

Surgical approach to Peyronie's disease

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Learning objectives

By the end of this module the reader should be able to:

- demonstrate a basic knowledge of the demographics of Peyronie's disease (PD)
- make appropriate decisions for the surgical approach to PD.

Introduction

The prevalence of PD ranges from 0.5–20.3%, depending on the population and the definition used for PD. The most commonly accepted hypothesis for the development of PD is that in genetically-predisposed men, repetitive microvascular trauma to the tunica albuginea, associated with penile buckling in the erect or semi-erect state secondary to sexual activity, initiates a cascade of extravascular protein deposition, fibrin trapping, macrophage recruitment, cytokine overexpression, and release of elastase [1–4]. This leads to a change in the tunical collagen, from the predominant type 1 to type 3 [5]. These structural changes on the tunica subsequently lead to the development of a fibrotic plaque. A single traumatic event, in either the erect or flaccid state may also trigger PD.

As a result of these tunical alterations, the tunica albuginea loses its elasticity and develops a penile curvature and/or indentations [6]. Furthermore, penile length loss might occur due to the loss of elasticity caused by these structural alterations. Almost 60–80% of men affected by PD reported subjective penile length loss [7]. However, this issue is mostly ignored when urologists consider treatment options.

PD not only has functional and physical consequences in a man's life; but also severely affects the patient's self-image and potentially results in depressive symptoms, relationship discord, and social isolation [8]. In addition, Smith *et al.* have reported that the loss of penile length leads to severe emotional challenges, which eventually leads to detrimental effects on the patient's quality of life and psychological condition [9].

Treatment of PD consists of conservative therapeutic modalities (such as injection therapy with collagenase clo-

tridium histolyticum [10], intralesional verapamil [11], intralesional interferone [12] and traction therapy [13]) and surgical correction of the underlying penile curvature with plication techniques, such as the Nesbit procedure [14], or plaque incision/excision and grafting procedures [1, 15, 16]. If a patient concomitantly suffers from medication-refractory erectile dysfunction (ED), a surgical correction of the curvature alone is not recommended; this is because the inability to engage in penetrative sexual intercourse will persist regardless of curvature correction. In these cases, a penile prosthesis should be implanted instead with straightening manoeuvres [1, 17].

This review will focus on the decision-making process for the surgical repair of PD (Table 1). The aim of the review is to enable readers to better understand PD and its surgical treatment options to an extent that will allow the reader to make informed treatment decisions based on current literature and guidelines.

Surgical therapeutic modalities for PD

In order to offer surgical reconstruction of the penis to patients affected by PD, certain parameters have to be met. These include [18]:

- at least three months with stable disease with no changes to the penile deformity
- absence of inflammatory penile pain (as experienced in the acute phase)
- compromised ability or inability to engage in penetrative sexual intercourse due to the degree of the penile curvature and/or inadequate axial rigidity of the penis
- patient's dissatisfaction with the shape of the penis
- patient's treatment wish.

In order to decide on the best surgical approach for each patient, a proper preoperative diagnostic work-up has to be performed. This includes the palpation of potential plaques on the penile shaft in the flaccid state, as well as the evaluation of the degree of curvature following the induction of an artificial erection. The presence of any indentations should be evaluated, preferably during the artificial erection test. Auto-photography of the curvature by the patient has not been found reliable. An ultrasound evaluation

of the PD plaque is important as well, as the information regarding the calcification status may have an effect on the therapeutical approach. Since ED is quite common, a duplex sonography of the penis may also be performed; its findings may be helpful in the decision making process. It is also important to evaluate whether a patient has suffered from significant penile length loss since the onset of the disease^[20]. Penile length loss is an issue that should be addressed pre-operatively, as certain surgical techniques (such as the widely-used Nesbit technique) will further reduce penile length and aggravate the negative effects on the psychological well-being of the affected patient. Once these data have been obtained, a decision on the best surgical treatment can be made.

According to guidelines on PD^[17-19], any surgical treatment decision should be based on the degree of the penile curvature and the aforementioned parameters.

PD resulting in minimal penile deformity and curvatures of less than 30°

Patients who suffer from a minor penile curvature of less than 30° usually do not face significant problems in engaging in penetrative sexual intercourse. In these cases, patients should be advised that refraining from any surgical intervention is a viable therapeutic option. This wait-and-see strategy implies that surgical interventions are deferred until the penile deformity worsens. Patients should be informed that one of the biggest aims of PD surgery is to restore a functionally straight penis (which is defined as less than 20° residual curvature), which will allow the patient to engage in sexual intercourse. Therefore, if the curvature is minimal and no impairment is reported, no treatment is necessary. At the same time, reassurance should be given to the patient that PD is not a malignant disease.

In patients who report penile length loss and depressive symptoms, surgical correction of the curvature can be offered. In these cases, a plication technique such as the Nesbit technique is recommended; the expected length loss with this technique is minimal, and thus, will not affect the patient as much.

PD resulting in curvatures of 30–60°

Patients with a significant penile curvature of 30–60° represent a big sub-group of patients with PD. These patients should be offered surgical treatment if the functionality of their penis is impaired and if a patient wishes treatment. Most guidelines on the surgical treatment of PD deformities recommend plication techniques (Fig. 1) for this subgroup of patients^[17-19].

Since the description of the original Nesbit technique in 1965^[14], multiple modifications have been published and used for the correction of PD. Examples of plication tech-

niques include the Yachia^[20], 16-dot^[21], Tunica Albuginea Plication (TAP)^[22], and Essed-Schroeder techniques, among others. The International Consultation of Sexual Medicine^[17] stated that there was no evidence that one surgical plication approach provides better outcomes over another (Table 2). It has to be stated that the experience of the surgeon rather than the technique itself has a direct impact on the result of the surgery and therefore on the patient satisfaction. If one is not familiar with penile curvature treatment, patients should be referred to specialised colleagues.

The recommendation to use plication techniques in this subgroup is based on the widely accepted belief that penile length loss is less significant in this subgroup of patients. Conversely, in the group of patients with curvatures of greater than 60°, plications can lead to significant loss of penile length and alternatives such as grafting procedures should be explored, if possible. Fewer length loss issues were seen in some patients within the 30–60° subgroup. However, in some patients, PD has already resulted in significant penile length loss; further penile length loss through surgery would have detrimental effects on the functionality of the penis and on the psychological well-being of these patients. Kueronya *et al.*^[23] demonstrated that penile length loss following any surgical intervention to correct a penile curvature is the greatest negative predictive factor for dissatisfaction with the outcome of a procedure. Length loss due to surgery is bothersome for many patients and can lead to depression^[8]. Therefore, it is recommended to assess subjective penile length loss due to PD preoperatively. Patients should be asked if they have lost penile length since the onset of PD, and if this is bothering them. Subjective penile length loss is present in 60–80% of patients when PD is evaluated preoperatively^[7, 23]. In cases where patients complained regarding significant penile length loss due to PD, patients should be offered length-preserving surgical techniques. Incision and grafting procedures, with or without partial plaque excision, have shown very good results in terms of curvature correction. However, these surgically more demanding procedures should only be offered if the patient does not suffer from concomitant ED, in order to avoid postoperative impotence. Incision and grafting techniques are also regarded as more technically demanding, and should therefore only be offered by surgeons with enough experience with this technique, as potential side effects as erectile dysfunction could arise following surgery.

