Mesh fixation to the perineal body is desired as well to promise latter stabilization of the construction. Normally, mucosal trimming is avoided or limited with mesh implants to reduce the possible tissue tensioning and ischemia.

16. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE - APICAL, POSTERIOR AND VAGINAL HIATUS SUPPORT DEFECT REPAIR

When the apical vaginal support defect is combined with posterior vaginal wall defect (recto-enterocele) and with widely opened vaginal hiatus should the apical and posterior compartment reconstruction (chapter 15) be followed with reconstruction of the perineal body to complete the pelvic floor repair. This might be done by classical perineorrhphy most of the times, if only the potential supportive characteristics of the recto-vaginal endo-pelvic fascia are judged to be sufficient for long lasting correction of the relaxed tissue. When the ano-vaginal septum is extremely poor, both sides the levator plate recruitment might be necessary for erection of solid perineal body and reducing the vaginal opening dimensions. Was the posterior wall reconstruction made with mesh, could the perineal body reconstruction be use for further covering the mesh, hence reducing the post operative mesh exposure hazard.

17. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE - APICAL, ANTERIOR AND POSTERIOR VAGINAL WALL SUPPORT DEFECT REPAIR

When the apical vaginal support defect is combined with anterior and posterior vaginal wall defects (cysto-recto-enterocele), should the apical reconstruction (chapter 13) be followed with anterior and posterior vaginal wall reconstruction (chapters 14&15) to complete the pelvic floor repair.

18. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE - REPAIR OF APICAL SUPPORT DEFECT COMBINED WITH STRESS URINARY INCONTINENCE

When the apical vaginal support defect is combined with mid urethral supportive defect (occasionally forming urethrorocele), should the apical reconstruction (chapter 22) be followed with an anti urinary incontinence procedure, usually a mid urethral support reconstruction to complete the pelvic floor repair. One of the trans-obturator or retro-pubic TVT slings might be chosen better than the newly developed “mini slings”, in case that an anterior mesh was implanted, as the required deep para-vesical dissection might impair the tissue ability to harbor these mini-sling’s tips and they might not be well fixed.

19. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE MESH RECONSTRUCTION - MESH CHOICE

Accurate diagnosis of all the prolapse features and site specific support requirements identification are mandatory for proper mesh choice. It is the presence of isolated apical supportive defect only at the central pelvic floor compartment or any additional anterior and/or posterior compartments prolapse that determine the requested mesh shape. It is the coexistence of urinary stress incontinence that indicates the need for additional mid-urethral support. The elected mesh or combination of meshes should be providing support for all the prolapsed pelvic floor sites. One must beer in mind that some commercially available anterior compartment meshes are designed for cystocele repair only while others provides the possibility to suspend the prolapsed uterus by cervical ring attachment, thus permitting it to be preserved. Other meshes provide support the mid urethra, concomitantly with anterior compartment reconstruction, hence avoiding the need for additional tape to support the mid-urethra separately. The later ones cure not only the anterior compartment prolapse only but the uterine prolapse and/or stress urinary incontinence simultaneously with the cystocele repair. Other meshes are designed for posterior compartment reinforcement, some of provides the possibility to support the prolapsed uterus or vaginal apex at the same time. Whenever there is a need to treat several sites of pelvic supportive defects more than one mesh might be needed. There should be a dissent and convincing published body of evidence to prove the safety and efficacy of the specifically chosen mesh. The surgeon must be properly trained with any new mesh by an experienced trainer and familiar with potential hazards' including prevention and management of these. The mesh texture need to be as soft and light as possible, none shrinking, small in dimensions, yet sufficient for complete replacement of all defected parts of the endo-pelvic fascia and pelvic floor herniation. Thorough defected endo-pelvic fascia substitution with the artificial fascia is crucial for insuring long lasting support. Host against graft and graft against host reaction formation should be ruled out according with any particular mesh prior to usage, so should any mesh related bacteria nesting or harboring. This is generally the case with type 1 mono-filament macro-porous knitted meshes, not interfering with macrophages migration. Long lasting anchoring method were reported to involve ligament through passing mesh arms, thus the particular mesh attachments to the pelvic chosen supportive points should be proved before hands for long lasting support, preferably with mesh arms through

