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Surgical treatment of Peyronie's disease
DOI: 10.1111/j.1745-7262.2008.00374.x

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·*Clinical Experience*·

Surgical treatment of Peyronie's disease: choosing the best approach to improve patient satisfaction

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Abstract

Aim: To discuss important points on medical history, preoperative evaluation, real expectations, and selection of the appropriate surgical procedure to improve patient satisfaction after surgical procedures for Peyronie's disease. **Methods:** Recent advances in approaches to Peyronie's disease are discussed based on the literature and personal experiences. Issues concerning surgical indication, patient selection, surgical techniques, and grafting are discussed. Lengthening procedures on the convex side of the penile curvature by means of grafting offer the best possible gain from a reconstruction standpoint. Penile rectification and rigidity are required to achieve a completely functional penis. Most patients experience associated erectile dysfunction (ED), and penile straightening alone may not be enough to restore complete function. Twenty-five patients were submitted to total penile reconstruction on length and girth with concomitant penile prosthesis implant. The maximum length restoration was possible and limited by the length of the dissected neurovascular bundle. The mean age was 55.4 years (32–69 years) and the mean angle of curvature 74.2 ± 22.4° (0–100°). Pericardial grafting was used to cover the defect. The mean follow-up time was 11.2 ± 5.9 months (3–22 months). **Results:** Mean functional penile length gain was 3.40 ± 0.73 cm (2–5 cm). Penile prosthesis maintained the penis straight. No infections occurred. Sexual intercourse was restored in all patients and all reported recovered self-esteem. **Conclusion:** Improving patient satisfaction with the surgical treatment includes proper preoperative evaluation on stable disease, penile shortening, vascular and erectile status, patient decision and selection as well as extensive discussion on surgical technique for restoring functional penis (length and rigidity). Length and girth restoration is very important for self-esteem and patient satisfaction. *(Asian J Androl 2008 Jan; 10: 158–166)*

Keywords: Peyronie's disease; erectile dysfunction; induratio penis plastica; penile induration; tunica albuginea; surgical technique; penis; graft; surgery; penile reconstruction

1 Introduction

Peyronie's disease (PD) is characterized by scarring of the tunica albuginea, which loses elasticity, resulting in penile deformity. The condition is invariably associated with penile reduction, and has major impact on quality of life and significant psychological effects [1]. Prevalence is 3–9% according to Rochelle and Levine [2]. Recent evidence suggests that the prevalence of PD is similar to that of diabetes mellitus and renal calculi [3].

Usta *et al*. [4] have shown that erectile dysfunction (ED) is strongly associated with PD raging from 20% to 54%. This is relevant when choosing the optimal surgical reconstructive treatment.

Provided the stability of the condition is established, surgical treatment will be indicated upon medical treatment failure. Stability is defined as at least 1 year of disease and at least 6 months of non-progression or regression of penile deformity and/or plaque, and absence of pain.

When surgical treatment is indicated, it must be individualized, aiming not only at restoring penile function but also restoring as much as possible the previous status of the patient.

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2 Materials and methods

2.1 Preoperative evaluation

2.1.1 Sexual and medical history

Preoperative evaluation should include complete clinical history as well as assessment of comorbidities, such as diabetes, heart/vascular/coronary conditions, arterial hypertension, smoking, alcohol consumption, signs and symptoms of hypogonadism, and regular medications, which may affect erection.

A detailed history should be obtained on associated ED prior to, or concomitant with, PD, as well as risk factors contributing to the development of the condition, such as sexual partner's lubrication status, achievement of an erection that continues until ejaculation, premature or late ejaculation, or inadequate habits that may cause injury to the tunica albuginea. A history of phosphodiesterase 5 (PDE-5) inhibitor use is key to establishing the presence of associated ED, as well as the response of this condition to the medication, patient's tolerance to its side effects, and his compliance with treatment.

Surgical treatment may be indicated in penile deformities that have been stable for at least 6 months and functionally impair or preclude intercourse. PD is consistently associated with decreased penile length. Some patients experience symmetric loss of elasticity, with little or no deformity. In such cases, a decrease in penile length may be the sole or the main complaint. It is very important during evaluation to ask the patient how much length has been lost after the onset of the fibrotic condition. This can be corroborated after erection induction and objective evaluation by the patient and physician.

2.1.2 Assessment of penile deformity, rigidity, vascular status, and arterial anomalies

A complete evaluation is essential in cases of sexual inadequacy with possible surgical indication. Patients with ED may need specific treatment as well as assessment of their response to treatment before surgery is considered as a therapeutic option.

