



The Outcome of Multiple Slit on Plaque with Plication Technique for the Treatment of Peyronie's Disease

Su Hwan Shin, Hyeong Guk Jeong, Jong Jin Park, Ji Yun Chae, Jong Wook Kim, Mi Mi Oh, Hong Seok Park, Je Jong Kim, Du Geon Moon

Department of Urology, Korea University College of Medicine, Seoul, Korea

Purpose: To evaluate the postoperative outcome of the multiple slit on plaque plication technique for the treatment of Peyronie's disease.

Materials and Methods: We retrospectively evaluated 22 patients who underwent plaque incision with penile plication for the surgical treatment of Peyronie's disease, who had failed medical treatment between 2009 and 2014. Patients were grouped by preoperative degree of penile curvature into Group I: mild (n=5, 22.7%), Group II: moderate (n=11, 50.0%), and Group III: severe (n=6, 27.3%). After a thorough review of the medical records, we evaluated (a) the correction of the curvature; (b) sexual function; and (c) any penile shortening or other complications.

Results: The mean postoperative follow-up period was 39 months. Complete correction of the curvature was attained in 21 patients (95.5%). As an inevitable complication, minimal penile shortening (<1.5 cm) was reported by 14 patients (82.4%) but did not adversely affect sexual intercourse (0%), and all patients found the extent of penile shortening to be acceptable. Nineteen patients had good erectile function (International Index of Erectile Function >21). The most frequent complication was subcutaneous penile edema in three patients (13.6%), which was resolved within about 3 months following surgery.

Conclusions: As a modified technique, multiple slit on plaque with plication is a simple, minimally-invasive and effective technique for correcting penile curvature regardless of curvature severity. The degree of penile curvature does not significantly predict the amount of penile length loss.

Key Words: Penile induration; Focal adhesions

INTRODUCTION

Peyronie's disease (PD) is a localized connective tissue disorder of the penis characterized by scarring of the tunica albuginea. Fibrous plaque(s) deposited within the tun-

ica albuginea impedes the expansion of the tunica during erection, resulting in shortening, penile bending, indentation, and, often, pain. PD is regularly associated with the onset of erectile dysfunction (ED). PD is a prevalent condition, impacting 3% to 9% of men [1,2], and is a common

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Correspondence to: Du Geon Moon

Department of Urology, Korea University College of Medicine, 73 Incheon-ro, Seongbuk-gu, Seoul 02841, Korea.
Tel: +82-2-2626-3201, Fax: +82-2-2626-1321, E-mail: dgmoon@korea.ac.kr

cause of quality of life impairment [3].

Surgical therapy remains the gold standard treatment for men in the stable or chronic phase of PD (at least 1 year from the time of onset and at least 6 months of no change in penile deformity) who are unable to engage in satisfactory coitus and fail medical treatment, or when the patient requests the most rapid and reliable end result [4,5].

There are several types of surgical techniques applied to PD, which can be categorized into three types: tunica plication, plaque incision or partial excision, and grafting [6]. Important factors that contribute to surgical planning include degree of curvature, presence of a hinge effect, penile length, and erectile function [7].

Surgical intervention aims to correct the penile curvature or deformity, preserve or restore erectile function, and prevent loss of penile length and girth. Among procedures, the major concern with applying tunical plication procedures for complex Peyronie curvature is the associated potential for penile length loss [8].

Although grafting has been recommended for patients with complex penile curvature [5], plaque incision with plication has also recently been shown to be effective and results in high patient satisfaction in complex biplanar curvatures [9,10].

In our study, we attempt to evaluate the safety and efficacy of surgical intervention on 22 patients, who underwent penile plication with plaque incision regardless of the degree of curvature, by analyzing the functional results and complications, with a mean follow-up of 39 months.

MATERIALS AND METHODS

1. Patient population

A retrospective review was performed for 22 patients who underwent penile plication with plaque incision between 2009 and 2014. Informed consent was obtained for all patients. This study was approved by the Institutional Review Board (IRB) of Korea University Guro Hospital (IRB No.: KUGH15244).