As previously mentioned, the potential drawbacks of plication techniques include further loss of penile length and the fact that these techniques do not address hinge effects or hourglass defects. In fact, these techniques may actually exacerbate them, resulting in an unstable penis^[19]. Furthermore, known side-effects of plication techniques are palpable knots and permanent pain on the penile shaft,

depending on the suture material used [17]. Nevertheless, plication techniques are effective and safe treatment options for patients with a minor PD-induced curvature and no issues with penile length loss. A review of the literature indicates that surgical straightening with a variety of plication procedures can be expected in 85–100% of patients. Of these, the risk of new ED is 0–23%, and diminished sensation is reported in 4–21% [19].

When talking about penile length loss due to plication techniques three aspects need to be mentioned and need to be taken into consideration. First, the perceived length loss by the patient depends on the direction and severity of the curvature. Greenfield *et al.* [24] showed that patients with ventral or ventrolateral curvatures had the highest percent loss of length [24]. Furthermore, postoperative penile traction therapy seems an effective tool to counteract perceived and measured penile length loss [25]. Last, but not least, it is a well-accepted fact that penile surgery goes along with a discrepancy in subjective versus objective measured penile length.

PD resulting in penile curvatures of over 60°

In this sub-group of patients, a plication technique is not the first choice. This is mainly based on the fact that curvatures above 60° have a significant difference between the concave and convex side of the curvature. This results because of the fact, that the Peyronie's plaque does not have the same elasticity as the surrounding tunica albuginea. Therefore, the side of the curvature where the plaque is located will shorten inevitably, resulting in a significant penile shortening. As a result, any plication technique that aims to shorten the convex side of the curvature according to the length of the concave side of the curvature would result in significant penile length loss (Fig. 2). Instead of plication techniques, grafting procedures should be offered. While proven to be safe, grafting procedures are more demanding and are associated with a higher complication rate in non-experienced hands. A prerequisite for the application of any grafting surgery is a good erectile function of the penis [26]. Predictors for postoperative ED include the age of the patient (over 55 years old), evidence of corporal veno-occlusive dysfunction on penile duplex sonography analysis (RI less than 0.8), ventral curvature, and possibly the severity of curvature [26–28].

Historically, grafting procedures started with plaque excisions, resulting in big tunical defects disrupting the veno-occlusive function of the spongy tissue and the tunica albuginea, which led to high rates of ED. Therefore, plaque incisions have been introduced, where a H- or Y-incision is made in the area of maximum curvature [15, 16, 29, 30]. Plaque incision techniques do not require the excision of large parts of the plaque. Once the tunica albuginea is incised, the tunica can expand in the area, thereby correcting the penile deformity. The aim of each of the grafting tech-

niques is to correct the penile curvature by lengthening the short concave side of the curvature according to the length of the long convex side (Video 1). Care should be given when the tunica is incised and the spongy tissue of the corporal bodies is exposed, so that minimal trauma to the spongy tissue is applied and the veno-occlusive relationship between the cavernosal spongy tissue and the overlying tunica and graft is not disturbed [19].

As mentioned previously, multiple grafting techniques are available, all of which aim to preserve the long convex side of the curvature. In an attempt to objectify the incision line on the penile curvature and the size of the graft reliably, Egydio published his approach for the correction of PD curvatures based on geometric principles [16]. This technique tries to identify the point of maximum curvature according to geometric principles, in which the tunical incisions have to take place. It also allows one to identify the length and the width of the graft required, even before the incisions are made (Figs 3 & 4). In general, this technique helps to objectify the underlying curvature and its surgical correction. A multicentre study evaluated the long-term outcomes of 157 patients affected by PD who underwent the incision and grafting technique based on the geometric principles of the Egydio technique. After a median follow-up period of 20 months (range: 12–24 months), mild residual curvature (12%) and glans hypoesthesia (3%) were the only causes of partial dissatisfaction. No rejection of the graft was observed. All patients recovered their ability to penetrate with no difficulty. In addition, an intraoperative average increase of 2.5cm (range: 1.7–4.1cm) in stretched penile length was recorded. The authors concluded that this procedure represents a safe and reproducible technique for the correction of penile curvature [31].

In cases of grafting procedures, one needs to identify the best graft for surgery. Autologous grafts [15, 32–37], which are harvested from the patient's own fat, dermis, tunica vaginalis, dura mater, temporalis fascia, fascia lata, saphenous vein, crura, and/or buccal mucosa have been widely abandoned, because of the necessity to extend surgery and harvest the graft from another part of the body. This increases the potential risk of complications, infections, and scarring. Furthermore, the contraction rate of these grafts is higher, resulting in a recurrent curvature.

Autologous grafts have been widely replaced by xenografts such as processed bovine (or human) pericardium, porcine intestinal submucosa, and porcine skin [38–40].

An interesting and relatively new approach of grafting is the use of a collagen fleece to cover the tunical defects following partial plaque excision and relaxing incisions on the tunica albuginea [41, 42]. This grafting procedure involves a ready-to-use collagen fleece coated with tissue sealant (TachoSil, Nycomed). Published data showed a total

straightening rate of 83.6% [41,42], which is comparable with all the other grafting techniques. The major advantages of this technique are decreased operative times and easy application of the graft without the need to suture it onto the tunica. Although the published results seem encouraging, the use of this ready-to-use collagen fleece is still not standard practice, as long-term data has to be published, and further evaluation of its safety is still outstanding.

PD resulting in indentations and hourglass defects, with or without curvatures

In cases of an hourglass deformity caused by PD (with or without a penile curvature), the decision-making process should be strongly based on the evaluation of the patient's erectile function and the axial rigidity of the penis. Hourglass defects and indentations may compromise the axial rigidity of a patient's penis, these structural alterations of the penile shaft might lead to hinge effects, which have to be taken into consideration when treatment decisions are made.