For deformity assessment, physical examination of a flaccid penis may reveal a palpable thickened tunica. Penile size may be determined by pulling the glans penis forward and upward to the position of a normal erection and asking the patient to indicate to which extent PD has shortened his penis.

Erection assessment is essential to determine whether surgery is indicated, as well as the most appropriate surgical procedure. Penile tumescence, or partial rigidity, is often mistaken for erection, and the objective test of pharmacologically induced erection may change the therapeutic plan.

Rigidity assessment is performed both subjectively, as reported by the patient, and objectively, as observed by the physician after intracavernous injection (ICI) of alprostadil 10–20 μg, which allows evaluation of penile deformity and objective rigidity, and, with Doppler ultrasound (DUS), provides essential data for vascular assessment (arterial insufficiency and/or veno-occlusive dysfunction) as well as detection and localization of collateral vessels between dorsal and cavernous arteries.

After ICI, the patient holds his penis in erection position, and the ultrasound scanning of thickened areas of the tunica, associated or not with calcification, is initiated. The measurement of flow indices-peak systolic velocity (PSV), end diastolic velocity (EDV), and calculated resistive index (RI) begins at least 5 min thereafter, and a correlation of these indices to penile rigidity is established.

Information on penile arterial anatomy may be very useful to the surgeon in selecting the type of surgical technique to be used. Knowledge of the existence of a collateral branch is important in safely dissecting the neurovascular bundle. If you have collateral arteries at the site of the maximum point of curvature the Nesbit type procedure should be discussed with the patient or if associated ED is documented a reconstruction and graft associated with penile prosthesis implantation must be discussed at preoperative evaluation.

Because penile size before PD is unknown, information from the patient on the perceived extent of his penile length reduction is relevant. During erection induction for deformity assessment, the patient must be asked how satisfied he would be with the length resulting from straightening his penis by diminishing the longer side, as it is being shown to him, and which would be the extent of length loss compared to his penile size before PD. Further decrease in penile length by PD is very likely to have occurred when more than one site of fibrosis is seen, or when there is fibrosis on opposite sides. However, even if a thickened tunica cannot be palpated, longer-side reduction is not precluded, because microstructure changes are enough to decrease the elasticity of the tunica. There are patients with penile curvature and no palpable thickened tunica who undergo surgery. Penile deformity, not the plaque, is the main complaint of a PD patient. Surgery should focus on deformity correction rather than on plaques.

As mentioned before, preoperative vascular assessment is very important to define functional status and some vascular anomalies of particular interest in regards to further surgical procedures. Schaeffer *et al.* [5] report 44% of arterial anomalies and 10% of distal collateral arteries between dorsal and cavernous arteries. In a retrospective study, Kendirci *et al.* [6] correlated vascular status to type of penile deformity, demonstrating a relationship between type of curvature and penile hemodynamics.

Evaluating patient's and partner's satisfaction and long-term results after surgical treatment for PD, Usta *et al.* [7] reported that PSV values of 35 cm/sec or above and RI greater than 0.9 were considered as parameters for a normal penile vascular system. EDV values greater than 5 cm/s were considered diagnostic for veno-occlusive dysfunction.

During or shortly after DUS, penile rigidity is objectively compared to self-reported rigidity. This allows more objective assessment of rigidity. If it is lower with the test, both crura penis are pressed over the pubic bone to obtain maximum rigidity in order to assess actual penile deformity while the other hand assesses axial rigidity by pressing on the glans to mimic an attempt at penetration. If deformity is not pronounced and with good rigidity allows reasonable axial stability and functionality, then surgical treatment may not be indicated. A good erectile response to oral or injectable medications may restore penetration ability in such cases.

Soon after this assessment, the patient is asked to palpate his penis and, by progressively relieving pressure on crura, to report the extent of rigidity he observes in an ideal setting of sexual stimulation. The physician is thereby provided with an objective evaluation, and, if a rigidity deficit is proven, the patient's ED can be treated. The physician will state what a good rigidity is, and if this desired goal can be achieved by the patient.

Mulhall *et al.* [8] published an algorithm for ED-associated PD and the need for intraoperative adjuvant maneuvers in PD when associated with penile prosthesis implantation [9].

2.2 Surgical alternatives

2.2.1 Tunical-shortening procedures

The Nesbit, modified Nesbit, and other plication procedures may be indicated when penile length reduction has little impact on quality of life, self-esteem, and penile functional length.