2. Preoperative evaluation

A full history was conducted with specific focus on PD symptoms, as well as known and possible risk factors.

These include a history of underlying disease (diabetes, hypertension, hyperlipidemia, and tobacco use), duration of the disease, pain on erection, and difficulties during sexual intercourse. A physical exam was performed, including stretched flaccid penile length, and identification of the plaque location. By using a vasoactive injection for pharmacological erection and dynamic duplex ultrasound, we determined the presence of a calcified plaque, the degree of tumescence, and the location and degree of curvature.

Surgery was offered only to patients who had difficulty with vaginal penetration, stabilized plaques for more than 3 months, persistent penile curvature for at least 6 months, and for whom medical treatment had been ineffective for at least 1 year. Patients under ongoing medical treatment, those with penile pain, and those with less than 12 months since the onset of symptoms were excluded from surgery.

Patients were grouped by preoperative degree of penile curvature into Group I: mild ($n=5$, 22.7%), Group II: moderate ($n=11$, 50.0%), and Group III: severe ($n=6$, 27.3%). Group I, II, III had a degree of curvature less than 30° , between 30° and 60° , and more than 60° , respectively. Before the surgical procedure, in 22 patients, median age was similar among the 3 groups (mean age, 50~57 years; $p=0.63$). The degree of curvature ranged from 20° to 90° (median, 60°) and direction of penile curvature was dorsal in 12 (54.5%), lateral in 5 (22.7%), ventral in 3 (13.6%), complex in 2 (9.1%) (Table 1).

3. Surgical technique

All procedures were performed by a single surgeon (D.G.M.) under general anesthesia. Before incision of the skin, an artificial erection was induced for a brief period with intracorporal injection of 10 μ g alprostadil plus a penile tourniquet at the base of the penis, to evaluate the direction and degree of the curvature.

After circumcision at the sulcus, the penile skin and underlying fascial layers were dissected for exposure of the tunica albuginea. Penile skin and fascia were mobilized proximally to deglove the penile shaft and as needed to reveal the distal penile shaft according to the severity and direction of curvature. A multiple longitudinal plaque incision with the back of a #11 surgical blade was done to the depth of the full thickness of the tunica (Fig. 1A).

Table 1. Preoperative characteristics of the patients

Characteristic	Degree of curvature			p-value
	Group I ^a	Group II ^b	Group III ^c	
Total patient	5 (22.7)	11 (50.0)	6 (27.3)	
Age (yr)	57 (50~63)	55 (23~75)	50 (27~63)	0.63
Preoperative curvature (°)	20	45 (30~50)	76 (60~90)	0.37
Site of curvature	Dorsal 3	Dorsal 8	Dorsal 1	0.82
	Lateral 1	Lateral 3	Lateral 1	
	Ventral 1		Ventral 2	
			Combined 2	

Values are presented as number (%), median (range), or mean only.

^aMild group (angle < 30°). ^bModerate group (30° ≤ angle < 60°). ^cSevere group (angle ≥ 60°).