In patients with indentations and/or hourglass defects and good erectile function, a straightening procedure (with grafting) should be the preferred approach to straighten the penis and restore penetrative ability. Simple plication techniques might straighten the penis, the indentation or hour glass defect will however not be counteracted. However, if poor erections are present and the axial rigidity of the penis is compromised, the insertion of a penile prosthesis is a better option. This is based on the fact that a hinge effect reduces the axial rigidity of the penis; a simple straightening procedure will not counteract this problem. Assessment of this parameter is therefore crucial in the decision making process [43].

In other words, in cases of severe indentations or hourglass defects resulting in a hinge effect, a penile prosthesis insertion is recommended when axial instability and ED is present. In cases of good-quality erections and axial instability a grafting procedure can be performed to correct the calibre of the penile shaft. This will result in a better axial rigidity.

PD resulting in severe deformities and therapy-resistant erectile dysfunction

In cases of PD with therapy-resistant ED, or in severe and complex PD deformities, insertion of a penile prosthesis seems to be the best solution, since it corrects the deformity and restores sexual function.

In minor curvatures or axial instability caused by an indentation or hourglass defect, a simple penile prosthesis insertion is sufficient, and no additional straightening manoeuvres are necessary [19]. However, in severe penile curvatures, penile straightening should be performed in

order to ensure a straight and functional penile axis. This can be performed by plications, relaxing tunical incisions, grafting, the so-called "modelling" [44], or by more invasive techniques that aim to reconstruct the penis, such as longitudinal and circular grafting [45, 46], the 'sliding technique' [47, 48] or the 'Modified Sliding Technique (MoST)' (Video 2) [49] or the tunica expansion procedure (TEP), an innovative non-grafting proposal for penile enlargement [50].

Wilson *et al.* [44] introduced the concept of "modelling", which aims to stretch or tear the plaque and straighten the penis by bending the curved penis into the contralateral direction of the original curvature for 60–90 seconds. The modelling procedure has to be performed following the insertion of the inflatable penile prosthesis cylinders and their inflation. In cases of a residual curvature following modelling, plications or relaxing tunical incisions (which may be covered by a graft) may be necessary. Care must be taken not to risk any needle puncture of the penile prosthesis, when plications are performed after the penile prosthesis placement.

Among the general population, satisfaction rates with inflatable penile prostheses are high (60–96%) [7, 51, 52]. However, the literature shows that patients with PD who undergo an insertion of a penile prosthesis belong to the sub-group with the lowest satisfaction rate [53]. Although not much data has been published on this topic, one can conclude that this low satisfaction rate might be attributed (among other reasons) to the additional penile shortening following the implantation of the penile prosthesis, with up to 54% of patients reporting a further decrease in penile length post-insertion [7]. Wang *et al.* demonstrated that a penile prosthesis insertion leads to a mean penile length loss of 0.74cm [54]. This additional length loss may aggravate the negative effect of PD on the psychological well-being of patients.

Therefore, it is recommended to evaluate the patient's subjective penile length loss preoperatively and address the fact that simple penile prosthesis insertion might shorten the penis further. In cases where the patient does not agree to further penile shortening and requests restoration of his original penile length, more invasive surgical options should be offered [55]. These men need special consideration during pre-operative counselling to address their loss of length and function due to PD and ED.

Multiple techniques have been published for such cases. The published results seem promising and encouraging, however, severe complications such as glans necrosis have become evident in some of the studies. Therefore, it must be pointed out that these reconstructive surgical measurements should only be considered in selective cases where penile length loss is an issue, and should only be performed in experienced centres by high-volume

surgeons, in order to avoid potential complications.

Egydio *et al.* [45] reported positive outcomes for circular and longitudinal tunica albuginea incisions with grafting to restore penile length and girth in 105 patients with severe PD. In that study, patients reported an overall satisfaction rate and the rate of satisfaction with penile length gain of 89.4% and 95.2%, respectively, according to the Erectile Dysfunction Inventory of Treatment Satisfaction (EDITS) questionnaire [56]. In addition, the mean functional length gain was 3.6cm (SD, 0.7; range, 2–5). One patient (1.0%) underwent removal of an infected prosthesis. Sansalone *et al.* [46] also reported a similar approach in 23 patients, which resulted in a mean length gain of 2.8cm (range, 2.2–4.5) and a 90% patient satisfaction rate.

Rolle *et al.* [47] developed the ‘sliding’ technique, which was based on a ventro-dorsal incision of the tunica albuginea, penile prosthesis implantation, and double dorsal-ventral patch grafting. Their initial series consisted of only three patients with PD, ED, and severe penile shortening; the average operative time was 170 min, with no major intraoperative or postoperative complications. In addition, the mean length gain was 3.2cm (range, 2.5–4.0).

The updated series by Rolle *et al.* [48] showed their long-term multi-centre follow-up study on the sliding technique. From June 2010 to January 2014, 28 consecutive patients with stable PD with severe penile shortening and end-stage ED were enrolled in three European PD tertiary referral centres. The mean follow-up was 37 (range, 9–60) months. There were no intraoperative complications. Postoperative complications included a penile prosthesis infection requiring the removal of the device (7%). There were no late recurrences of the shaft deformation. The mean penile length gain was 3.2 (range, 2.5–4.0)cm.

Egydio and Kuehhas [49, 57] published their modification of the sliding technique (Fig. 5). This modification consists of three key elements:

1. the sliding manoeuvre (Video 2) [47] for the restoration of penile length
2. potential complementary longitudinal ventral and/or dorsal tunical incisions for the restoration of penile girth
3. coverage of the newly-created tunical defects, using Buck’s fascia rather than a graft.

The intended benefit of the modified sliding technique is to reduce operative times and costs associated with the surgery. Circular grafting and the ‘sliding technique’ can be time-consuming procedures and an extended operative time is a potential risk factor for penile prosthesis infection.

A more recent development is the so-called tunica expansion procedure (TEP) [50, 58]. The goal of Egydio was

to develop a non-grafting procedure to promote lengthening and widening of the penis in cases of length and girth compromising diseases such as Peyronie’s disease with concomitant severe erectile dysfunction. In such cases a simple penile prosthesis implantation would only fix the functional issues as we know, but would completely disregard the complaints of the patients regarding their loss of length and girth. Therefore, Egydio described a geometric pattern of multiple staggered small cuts on the tunica albuginea with an optimal ratio between tissue expansion and resistance to confine the cylinders of the penile implant inside the corpora cavernosa, avoiding dents and bulging defects (Fig. 6). Between February 2016 and February 2019, 416 patients suffering penile shortening with or without Peyronies disease underwent the TEP procedure with concomitant placement of a penile implant. 287 patients out of the cohort of 416 patients suffered from Peyronie’s disease (mean axial deviation 51°, range 0-90°). 40,86% of the patients had tunical constrictions, which were corrected with vertical relaxing incisions. A mean penile length gain of 3.3 cm (range 2-6 cm) was reported. The limiting factor of the lengthening is always the elasticity of the neuro-vascular bundle. The advantage of the TEP procedure is that it effectively resolves problems of penile size reduction independently of the presence of a penile curvature. It eliminates the necessity of grafting and improves the known penile lengthening techniques using small, staggered cuts on the tunica albuginea, while maintaining the structural resistance of the tunica in order to contain the cylinders of the penile implant within the corporal bodies. Bulging and denting are not seen. Furthermore the technique allows a restoration of axial rigidity. The TEP technique allows for longitudinal and horizontal restoration of the elasticity (Fig. 7).

