Surgical Reconstruction of Penile Curvature due to Peyronie's Disease by Plaque Incision and Buccal Mucosa Graft

Yernur Ainayev, MD,[1] Ulanbek Zhanbyrbekuly, MD, PhD,[1] Abduzhappar Gaipov, MD, PhD,[2] Makhmud Suleiman, MD,[1] Kainar Kadyrzhanuly, MD, MPH,[2] Nurlan Kissamedenov, MD, PhD,[3] Ulan Zhaparov, MD,[1] Daniyar Akhmetov, MD, PhD,[1] and Gafur Khairli, MD, PhD[1]

ABSTRACT

Background/aim: We aimed to evaluate the effectiveness and safety of penile plaque incision and buccal mucosa grafting in patients with stable-phase Peyronie's disease (PD).

Methods: This was a prospective evaluation of patients with stable-phase PD who were treated by plaque incision and buccal mucosa grafting. Preoperative evaluation included International Index of Erectile Function Questionnaire (IIEF-5), measurement of erect penile length, and penile Doppler ultrasound during prostaglandin-induced erection. At 3- and 24-month follow-up visits, penile length and residual curvature were measured along with penile Doppler ultrasound and IIEF5 questionnaires. Patient and sexual partner satisfaction were also assessed at 24-month-visit.

Results: The study was completed with 20 patients (mean age 46.5 ± 9.9 years). Dorsal curvature was the most frequent site of curvature (45%). The median curvature at preoperative evaluation was 45°(range 40-90°). The postoperative median curvatures were 5°(5-10, IQR) and 7°(5-10, IQR) at 3- and 24-month postoperatively, respectively. Success rate was 95% at 3-month and 90% at 24-month. There was no significant penile shortening. The mean IIEF-5 score was 17.5 ± 2.2 at preoperative evaluation. The median IIEF-5 scores were calculated as 20.1 ± 2.2 and 21.3 ± 2.2 at 3-month and 24-month visits, respectively ($p<0.0001$). Compared with baseline IIEF-5 score, both postoperative IIEF-5 scores were significantly higher. There was no de novo erectile dysfunction. There were no serious complications during and after the surgery. Ten percent of patients were poorly satisfied with the results of the surgery.

Conclusion: Corporoplasty with buccal mucosa graft led to excellent structural and functional results and patient satisfaction. **Ainayev Y, Zhanbyrbekuly U, Gaipov A, et al. Surgical Reconstruction of Penile Curvature due to Peyronie's Disease by Plaque Incision and Buccal Mucosa Graft. J Sex Med 2021;XXX:XXX−XXX.**

INTRODUCTION

Peyronie disease (PD) is defined as an organic disorder characterized by penile deformities and pain, commonly accompanied by a palpable plaque.[1] Penile deformities involve curvature, shortening, and hourglass deformity. A recent population-based study in Australia revealed that 19% of the surveyed men had a penile curvature.[2] Several studies reported the prevalence of PD ranging between 0.4 and 20%,[3-5]

Though it is thought that PD results mainly from repetitive trauma to the erect penis, the pathophysiology seems multifactorial. These repetitive traumas during intercourse lead to microbleeds with subsequent inflammation and fibrous plaque development, for which transforming growth factor beta plays a prominent role.[6] Two stages are distinguished during the course of PD; the active phase usually lasts less than 6 months and is characterized by pain and changing penile curvature. The stable phase develops 6-12 months after the disease onset and is recognized by palpable plaque and penile deformity in the absence of pain. Although PD is a progressive disorder, in a minority of patients, spontaneous resolution may be seen.[7]

Although none is curative, several medical and surgical treatment options exist for PD. Despite significant improvements in medical

and conservative treatment modalities, surgical reconstruction still remains the gold standard of chronic stable phase PD.[8] Currently, the most popular surgical technique is plaque incision and grafting. Several graft materials have been tried to be able to attain the best functional result with the lowest complication rate.[9]

Autografts, including dermis, saphenous vein, temporal fascia, tunica albuginea, and more recently, buccal mucosa have been used with varying success rates. Since the use of heterogeneous patient populations with differing measurement and reporting tools, we are still far from the point of recommending one graft material unanimously over others. Kakonashvili and Shioshvili first performed a dog study in which they compared different biologic autografts, including buccal mucosa, and found that buccal mucosal graft provided the best results regarding elasticity, morphological structure, and revascularization.[10] Then the same group reported their results with human subjects with PD.[11] Several authors reported their experience with buccal mucosa grafting since the pioneering studies of Shioshvili et al.[12-16] These studies as a whole reported an 87.5-100 surgical success rate along with 0.7-7% erectile dysfunction rate. Compared with older autografts such as dermis and saphenous vein, the experience with buccal mucosa patch in PD is the more limited in part due to more recent introduction of buccal mucosa grafting. Thus, we aimed to evaluate the efficacy and safety of buccal mucosa patches along with tunica incision in the correction of curvatures in patients with PD.