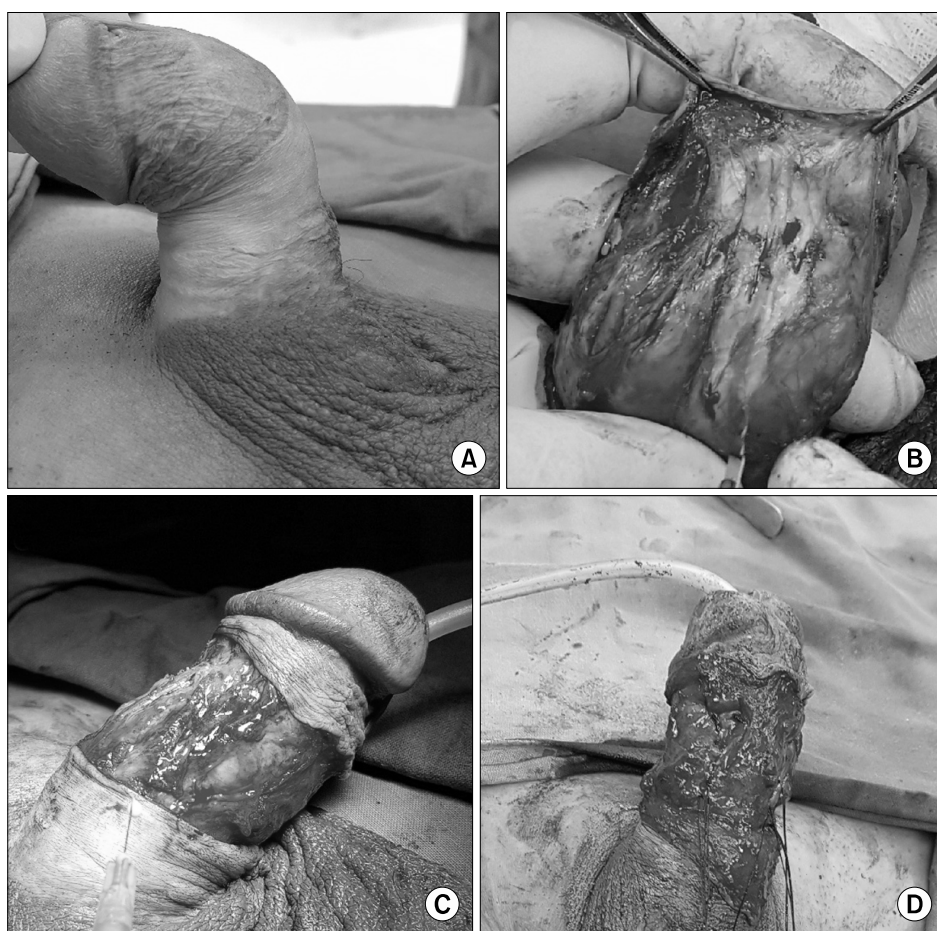


Fig. 1. (A) Preoperative state. (B) Multiple slit on plaque. (C) Steroid injection. (D) Plication.

Multiple slits were made until the plaque was soft and non-palpable, thus allowing for a flat and pliable tunica. Thereafter, 1~3 mL of triamcinolone was injected into the incised plaque.

After complete incision and the injection of triamcinolone, severe penile curvature was usually released and residual curvature remained for plication. Penile pli-

cation was performed in 16 (2 pairs) or 24 (3 pairs) dots on the convex side (Fig. 1B). Additional dots were applied longitudinally to correct the major curvature and circumferential dots were also applied to adjust the asymmetry of circumference in each patient, until curvature with circumferential asymmetry was completely corrected. Each 3-0 silk Lembert suture spanned a total of 15 mm and in-

volved 2 needle passages covering approximately 7~9 mm. This was done in buried, interrupted, vertical mattress fashion.

A sterile dressing and compressive wrap were applied. Patients were discharged either the first day after operation, or the following morning, with instructions to return for dressing removal after 5 to 7 days.

4. Postoperative evaluation

All patients who completed a postoperative questionnaire (International Index of Erectile Function, IIEF-5) were included in this study. The angle of deformity was documented via postoperative photographs after alprostadil injection and after plication. The angle of correction, the stretched penile length, and postoperative patient-reported outcomes were assessed. The follow-up patient-reported data included a telephone interview performed by an independent investigator unaware of the clinical record. Statistical analyses were conducted using IBM SPSS ver. 20 (IBM Co., Armonk, NY, USA). Data were compared using the Nonparametric test (Kruskal-Wallis test), and p-values <0.05 were considered statistically significant.

RESULTS

Between 2009 and 2014, 22 patients underwent penile

plication with plaque incision, and complete subjective and objective postoperative data were available (Table 2).

The mean follow-up period was 39 months. As in preoperative evaluation, patients were grouped by preoperative degree of penile curvature as follows: Group I, mild (n=5, 22.7%); Group II, moderate (n=11, 50.0%); and Group III, severe (n=6, 27.3%). After the operation, each group had a lesser degree of curvature, regardless of the degree of preoperative curvature (2° for mild, 7° for moderate, 14° for severe; p<0.001) and the '5-degrees of correction per plication suture' rule for our technique was confirmed in simple and complex curvatures [9,10].