ATFP or SS ligaments anchoring. Mesh and arm delivery systems for mesh individually prepared or pre-cut kits should be proven to yield the desired correct mesh and arms placement at the pelvic floor. Some pre-cut meshes might be too small to provide the necessary complete coverage of the whole fascial defects, thus easier to place because less dissection is required. Others might provide relatively easy arm placing devices, but at the price of improper arm passage at the deep ligaments of the pelvis for appropriate high support. These meshes might be prone to operative failure and recurrent prolapse. One should not be tempted for these easy to apply kits but rather go for the highly curative ones. Bio meshes where not proven to yield any advantage over the synthetic ones and one should not endanger his patients with bio-hazards. Smilingly, the absorbable meshes where not reported to entail any superiority and one should ask himself is there any potential benefit of a vanishing mesh in herniation repair at all. The list of available commercially manufactured products expends fast and the existing ones are regularly re-shaped, thus there is no point in referring to any particular currently available mesh. With this atmosphere of many newly designed meshes popping up almost monthly, one must be extra couches when choosing his own mesh. Of huge importance is solid clinical data, proving high cure rate and low rate of complications of mild nature. One should seek for proper training before adopting any new operation and maintain his skills with frequent operation performance.[36]

20. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE MESH RECONSTRUCTION RELATED COMPLICATIONS: A. INTRA-OPERATIVE COMPLICATIONS

Superficial or deep bleeding might occur during operation, related to arterial or venous breakdown. While dissecting or at needle insertion might the neighboring viscera be perforated; this could involve the urethra, the bladder – at the ureteral orifice or remote from there, the small or large intestine. **B. early post-operative:** at the post operative course might partial or complete bladder outlet obstruction present, field infection could be evident, hematoma formed, vaginal, pelvic or at the thigh pain could appear- with or without neurological deprivation. **C. late post-operative complications:** chronic vaginal, pelvic or at the thigh pain and dispareunia were reported to complicate prolapse reconstructive surgery, with or without neurological deprivation, so was also vaginal mesh protrusion and bladder or rectal mesh protrusion. There is some unclearness whether the last ones occurred during or after the operation. Sacral abscess formation and vesico and recto-vaginal fistula are severe and health threatening post operative complications related to POP reconstruction. Mesh exposure has been described to complicate the postoperative course of these procedures in about 15% of the patients, other complications are relatively rare, yet important because of their potentially sever consequences. All the above mentioned complications were reported to complicate the abdominal as well as the vaginal operations, with type 1 or non type 1 mesh.

21. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE MESH RECONSTRUCTION - REDUCING OPERATIVE COMPLICATIONS RATE

Proper training, skill maintaining and good surgical technique keeping are always the golden keys for any operative complication rate reduction. **Avoiding intra-operative bleeding:** hydro-dissection first, than dissecting at vessel free anatomical planes will reduce vessel breakage and bleeding. So will sharp dissection and proper needle passing through a-vascular tissues. **Avoiding intra operative urethral, bladder and intestinal injury:** meticulous dissection, according with standardized and pre-designed surgical steps and respecting anatomy alternating adhesion and fibrosis related to prior surgeries, might contribute to avoiding visceral operative damage. **Avoiding early post operative bleeding:** proper and meticulous intra-operative hemostasis and use of coagulation inducing agent when indicated will definitely reduce post operative bleeding potential. So might the usage of vaginal tampon. **Avoiding post operative pain:** post operative vaginal and pelvic pain and dispareunia might be reduced with proper placement and flattening of the mesh and with tension free surgical technique for both – tissue and mesh. Radiated thigh and leg pain are reduced by properly passing the mesh arms within the pelvic structures – away from neighboring situated nerves. **Avoiding post operative urinary obstruction:** urinary obstruction will be widely avoided by proper non tension mesh placement at the bladder neck level. **Avoiding post operative mesh exposure:** choosing the type-1 mesh for bacterial infection avoiding, vessel and innervation sparing full thickness vaginal wall dissection, shortening the vaginal surgical cuts as much as possible, meticulous hemostasis, non tensile mucosal closing, minimal mucosal trimming – all these will reduce tissue ischemia, necrosis, mal-healing and risk for mesh exposure. **Avoiding post-operative vaginal mesh bladder or rectal mesh protrusion or fistula formation:** meticulous anatomically wise dissection at the proper inter organ planes as well as tension free surgical techniques for both – tissue and mesh and blood vessels preservation will prevent late visceral mesh injury.37

22. POST HYSTERECTOMY VAGINAL VAULT PROLAPSE MESH RECONSTRUCTION - MANAGEMENT OF RELATED COMPLICATIONS: INTRA-OPERATIVE BLEEDING