Last, but not least, although the published data on the various lengthening techniques seem promising, and the results show the safety and feasibility of these techniques, it also has to be stated that all of these lengthening techniques do not yet conform to guidelines, as long-term data is still scarce. Their indication is very narrow, and they should only be performed in experienced hands, as potential complications might have detrimental outcome on a patient’s life. Potential complications include:

- (partial) loss of glans sensation
- glans and urethral ischemia resulting in necrosis of the affected tissue
- penile prosthesis infection including all the devastating sequela
- loss of the penis
- cylinder displacement
- cylinder bulging
- failure to gain substantial length.

It is also worth noting that the majority of the cases re-

ported with length restoration procedures were with malleable and not with inflatable penile prostheses. This is an important factor that has to be addressed as well, as the insertion of inflatable penile prostheses might bear more potential complications compared to the insertion of a malleable penile prosthesis. Issues such as bulging defects or aneurysmatical defects of the cylinders might be potential issues that the implanter and the patient have to face. It is therefore important to evaluate these techniques when more long-term data is available and enough data on the use of inflatable devices is available.

Conclusion

The surgical approach to PD is complex and many parameters should be taken into consideration. Patient wishes, surgical options, severity of the penile deformity, preoperative erectile function, and presence of hourglass defects are among some of the parameters that have to be evaluated in order to decide on the best surgical approach for an affected patient.

Key learning points

Demographics

- Prevalence rates for PD range from 0.5–20.3%.
- The most well-accepted hypothesis for the development of PD is that in genetically-predisposed men, repetitive microvascular trauma to the tunica albuginea or a single traumatic event in either the erect or flaccid state initiates a cascade of abnormal wound healing on the tunica, which eventually results in the formation of a plaque.
- Plaque formation leads to the loss of elasticity of the tunica albuginea, which will lead to the typical signs of PD: curvature development, indentations (hourglass defect), and penile length loss.
- Among the patients with PD, 60–80% complained of penile length loss before any treatment was started.
- PD is associated with negative functional and physical consequences and can affect a patient's self-image and lead to depressive symptoms.

PD surgery general

- Patients with PD must be eligible for surgery and meet certain criteria, which include:
 - at least three to six months of stable disease, with no changes to the penile deformity
 - absence of inflammatory penile pain (as experienced in the acute phase)
 - compromised ability or inability to engage in penetrative sexual intercourse due to the degree of the penile curvature and/or inadequate axial rigidity of the penis
 - patient's dissatisfaction with the shape of the penis
 - patient's treatment wish.

PD with a curvature of less than 30°

- Surgery is not a compulsory treatment option in PD cases with penile curvatures of less than 30°, as the functionality of the penis is mostly not affected in these cases.

PD with a curvature of 30–60°

- PD patients with penile curvatures of 30–60° are recommended to undergo one of the plication techniques available.
- In cases where penile length loss is significant, further penile length loss through plications should be avoided. Instead, a grafting procedure should be offered.
- Grafting procedures should only be offered if no ED is present.
- Plication techniques will shorten the penis (depending on the direction of the curvature).
- Postoperative traction therapy counteracts potential penile length loss due to surgery.
- Grafting techniques aim to preserve the long convex side of the penile curvature.

PD with a curvature of greater than 60°

- Grafting procedures are recommended for penile curvatures of greater than 60°, as plications would lead to severe penile shortening.
- Grafting is only possible if good erections with or without PDE5 inhibitors are present.

PD with hourglass deformities

- In cases of severe indentations or hourglass defects, penile prosthesis insertion is recommended when axial instability and ED is present.
- In cases of good quality erections and axial instability a grafting procedure can be performed to correct the calibre of the penile shaft. This will result in a better axial rigidity.

PD with therapy resistant ED

- A simple penile prosthesis insertion should be offered in cases of PD with minor curvatures and therapy-resistant ED.
- A penile prosthesis insertion may require 'modelling', plications, or grafting, if the curvature is severe.
- Although the general penile prosthesis population reported very high satisfaction rates, PD patients who underwent penile prosthesis insertion have the lowest satisfaction rates with penile prosthesis.
- The main reasons for dissatisfaction with penile prostheses in cases of PD is the preceding length loss due to PD, length loss following the insertion of the prosthesis, and length loss caused by concomitant plication techniques.

- In cases with significant penile length loss, severe curvatures, and therapy-resistant ED, more invasive surgical options such as the 'sliding technique', the 'MoST - Modified Sliding Technique', circular grafting or the TEP procedure may be offered to patients. These techniques are still under evaluation and not part of standard guidelines on the treatment of PD. The indication for these techniques is very limited and should only be performed by experienced and specialised surgeons.

Disclosures

Authors

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Table 1. Decision-making tree for the surgical treatment of Peyronie's disease in potent man (adapted from the guidelines of the European Association of Urology [18], Levine and Burnett [19] and Ralph *et al.* [17]) NB. The sliding technique, as well as the modified sliding (MoST) technique, circular grafting and the TEP procedure should only be performed by experienced surgeons. The indication is for these techniques is narrow.