Measured mean penile length loss was not significantly different among the 3 groups: 0.5 cm (range, 0.3~0.7 cm) for mild, 0.6 cm (range, 0.2~1.0 cm) for moderate, and 0.6 cm (range, 0.2~1.0 cm) for severe groups (p=0.52). Therefore postoperative shortening of the penis by more than 1.5 cm did not occur in any patient.

At initial postoperative follow-up, the same number of patients from each group reported penile pain after 1 month (1 patient from each group; p=0.91).

We considered as residual a curvature >20° 6 months after surgery. After plication with plaque incision, 21 patients presented minimal penile curvature under 20° while 1 patient (4.8%) in the severe group did not. The one patient with residual curvature showed impaired sexual intercourse and required reoperation (p=0.80). In reopera-

Table 2. Objective and patient-reported outcomes after operation

Variable	Degree of curvature			p-value
	Group I ^a	Group II ^b	Group III ^c	
Time to survey (mo)	37 (28~41)	32 (19~42)	35 (25~42)	0.53
Postoperative curvature (°)	2 (0~5)	7 (0~10)	14 (10~25)	0.001
Correction (°)	14 (10~20)	37 (20~44)	43 (32~65)	0.47
Loss SPL (cm)	0.5 (0.3~0.7)	0.6 (0.2~1.0)	0.6 (0.2~1.0)	0.52
Patients with pain after 1 month	1 (20.0)	1 (9.1)	1 (16.7)	0.91
Patients with repeat procedures	0 (0)	0 (0)	1 (16.7)	0.18
IIEF-5 score at long-term follow-up (mean 39 months)				0.79
< 10	0	0	1	
10~21	0	2	0	
> 21	5	9	5	

Values are presented as median (range), number (%), or number only.

SPL: stretched penile length, IIEF: International Index of Erectile Function.

^aMild group (angle<30°). ^bModerate group (30°≤angle<60°). ^cSevere group (angle≥60°).

Table 3. Patient-reported results from telephone follow-up performed by an independent investigator unaware of the clinical record (mean follow-up 36 months, n=17)

Question	Number (%)
How would you rate the improvement in the curvature after surgery?	
Complete/Somewhat improved	8 (47.1)/8 (47.1)
No improvement	1 (5.9)
Does the remnant curvature continue to interfere with sexual intercourse?	
No	16 (94.1)
Yes	1 (5.9)
Are erections enough for sexual intercourse?	
Yes	14 (82.4)
No	3 (17.6)
How would you describe the length of your penis after the surgery?	
Longer/Same	1 (5.9)/2 (11.8)
Shorter	14 (82.4)
If length described as 'shorter', is this a problem for sexual intercourse?	
No	All patients
Yes	No patients
Overall, how satisfied are you with the surgery?	
Very satisfied/Satisfied	5 (29.4)/9 (52.9)
Not satisfied	3 (17.6)
Would you undergo this procedure again?	
Yes/No	15 (88.2)/2 (11.8)

tion, the penile curvature was completely corrected only by plaque incision without plication.

At the time of the long-term follow-up (mean, 39 months), 19 patients (86.4%) maintained valid erectile function (IIEF-5 > 21), whereas the remaining 3 patients (13.6%) reported that they had suffered a decline in erection quality over the years. The most frequent complication was subcutaneous penile edema in 3 patients (13.6%), which, however, resolved spontaneously within 3 months and did not result in problems during sexual intercourse, such as vaginal penetration. No patient suffered a urethral injury.

Despite the limitations of this retrospective review, which covered only 22 patients who underwent the surgical technique, the results of a standardized telephone survey were available for 17 patients, telephone follow-up was added for tracking patients, the postoperative outcome was re-evaluated, and reliability was calibrated (Table 3).

In telephone follow-up, two patients refused the telephone survey, and three were lost to follow-up, yielding a response rate for evaluable patients of 77.3% (17 of 22 patients). The rigidity of erections after surgery was sufficient

for vaginal penetration in 82.4% of patients (14 of 17 patients), and this result was similar in IIEF-5 for long-term follow-up: 19 patients (86.4%) had an IIEF-5 score > 21. As an inevitable complication, minimal penile shortening (< 1.5 cm) was reported by 14 patients (82.4%), but this did not adversely affect sexual intercourse (0%) and all patients found the penile shortening to be acceptable.