These procedures are associated with penile length reduction, which, in addition to a diffuse elasticity decrease of the tunica including the longer side, as occurs in some cases of PD, may further add to penile length loss (from PD and from surgery).

The size of the penis when pulled to the erection position corresponds largely to the size expected after these procedures [10]. This is the size to be shown to the patient before surgery.

Gholami and Lue [11] reported a 16- or 24-dot plication technique using parallel, minimal-tension dots to be minimally invasive because it requires no dissection of the neurovascular bundle.

Van der Horst *et al.* [12] highlighted the importance of choosing appropriate sutures for plication procedures in order to prevent the development of granuloma and pain, which can impair the patient's quality of life. Polytetrafluoroethylene sutures resulted in only 13% of patients complaining of postoperative pain, versus 52% with polypropylene sutures.

Giammusso *et al.* [13] published a modified Yachia procedure consisting of resecting the deep dorsal vein and performing a longitudinal incision and transversal suture with absorbable suture (3.0 polydioxanone) on the venous bed, achieving 100% rectification with no need to mobilize the neurovascular bundle. The use of absorbable thread may prevent pain and definitive palpability of the stitch as may occur with nonabsorbable sutures.

Bokarica *et al.* [14] recommend basing the surgical technique selection on penile length and curvature degree, so that procedures that shorten the longer side of the penis would be indicated for cases of curvature that is less than 60 degrees with a preoperative penile length in erection greater than 13 cm. They further state that the satisfaction of most patients, in spite of significant penile length loss, was largely due to proper patient selection and preoperative information.

Although these longer side-reducing procedures for correction of penile curvature are less invasive, they are consistently associated with a decrease in penile length.

2.2.2 Tunical-lengthening procedures

2.2.2.1 Excisional procedures

A drawback to excisional procedures is the fact that not all patients have palpable plaques at the time of surgery; in the case of multifocal plaques, the issue is which ones should be removed; the tunica albuginea may be injured diffusely, and not plaque-restricted, so that removal and grafting may not be enough to correct the curvature and restore length properly, requiring the addition of other relaxing incisions. Because deformity, not plaque, is the patient's main complaint, surgical procedures should address deformity. Reports on excisional procedures using different biologic or synthetic grafts show various outcomes, which may be associated with excision itself rather than grafting. There are reports of an association between excisional procedures and increased rates of ED; it is therefore suggested that they be replaced by incision and grafting [15, 16].

With these explanations and the experience from literature a consensus has almost been reached that the use of relaxing incisions is the best treatment option.

2.2.2.2 Incisional procedures

In 1995, Gelbard [17] published a paper including different types of relaxing incisions suggested for each specific type of penile deformity.

In 1998, Lue and El-Sakka [18] described the H-incision. The main issue has always been to determine the site, size, and number of such incisions on the cur-

vature area [15, 16, 19]. There are reports of many surgeons who had to add complementary plication procedures after grafting [15]. This implies longer-side reduction and no achievement of the best possible gain in penile length from a reconstructing procedure.

In 1999, Lue and El-Sakka [20] described the lengthening shortened penis caused by PD using circular venous grafting.

Egydio *et al*. [21, 22] described the geometric principles applied to a single incision model of "tripod-shaped 120-degree forks," resembling the Mercedes-Benz logo [23], with the purpose of accurately determining the site and size of a single relaxing incision that could be adapted to individual cases.

2.2.3 Surgical technique of single geometrically determined incision [21, 22, 24–26]

A saline-induced erection is obtained and the area neurovascular bundle dissection is marked by two para-urethral incisions on Buck's fascia at the curvature area. Dissection is performed until both sides meet along penile circumference.

Erection is again induced and maintained to mark two lines tangential to penile axis drawn on proximal and distal straight areas of the penile shaft (a–a' and b–b'). A point (P) is generated at the intersection site from which a circumferential line is drawn at the bisector of the angle formed by the two tangential lines (Figure 1).

The width of the defect to be created on the tunica must be equivalent to the difference between measurements on shorter and longer penile sides, corresponding to the difference of distances between any two circumferential lines perpendicular to penile axis on straight penile segments, i.e. outside the curvature area. The difference (W) between d–e and d'–e' corresponds to the width of the defect on either side of the urethra in cases of dorsal curvature (Figure 2).