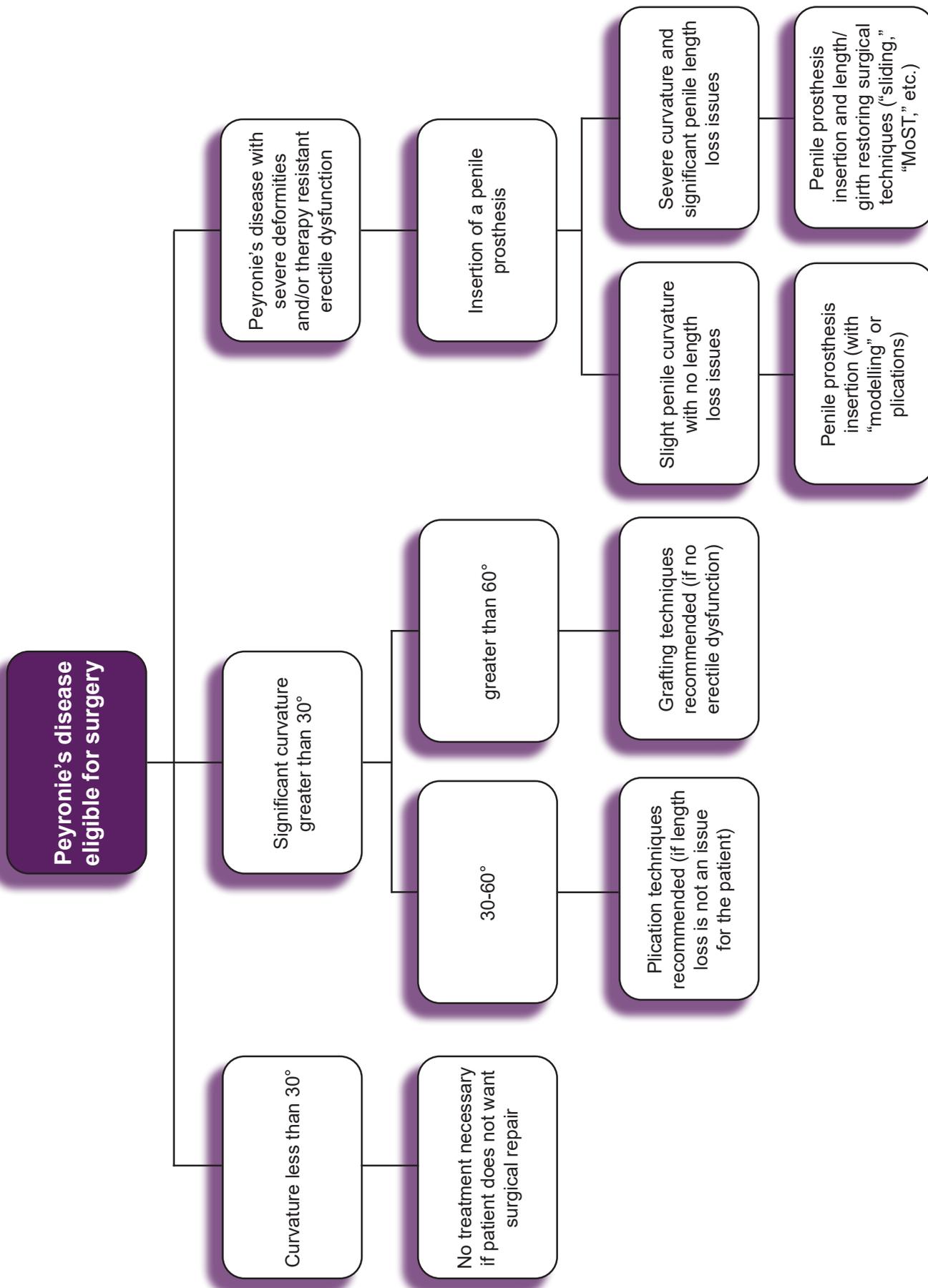


Table 2. Comparison of surgical outcome of different surgical approaches for the treatment of Peyronie's disease.

	Plication techniques/Nesbit	Grafting with or without (partial) plaque excision
Penile straightening %	58–100	74–100
Penile shortening %	41–90	0–40
Residual/recurrent curvature %	10–27	0–17
Penile hypoesthesia %	2–21	0–17
Postoperative erectile dysfunction	2–23%	0–15%

Data based on non-comparable studies [15, 32-37, 59-66]

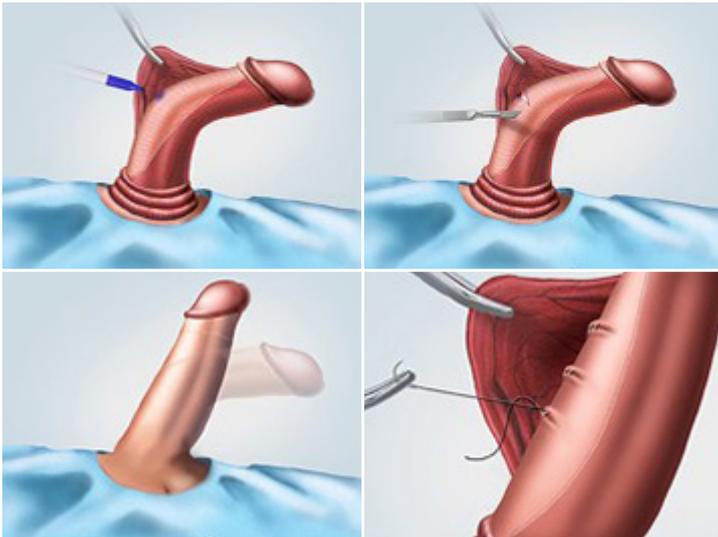


Figure 1. Schematic animation of a Nesbit procedure: **clockwise from top left.** **a)** mobilisation of the neurovascular bundle and marking of point of maximum curvature; **b)** excision of a small tunical Nesbit ellipse; **c)** closure of tunical defect; **d)** multiple excisions might be needed until the penis is fully straightened.