DISCUSSION

This report presents the postoperative outcomes and therapeutic effect of the multiple slit on plaque incision with plication technique as a modified technique for the surgical treatment of PD, which is an intractable disease. Our results have indicated good success for the correction of curvature, maintenance of erectile function, and patient-reported treatment satisfaction.

In PD, although conservative approaches will succeed in relieving pain for most, they do not have a significant effect on penile curvature and surgical intervention is often needed. The optimal timing for operative intervention is greater than 12 months after the onset of symptoms and more than 3 months from plaque stabilization [5].

Several major surgical strategies are employed in PD [11]. Currently available surgical options in PD include tunical plication procedures such as the Nesbit wedge resection and the various plication modifications, which are performed on the convex side of the penis. The first reported technique was the Nesbit procedure, which entails excision of a piece of the tunica albuginea on the contralateral side of the curvature [12,13]. Since then, modified Nesbit, Yachia, Essed-Schroeder, Duckett-Baskin-Levine, and 16-dot or 24-dot plication techniques have been reported [8,14-17]. These techniques have reasonable success rates with common limitations, including penile shortening, ED, plaque progression, palpable nodule, and recurrence [18,19].

Tunical lengthening procedures with the use of a graft and incision, or excision of the plaques (the Lue procedure) are performed on the concave side of the penis and are more suitable for more technically difficult cases where curvature is severe, plaques are large, and deformities are present [5,20-23]. This involves making an H-shaped incision in the plaque and inserting a vein graft into the incision [23,24]. But ED, numbness of the glans penis, and shortening of the penis, although less than in the Nesbit procedure, can still occur. Furthermore, these procedures are more complex and may involve the additional morbidity of harvesting autologous tissue. More extensive disruption of tunical integrity has been implicated as a cause of the subsequent loss of rigidity often found with grafting techniques [21,22]. And these procedures are more costly and require greater experience in the surgeon. The reasons for patient dissatisfaction among those undergoing this type of procedure are the residual curvature due to graft contraction and postoperative ED due to venous leakage from the incision or resection of large plaques, or due to venous leakage that is secondary to the replacement of the graft material by the scar tissue.

Penile prosthesis implantation is typically reserved for patients with PD and concurrent ED, especially non-responders to medical management [4,25,26].

Recently there have been reports that the incision on plaque technique without grafting is effective for correcting penile curvature. The first description of a minimally invasive, intracorporal technique for PD repair was reported by Bella et al [27]. Bella et al [27] reported that in 23

patients with localized Peyronie's plaque, dissection allowed atraumatic introduction of the blade along the inside wall of the tunica to the plaque, which was incised using multiple passes at varying angles from within the corpora, and correction of the deformity was successful in all but 2 patients (less than 10° residual curvature) without grafting.

Our modified technique, multiple slit, has different characteristics than various existing procedures like excision of plaques with grafting. Our report contains several differences from the report of Bella et al [27]. Bella et al [27] used saline for confirming the preoperative erection in plaque incision with plication, and incisions for plaques were not made through the full thickness of the tunica albuginea. In our study, normal saline was not injected into the corporal body because it requires frequent injection and leads to inaccurate curvature correction due to temporary loss of rigidity after several tunical stitches during the operation. In addition, it led to postoperative subcutaneous edema and could not produce a uniform line of penile skin. At first, multiple longitudinal plaque incision was done at the depth of the full thickness of the tunica in our study, because incision through the full thickness of tunica made the tunica flat and pliable. Consequently, multiple incision releases the main restriction from the plaque, therefore residual correction of curvature is easier with minimal plication on the contralateral convex side.

A plaque in the penile shaft site causes contraction with adjacent tissues and decrease in penile circumference and thickness; therefore the penile site distal to the plaque has decreased rigidity during erection in some patients. Multiple slits on the plaque without excision of the plaque released tension around the plaques, and increased the circumference of the tunica at the level of the plaque. Additional injection of triamcinolone was helpful for preventing recurrence at the site of the incised plaques.