On the circumferential line, a length of W/4 away from the site where it meets the g line, points F and F' are determined to mark the start of bifurcation, which extends to either side of the g line at a length of W/2, thus generating a 120° angle (Figure 3) resulting defect will be more simple and stable as a tripod. Defect length (L) will be equivalent to the distance between the two para-urethral incisions for dorsal curvature, or between the two ends of the fork-shaped incision for any type of curvature (Figure 4).

A relaxing incision is based on deformity rather than on plaque features and/or available graft size only. Because the defect is produced by expansion rather than replacement, it produces predictable tunica-defect size that should be measured in full erection and individualized. This technique uses a single, incomplete, circumferential, relaxing incision forked at the ends by precise application of geometric principles, to determine the exact incision site in the tunica or plaque so that the shorter side may be lengthened to equal the longer side, and to create a simpler defect in the tunica to make grafting placement easier. In the case of calcified plaques, the outer longitudinal layer of the tunica may be preserved, and the calcified inner circular layer may be removed at the trans-

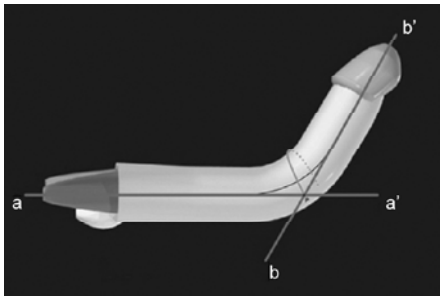

Figure 1. The point of maximum curvature (P) is determined at the intersection of lines a–a' and b–b' tangential to the penile axis. A circumferential line is drawn at point P on the angle bisector.

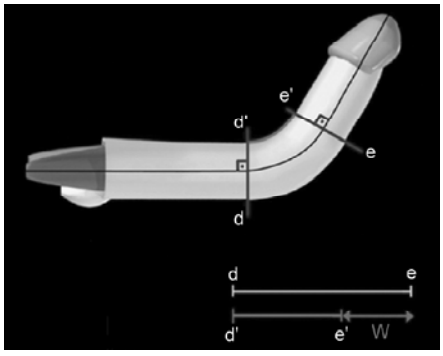

Figure 2. The difference (W) equals d–e (distance between two points along the longer side of the penis) minus d'–e' (the corresponding distance along the shorter side of the penis), measured outside the curvature area (□ = 90 degrees).

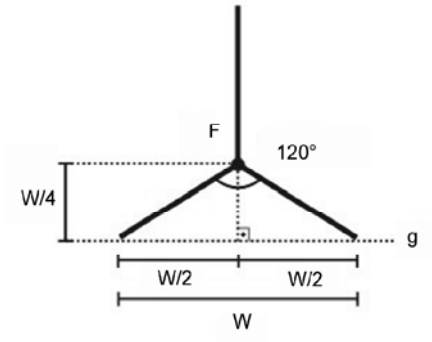

Figure 3. The starting point of the 120-degree bifurcation at the end of circumferential lines is established by marking a length of W/4 back from the intersection with the g line. W, the difference measured between the longer and shorter side of the penis, that correspond to the width (W) of the tunica defect.

verse incision site (Figure 5).

Perovic and Djordjevic [27] described the penile disassembly technique for distal penile deformity, which allows excellent distal exposure.

The geometrical tunical incision technique was combined for penile straightening with maximum penile length gain.

2.3 Grafting

An ideal graft should be ready to use, available in various sizes, have good tensile strength and low potential for inflammatory reactions, be infection-resistant, with minimal or no risk for disease transmission, and cost-effective.

Several types of grafts have been used, including biologic autografts-dermis, vein, penile crura, dura mater, tunica vaginalis, fascia lata- and allografts/xenografts-cadaveric pericardium, porcine small-intestine submucosa, acellular dermis, or synthetic grafts: polytetrafluoroethylene, Dacron, or silastic [28]. The disadvantages of using autologous grafting include increased surgical time, increased morbidity, and scarring on the harvest site. The amount of tissue may be another limiting factor, especially for vein and penile crura autografts.

Hellstrom and Reddy [29] reported on using human cadaveric pericardium, as did Chun *et al.* [30] and Levine and Estrada [31]. Leungwattanakij *et al.* [32] compared several types of grafts in a rat model showing a low rate of inflammatory reactions with cadaveric pericardium.

Knoll [33] reported the use of porcine small-intestine submucosa (SIS) grafts as a tunical substitute, with promising results. Larger-sized and more uniform patches are advantages of SIS grafts, but absorption on larger defects must be slower to avoid constriction at the graft site, requiring the use of SIS with multi-layers.