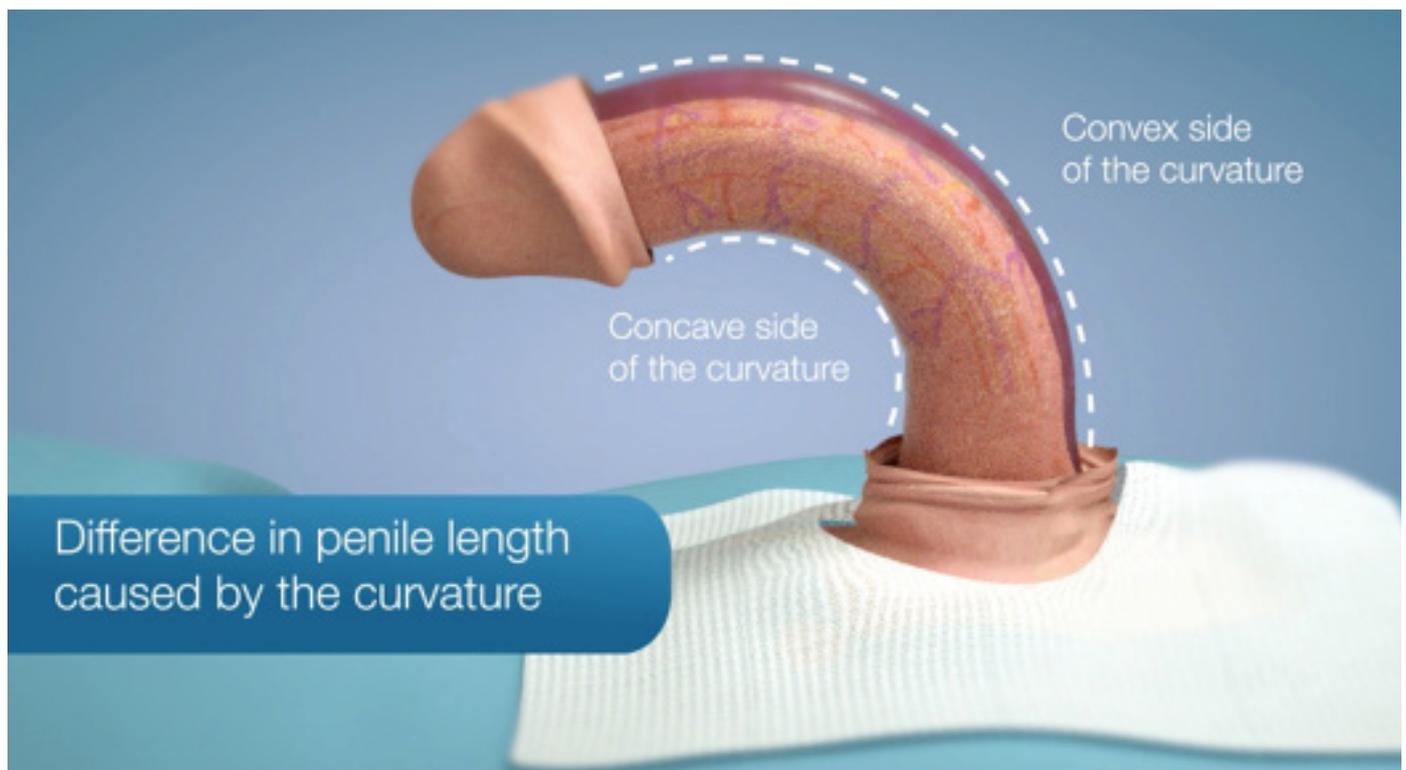


Figure 2. Schematic explanation of the difference between the long convex and the short concave side of a penile curvature. Any plication technique aims to straighten the penis by shorten the long convex side of the penile curvature according to the length of the short concave side. Grafting techniques (video 1) aim to lengthen the short concave side of the penile curvature according to the length of the long convex side of the penile curvature by the application of releasing incisions or (partial) plaque excision.

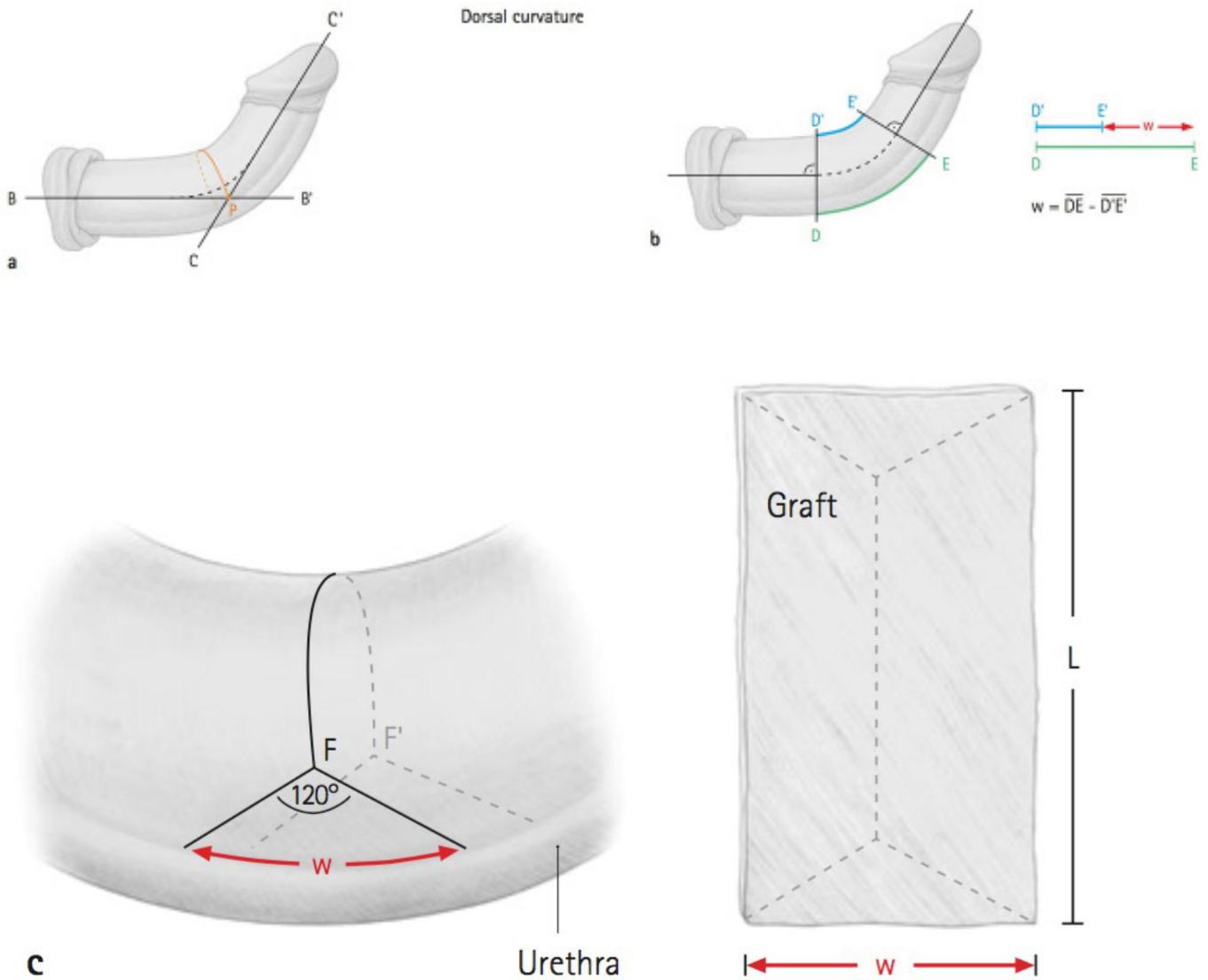


Figure 3. Schematic explanation of the geometric principles of the Egydio technique: **a)** application of the geometric principles to identify the point of maximum curvature “P”; **b)** application of the principles of the Egydio technique to identify the length and width of the tunical defect/graft; **c)** length and width of the graft and tunical incision lines according to the geometric principles.