Apply direct pressure upon bleeding zone, either manually or by packing, if needed - use advanced hemostatic agents or place hemostatic sutures to secure the broken blood vessels, consider selective arterial embolization or pack and finish the procedure. Note: bleeding might be extra-peritoneal, thus large in volume, be ready for blood transfusion, **Intra operative urethral injury:** vaginal repair is possible with 3 different anatomical tissue layers: urothelium, connective tissue and vaginal mucosa. Visualize urethral patency; keep the bladder drained for a week, continuing the mesh placement is optional. **Intra operative bladder injury:** evaluate damage with cystoscopy whenever bladder injury might be suspected. Unless ureteral orifice is involved - vaginal repair is possible, otherwise repair abdominally. Correction is best performed with 3 different anatomical tissue layers: urothelium, connective tissue and vaginal mucosa. Consider use of ureteral catheter; visualize ureteral patency, keep the bladder drained for a week. Controversy exists regarding mesh implantation after cystotomy, continuing the mesh placement is optional only if the bladder injury is mild in nature and leakage is not anticipated. **Intra operative small intestine injury:** if minor – repair and proceed with operation, otherwise – repair but refrain from mesh placement. **Intra operative large intestine injury:** if small – repair, otherwise consider diversion and colostomy. Abort procedure and do not implant mesh to avoid infection and protrusion. **Early post operative bleeding:** if patient is stable hemodynamicaly - use vaginal tampon and monitor vital signs as well as Hematocrit levels and ultrasonic imaging of the hematoma. Consider hematoma evacuation only if clinically significant, provide

preventive antibiotics. **Early post operative pain:** to a certain level of post operative pelvic pain is frequent and successfully dealt with by oral analgetics. When excessive or referred pain is evident, suspect nerve involvement or pelvic hematoma, take necessary diagnostic steps and act accordingly by removing the mesh or evacuating the hematoma. **Early post operative urinary obstruction:** complete post operative urinary obstruction is rarely improved with expectancy, thus early intervention to relieve increased mesh tension is indicated. This is easily achieved by re-opening the primer surgical cut at the anterior vaginal wall, clamping the mesh on midline sides and gentle downpulling, avoiding urethral damage as well as exaggerated mesh loosening. If just partial obstruction is diagnosed, and the residual urine volume is only moderately increased, recatheterization is probably sufficient as spontaneous relief occurs frequently. **Post-operative vaginal mesh protrusion** - small mesh exposures, occurring after abdominal colpo-sacro-pexy or vaginal reconstruction, might it be subject to local estrogens for a month time. There after - surgical removal is indicated if persistent. With large mesh exposures or with non type 1 mesh surgical removal should be performed as first measure as conservative treatment would be fruitless. **Late post-operative pain:** mesh exposure or retraction and vaginal tissue fibrosis might cause vaginal, pelvic, buttock or thigh pain, with or without neurological deprivation. Local treatment with estrogen and anti inflammatory might reduce pain, otherwise intervention should be considered for exposed mesh removal or mesh tension release. Chronic irradiated pain to lower extremity, especially when combined with neural deprivation, calls for mesh arm removal. This is not easy to perform and entails limit results. **Late post-operative discharge:** chronic vaginal discharge might be due to mesh exposure or vaginal granulation tissue formation; thus removal of these is indicated. **Post-operative dispareunia:** mesh exposure or vaginal wall tissue fibrosis should be suspected, especially if the partner is inconvenient during sexual intercourse as well. Thus, removal of these is indicated. **Post-operative vaginal mesh bladder or rectal mesh protrusion and vesico or recto-vaginal fistula:** These should be dealt with surgical therapy. The mesh should be removed and injured viscera should be treated. Surgeons should be familiar with and well trained for managing these complications, yet one should seek for proper assistance with decision making as well as with the requested surgical measures.[38-44]

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TABLE 1. – Surgical mesh reconstruction for post hysterectomy vaginal vault prolapse.

	Non Mesh Operations		Mesh Operations		
	Vaginal Obliteration and Colpectomy	Sacro Spineous fixation	Vaginal	Abdominal	Laparoscopic
Skill requirements	Average vaginal skills	Advanced vaginal skills	Advanced vaginal skills	Average abdominal skills	Advanced laparoscopic skills
Complication rate	Low grade	Medium grade	Medium grade	Medium-high grade	Medium-high grade
Operative time	Relatively short	Relatively short	Relatively short	Relatively long	Relatively long
Rehabilitation time	Relatively short	Relatively short	Relatively short	Relatively long	Relatively short
Cure rate			Relatively high		
Cure durability	Presumably long	Presumably long	Presumably longer	Presumably longest	Presumably long
Cure of coexisting other POP features	Feasible		Feasible	Relatively complicated to perform	
Post operative vaginal sexual intercourse	Sacrificed		Low rate of dispareunia		

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