With the increasing use of tissue engineering, new tunica albuginea substitutes may be developed [34, 35]. Advances in this area are pronounced, and in the future, grafts will be available that are much more similar to the tunica albuginea, or an acellular matrix that may allow the tunica to be rebuilt, whether associated with cell culture and seeding or not.

A discussion concerning the best graft often involves postoperative outcomes, although the type of relaxing incision or excision has varied. Postoperative outcomes are not solely dependent on the graft used.

Personal experience with cadaveric bovine pericardium associated with plaque excision gave discouraging results. In contrast, results were promising when using the same type of graft associated with a relaxing incision procedure [21].

In another personal experience with four cases, it was necessary to remove the pericardium graft 2.5 to 8.0 months after surgery (in three cases due to infection in immunocompromised patients and in one case due to absorption of graft-graft suture with dehiscence and local hematoma formation); no leakage was seen after saline-induced erection, and the operative sites were left without grafts. After the recovery period, patients still have good-quality erections and axial rigidity, and are capable of having sexual intercourse. This has shown that grafts may even be absorbable, i.e. the tunica may be allowed to rebuild on the structure of the graft, provided this allows no new blood-vessel formation, which may lead to veno-occlusive dysfunction.

It is expected that all patients have a hematoma under the graft following a grafting procedure. A personal series of 20 patients were followed for 8 months, after which the hematoma disappeared in 50% and remained as a laminar hematoma in 50%, not causing any disturbance of penile functionality based on axial rigidity. It is a matter of concern to maintain a large hematoma that limits the expansion of spongy cavernous tissue based

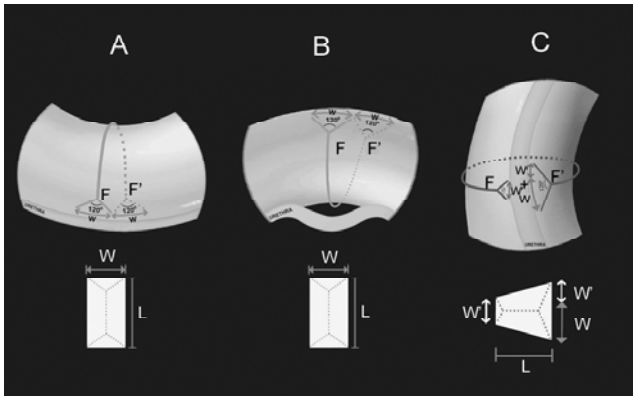

Figure 4. Bifurcations of transversal incisions and corresponding tunica defects for dorsal and dorso-lateral curvature (A); ventral and ventro-lateral curvature (B); and lateral curvature (C). W, defect width; L, defect length with maximum penile erection (measured outside any tunical constriction area); F and F', starting points of bifurcation of transversal incisions.

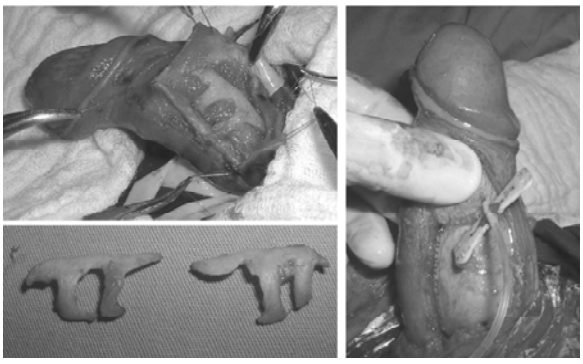

Figure 5. Example of preservation of the outer longitudinal layer of the tunica albuginea (TA) and excision of the calcified portion of the inner circular layer of the TA. This approach permits maintaining the same geometrically determined correction principles even in the case of tunica calcification.

on the concealed fibrotic area in the outer part of the spongy tissue. The graft is important during this period to block leakage from the spongy tissue and to maintain good penile shape.

Two of the four patients who had their grafts removed and had no leakage maintain a permanent constriction area at the site of the removed graft, which was filled by the hematoma underlying the graft.

With the purpose of trying to maintain a minimal hematoma under the graft until blockage occurs in the outer part of the spongy cavernous tissue, a light compressive postoperative dressing is applied to be kept in place for 7 to 10 days, and the patient is started on a PDE-5 inhibitor at bedtime on the 5th to 7th postoperative day, to stimulate smooth muscle relaxation, thereby expanding the cavernous tissue and compressing the hematoma as a means to help it be absorbed or transformed into a laminar shape that does not affect axial rigidity. These medications are particularly important for patients with preoperative ED, and of utmost interest to reduce the hematoma and maintain physical therapy with stimulated or reflex erections. Early postoperative use of a vacuum device can only increase the hematoma underlying the graft, due to negative pressure.