Taken from: Egydio PH, Lucon AM and Arap S. A single relaxing incision to correct different types of penile curvature: surgical technique based on geometrical principles. *BJU Int.* 2004;94(7):1147-57 ^[16]

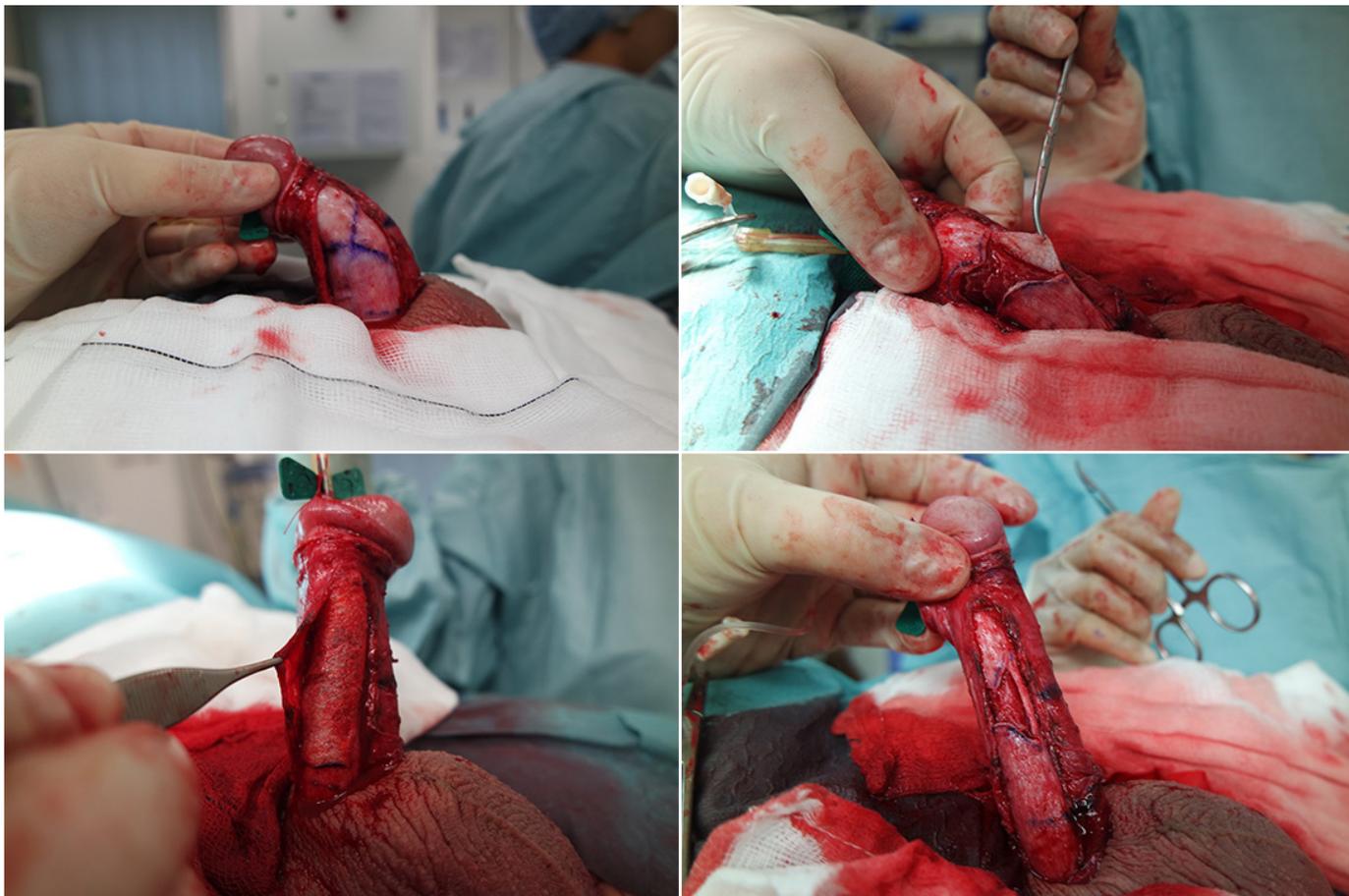


Figure 4. Illustration of an incision and grafting procedure (video 1): **clockwise from top left.** **a)** the point of maximum curvature has to be determined, and the incision lines have to be marked; **b)** the tunica has to be incised accordingly; **c)** the penis has to be stretched and it has to be evaluated whether or not the maximum length gain on the concave side has been achieved; **d)** the grafting takes place and the graft is covered with Buck's fascia.