Although plication sutures like the 16-dot or 24-dot plication techniques are effective for correcting penile curvature, they entail postoperative penile shortening as an inevitable complication [8]. Plaque disruption, as with multiple incisions on the plaques, minimizes or eliminates the need for plication sutures, thereby limiting penile shortening in men with more pronounced curvature.

Multiple slit is a minimally-invasive technique for pla-

ques, unlike grafting, and is effective in correcting severe penile curvature greater than 60°. In our study, the grafting and excision of plaques was not done for correcting the curvature even in patients with degrees of curvature greater than 60°. After plication with plaque incision alone, 21 patients presented minimal penile curvature under 20°, while 1 patient (4.8%) in the severe group did not. Postoperative minimal curvature did not cause problems in sexual intercourse and in the telephone follow-up, 94.1% of patients reported erections sufficient for intercourse and a treatment satisfaction of 82.4%. ED or disruption of tunical integrity, often found with grafting techniques, did not occur in our study, because multiple longitudinal incision to the plaques did not damage neurovascular bundles.

Therefore, as a modified technique, multiple slit on plaque with plication shows differences from previously reported procedures including the Nesbit procedure, the Lue procedure, and plaque incision with grafting. The first difference is that it does not need grafting, the second is that it is applicable for severe penile curvature greater than 60°, and the third is that it does not produce penile shortening greater than 1.5 cm.

Greenfield et al [28] reported that in a review of 102 patients, the direction of curvature (ventral and ventrolateral) and the degree of curvature measured at the time of surgery (particularly when >60°) significantly predicted the amount of penile length loss. But in our study, the measured mean of penile length loss was not significantly different among the 3 groups: 0.5 cm (range, 0.3~0.7 cm) for mild, 0.6 cm (range, 0.2~1.0 cm) for moderate, and 0.6 cm (range, 0.2~1.0 cm) for severe groups ($p=0.52$). And postoperative shortening of the penis greater than 1.5 cm did not occur in any patient.

Even in telephone follow-up, the most common self-reported complaint was penile shortening, for which all patients were counseled at the clinical assessment. However, none of the 17 patients who reported decreased length indicated that it had had an adverse effect on sexual function. Therefore, most patients accepted minimal shortening less than 1.5 cm and did not sense intromission, per our telephone follow-up. The majority of patients reported improvements in curvature and their global condition postoperatively, regardless of primary curvature complexity. While objective measurements of

erect penile geometry were not repeated postoperatively, the positive reported outcomes from patients suggest that plication is durable well beyond 3 years.

The penile plication technique has traditionally been recommended as the standard treatment in patients with PD who have curvature less than 60° [4,8,29]. In any type of surgical procedure for PD, there are some potential postoperative risks; these include penile shortening, ED, penile numbness, and unresolved curvature [4]. Our study reveals that, in the severe plication group (>60°), only 1 patient complained about postoperative penile pain and had repeated plication procedures, whereas the other 5 patients had no significant symptoms or complications such as ED or residual penile curvature, but did experience a significant correction of penile curvature.

In a report of 89 PD patients treated with a Nesbit plication since 1990, 91% reported complete correction of curvature and 89% had preserved erectile function [30]. In our study, 95% reported excellent surgical outcomes that showed complete correction of penile curvature and 86% had preserved erectile function.

Therefore, multiple slit on plaque with plication may be a simple, minimally-invasive, safe, and effective technique by comparison with previous techniques. Despite the excellent cosmetic and functional results, this study represents a retrospective, single-institution review with limited follow-up from some patients. Additionally, any study on PD relies on patient-reported outcomes. Thus in the future, we anticipate multi-centered studies with plication and plaque incision for various degrees of penile curvature and more objective postoperative outcomes.

CONCLUSIONS

As a modified technique, multiple slit on plaque with plication is a simple, minimally-invasive and effective technique for correcting penile curvature in patients with PD, regardless of curvature severity, even with curvature greater than 60°. And the degree of penile curvature does not significantly predict the amount of penile length loss.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article

was reported.

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