2.4 Penile prosthesis implantation

Patients with PD and ED that are nonresponsive to oral or injectable treatment will be candidates for penile prosthesis implantation. Depending on the type and degree of penile deformity, associated procedures (e.g., modeling [36], Nesbit/plication, or incision/excision and grafting for penile rectification and/or correction of constrictive lesions) may be necessary [37].

Rahman *et al.* [38] reported penile plication surgery associated with penile prosthesis. The inconvenience of this procedure is penile length reduction. The higher the curvature degree, the greater this reduction will be.

Usta *et al.* [7] reported the long-term results of surgical treatment for PD, showing that penile prosthesis implantation and curvature correction with pericardium graft added no risks of complications as compared to prosthesis implantation surgery alone.

Twenty-five patients were submitted to total penis reconstruction on length and girth with concomitant penile prosthesis implant. The maximum length restoration was possible and limited by the length of the dissected neurovascular bundle. The mean age was 55.4 years (32–69 years) and the mean angle of curvature 74.2 ± 22.4° (0–100°). Pericardium graft covered the defect. The mean follow-up time was 11.2 ± 5.9 months (3–22 months).

Personal experience is that pericardium reconstruction has not increased the risk for infection and complications. This may be due to the fact that pericardial tissue, in contrast to vein and dermal grafts, needs no imbibition to survive. That is why we prefer reconstruction with pericardium grafting according to geometric principles and single incision [21, 22], and concomitant implantation of malleable or inflatable two or three-piece prosthesis of a size compatible with the longer side, as the shorter side has been elongated. In my opinion, the best time for grafting length restoration is when reconstruction associated with penile prosthesis implantation is indicated (Figure 6).

Even those patients with mild or no curvatures but with significant penile length reduction because of diffuse tunica elasticity damage should undergo reconstruction by circular incision and graft. Penile size recovery in these cases is limited by the size of the neurovascular bundle dissected, as the urethra, composed by spongy tissue, stretches easily (Figure 7).

For patients reporting major penile size loss even with small curvatures, circular graft reconstruction should be considered, aiming at maximum penile size recovery within the limits of the neurovascular bundle dissected. Diffuse shaft constriction should be corrected with lateral grafting as well (Figure 8).

Glans disassembly will not be necessary when no transversal distal reconstruction is required (Figure 9).

It is important to note that all these penile reconstruction procedures associated to implantation of a prosthesis (malleable or inflatable two or three-pieces) were exclusively performed by skin circumcision incisions.

3 Results

Mean functional penile length gain was 3.40 ± 0.73 cm (2–5 cm). Penile prosthesis maintained the penis straight. No infection was observed. Sexual intercourse was restored in all patients that resulted in improved satisfaction and self-esteem.

Recovery of penile length is limited by the dissected neurovascular bundle length. Bundle dissection maintained glans sensitivity without ischemic complications and with preserved orgasm.

4 Discussion

The technique herein presented is based on tunical incision irrespective of the plaque characteristics and localization. It may be used to correct all types of curvature, whether associated with constriction or not. This reconstructive surgical approach including extensive preoperative discussion with patients produced the highest satisfaction.

The dissection of the neurovascular bundle was standardized for all cases by means of the two para-urethral incisions in Buck's fascia. At this level the circumflex veins were of narrower caliber, thus facilitating their

cauterization, which means a reduced number of ligatures; the manipulation of the bundle is made far from the dorsal nerves of the penis, and as the deep dorsal vein is preserved even with stretch of the bundle it protects the nerves against damage preventing their lesion; the dissection may be limited to the area of the curvature allowing possible extension for maximum length elongation according to the requirements of individual patients. The risk of lesions to the collaterals of the dorsal arteries is minimized with a smaller dissection associated with preoperative Doppler ultrasound to define the sites of these collaterals when present.