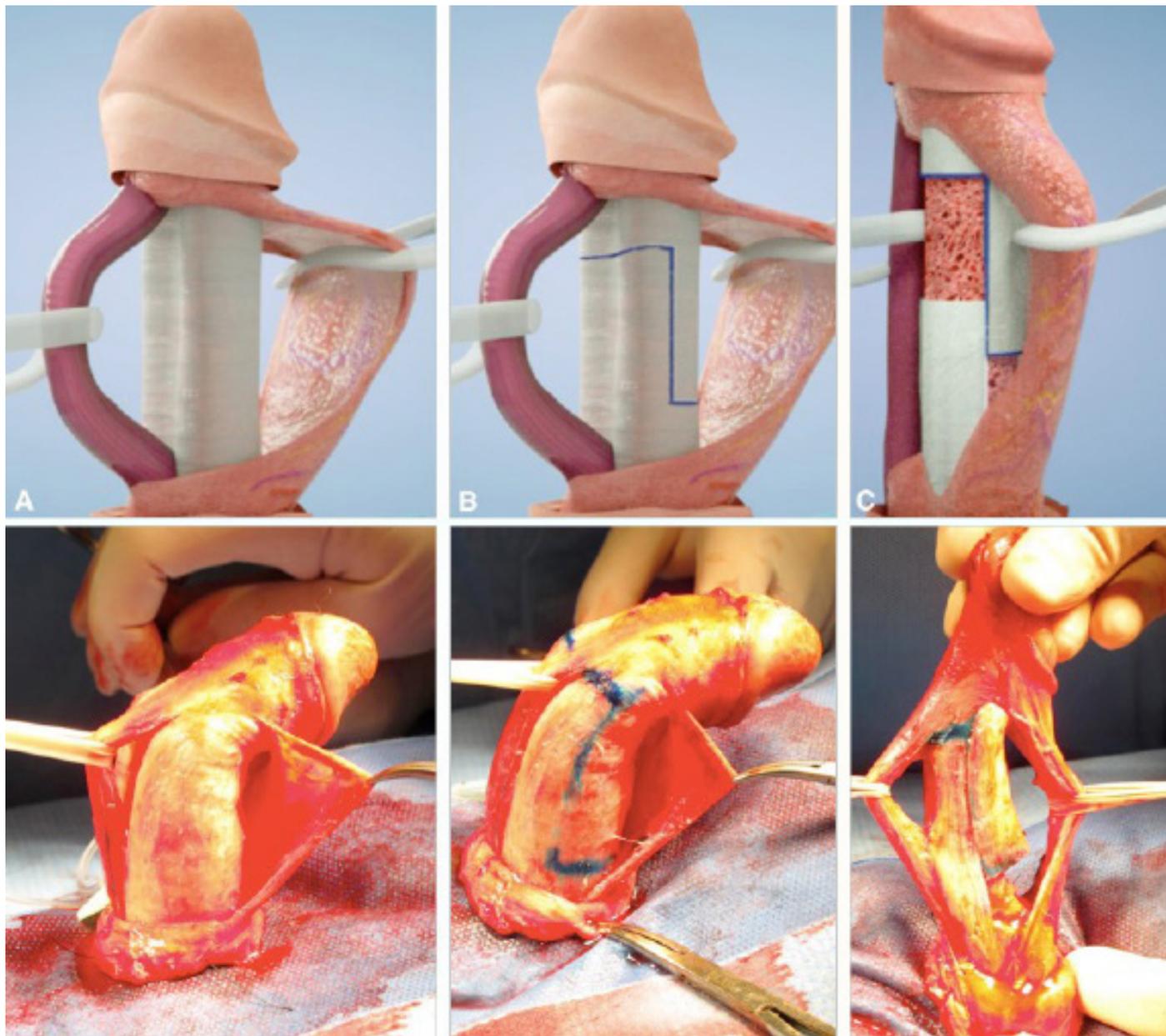


Figure 5. Illustration of the preparation of the modified sliding (MoST) technique (video 2) ^[66]: **a)** mobilisation of the urethra and the neurovascular bundle through two longitudinal para-urethral incisions on Buck's fascia; **b)** marking of the "sliding edges"; **c)** the penis is stretched to its maximum length, limited only by the elasticity of the neurovascular bundle and the urethra.

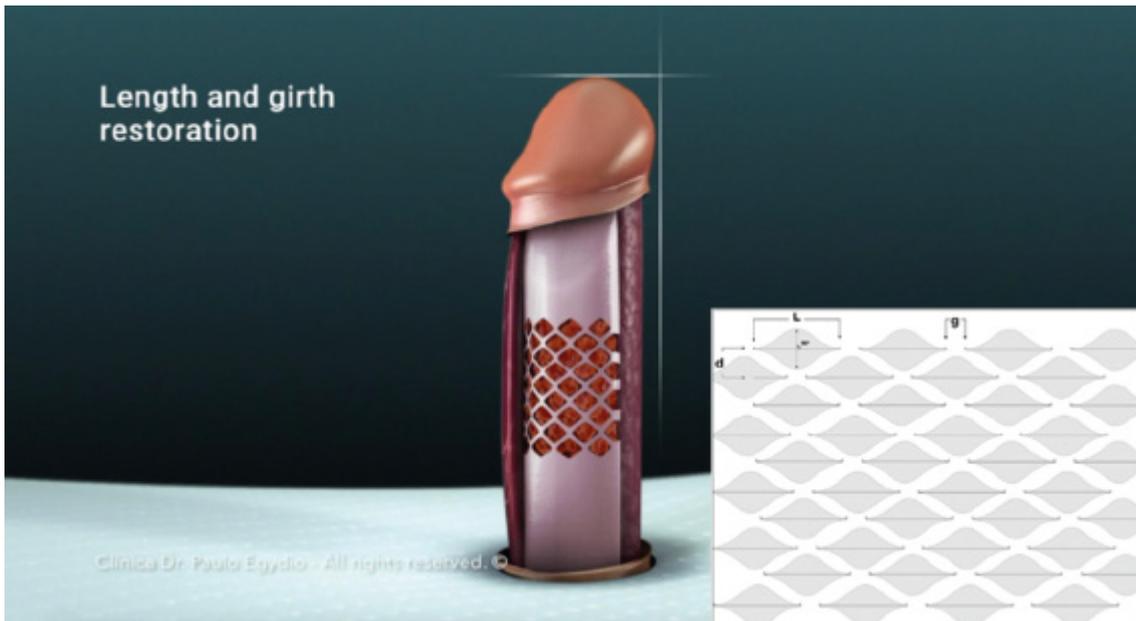


Figure. 6 Multiple horizontal incisions permit tissue expansion along the shaft of the penis to increase length to the limits of the urethra and the dissected neuromuscular bundle without urethral mobilization (L - length of the cut, g- gap between the cuts, d - width between the cuts).

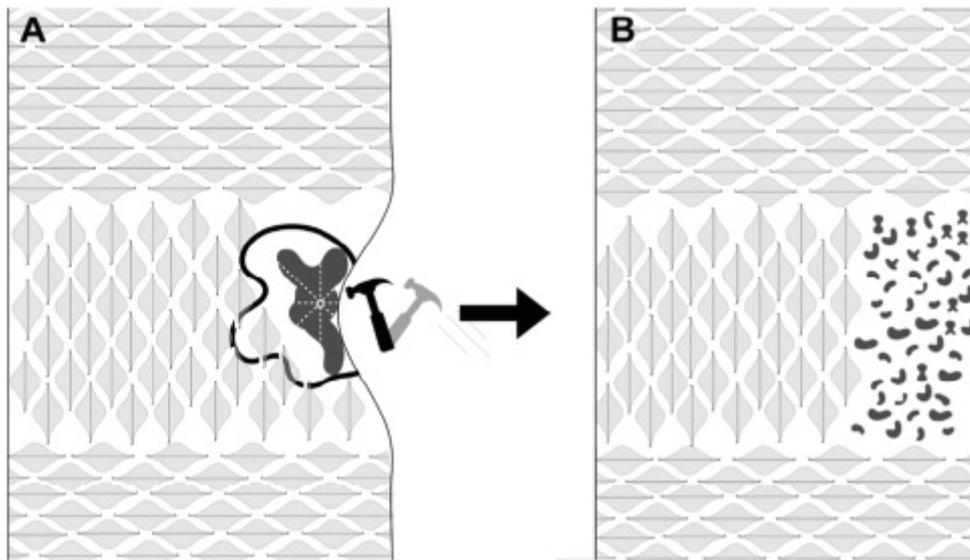


Figure 7. Correction of an indentation without the need to excise the calcification in cases of Peyronie's disease. A- Horizontal cuts allow for length restoration and vertical cuts allow for girth restoration. B- Once the cuts have been performed the tissue will expand adjacent to the area of calcification without the need of excision of the calcification, this leads to a reduction of bulging.