Creation of a full erection is of great importance for the accurate application of these geometrical principles and consequent determination of the appropriate tunical incision site. The difference between longer and shorter sides, which defines the width of the defect (W), can be measured between any two points on the straight portions of the penis because it will always be the same. Sectioning the septum on both edges of the tunical incision on the shorter side of the penis is key to adequate lengthening of the shorter side and complete penile

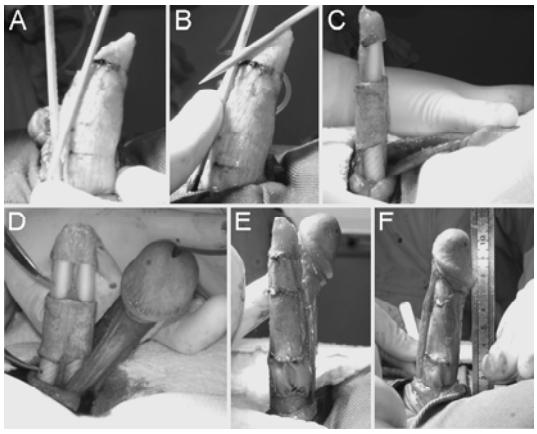

Figure 6. (A) and (B): Two points of curvature after disassembly technique (indicated for distal shaft transversal reconstruction). (C) and (D): Malleable prosthesis implantation after maximum length gain limited by the neurovascular bundle length. (E): Pericardium graft placement on the two tunical defects. (F): Repositioning of glans at the end of the reconstructed shaft, with a final length of 10.5 cm.

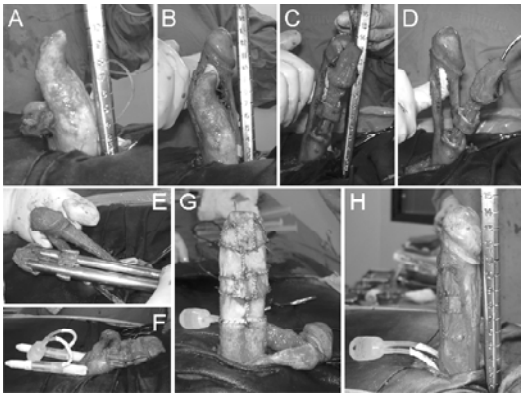

Figure 7. Patient reporting preoperatively a penile length loss of 4 cm, associated with a floppy glans, erectile dysfunction (ED), and a two–point, S–shaped curvature. (A): Disassembly technique (indicated for distal shaft transversal reconstruction) with 10 cm penile shaft. (B): Two curvature points, distal narrowing, and the size of the dissected neurovascular bundle relative to the penile shaft are seen. (C) and (D): Penile shaft elongation by means of two circular incisions at the maximum curvature points (ventral and dorsal) reaching 13 cm at the limit of the neurovascular bundle. (E): Lateral incisions between the two circular incisions to increase circumference up to the diameter of the non-affected area, and distal dorsal incisions for distal widening and consequent resolution of floppy glans, since the prosthesis will thus reach the distal limit of the penile shaft. (F): Penile shaft with sutured grafts during the implantation of the two-pieces inflatable prosthesis; (G): Implanted prosthesis inflated to show recovering of penile shaft length and diameter. (H): Glans repositioned at the end of the reconstructed shaft with a final penile length of approximately 14.5 cm.

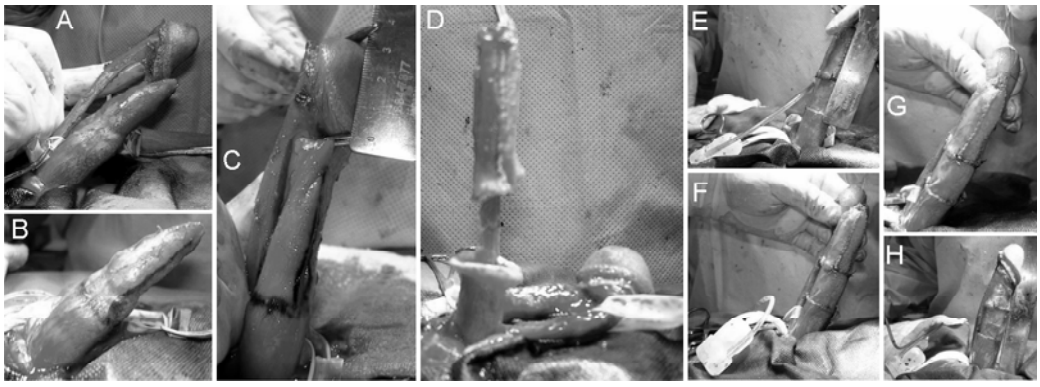

Figure 8. Patient reporting preoperatively a penile length loss of 3 cm, associated with shaft constriction and erectile dysfunction (ED) and no curvature. (A): Disassembly technique. (B): Marking of the circular and lateral incision sites. (C): Penile shaft likely to be elongated to the limit of the neurovascular bundle. (D): Circular incision preserving corpora cavernosa. (E), (F) and (G): Penile shaft with a circular 3 cm graft, lateral grafting, and an inflatable three pieces prosthesis implanted. (H): Repositioned glans and final aspect of penis.

straightening. Complete penile straightening can be checked by penis traction after final tunical and septal incision and tunical dissection from the spongy tissue of the corpus cavernosum. If the neurovascular bundle is restricting penile straightening, its dissection may be extended.

Tripod-shaped 120-degree forking produces a simpler configuration of the tunical defect, resulting in geometrically-shaped grafts that can be easily sutured. Forking also permits the relaxation of constricted areas on the tunica and the correction of associated constrictive lesions at the site of curvatures.

When geometrical principles and induced erection are used, the size of the defect in the tunica albuginea can be calculated before the incision is made, enabling previous graft preparation.

If the graft is not likely to shrink, as is the case with pericardium [21, 29], its size should match the size of the defect. For grafts known to be likely to shrink, such as dermis [39], a percentage should be added to the dimensions of the graft to compensate for the shrinkage.

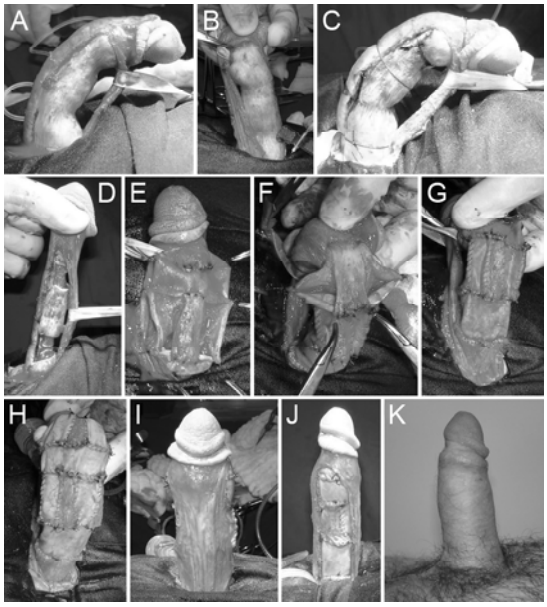

Figure 9. Patient reporting preoperatively sexual inadequacy due to curvature and erectile dysfunction (ED). (A): Two points of curvature associated with diffuse shaft constriction. (B): Bundle dissection without disassembly. (C): Application of geometric principles at the two maximum curvature points. (D): Transversal relaxation incisions (which proved sufficient to reach the limit of the neurovascular bundle dissection, not requiring extension to circular incision). (E): Lateral incisions between the two transversal incisions to correct shaft constriction. (F): Two dorsal distal incisions to correct distal shaft constriction. (G) and (H): Transversal, lateral, and dorsal grafts sutured; (I) and (J): Final aspect with an inflatable three-pieces prosthesis implanted. (K): Aspect on the 40 th postoperative day.

The length of the defect should be measured on an erect penis and at a point without constriction. Under these circumstances, only one incision and graft are necessary, providing that the penis presents only one point of maximum curvature. If there are two significant curvatures at different points of the penis, two grafts should be made as described. Complementary plication should be avoided whenever possible, as it not only damages the healthy side but also leads to penile shortening.

The present technique permits standardization of a tunical incision procedure that may be reproducible in multicenter studies leading to a better understanding of the advantages and disadvantages of the different types of graft materials [30, 32, 40].

This incision technique applying geometrical principles is a standardized procedure for the correction of any penile curvature, whether associated with tunical constriction or not, resulting in maximum penile gain. Preoperative assessment of penile length and curvature degree is important for proper selection of the surgical procedure to optimize patient satisfaction. It must be emphasized that even patients with a penis longer than 13 cm may not accept the size reduction imposed by the disease and the surgical procedure. Such patients are candidates for grafting procedures.

The present technique is effective for correcting all types of penile deformity, regardless of plaque characteristics.

Future measures to prevent treatment failures include assessment at full rigidity performing geometrically determined relaxing incisions with known defects, and developing more adequate grafts. Procedures that shorten the penis are to be employed cautiously, and not without extensive preoperative discussion. Prosthesis implantation is indicated for cases of inadequate rigidity. The improvement of tissue engineering techniques will contribute to the development of grafts increasingly closer to the ideal for tunica albuginea replacement.

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