MATERIALS AND METHODS

Study Design and Patients

This was a prospective evaluation of consecutive adult patients with Peyronie's disease who were treated by plaque incision and buccal mucosa grafting between September 2013 and May 2020 at our institution. All patients had stable-phase PD, which was diagnosed by color Doppler ultrasound with provoked erection and were refractory to conservative management. None of the patients had undergone previous surgical intervention for PD. Exclusion criteria were as follows: PD lasting less than 12 months or in active inflammatory phase, history of penile trauma, severe erectile dysfunction (ED), bleeding disorders, congenital penile curvature, a recent history of stroke, uncontrolled hypertension and/or uncontrolled diabetes mellitus, or other significant medical conditions.

Local ethical committee approved the study protocol (IRB #5). Each study participant was informed thoroughly about the nature of the surgical procedure and potential adverse events. All patients signed informed consent forms in light of this information. Study procedures were performed in accordance with the principles of the Declaration of Helsinki.

Preoperative Work-up

Each study participant underwent preoperative evaluation that included detailed medical history, comprehensive physical
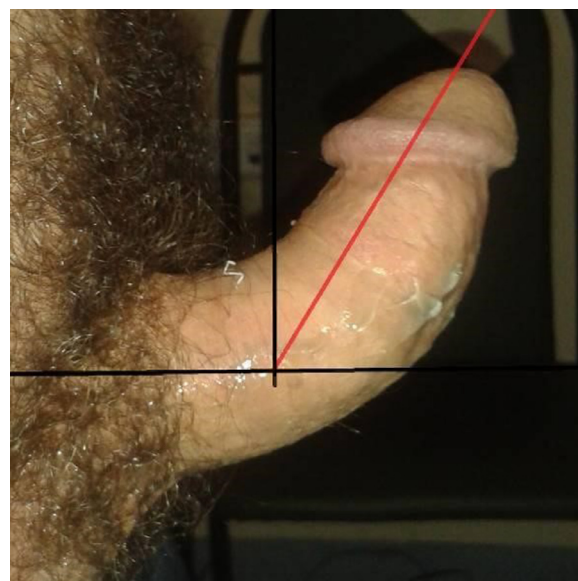

Figure 1. Measurement of penile curvature (55º) in a study participant during alprostadil-provoked erection.

examination, the International Index of Erectile Function Questionnaire (IIEF-5), measurement of penile length during relaxation and erection, and penile Doppler ultrasound during prostaglandin-induced erection. Erectile dysfunction was defined as an IIEF-5 score <22. Patients with an IIEF-5 score between 12-16 and 17-21 were defined as mild to moderate and mild ED, respectively.[17]

The penile Doppler ultrasound was carried out by intra-cavernous injection of 10 mcg alprostadil to assess the angle and direction of the curvature of the penis by means of a protractor during maximum erection (Figure 1). Each procedure was also recorded photographically for future reference.

Surgical procedure

The same urologic surgeon (Y.I.A) carried out all surgeries. Surgery was performed under general anesthesia. The buccal mucosa grafts were harvested by Y.I.A. with the method defined by Eppley and colleagues.[18] This procedure is done under general anesthesia. After penile degloving, the bucks fascia is carefully divided under clear vision, the dorsal neurovascular bundle was mobilized, and an intraoperative erection was created by introducing 0.9% NaCl into the corpus cavernosum using a 23 G butterfly needle until the erection was obtained. Under the erect condition of the penis, a section of fibrosis of the tunica albuginea was reached. An "H" or "Y" shape incision was made at the site of maximum curvature, and the fibrous plaque was dissected via expanding the ends of the incision. If the plaque was located in the median septum, we dissected the plaque together with the septum to straighten the penis. The edges of the wound were expanded as much as possible, the distance between the edges of the defect measured by ruler, and then we deliberately
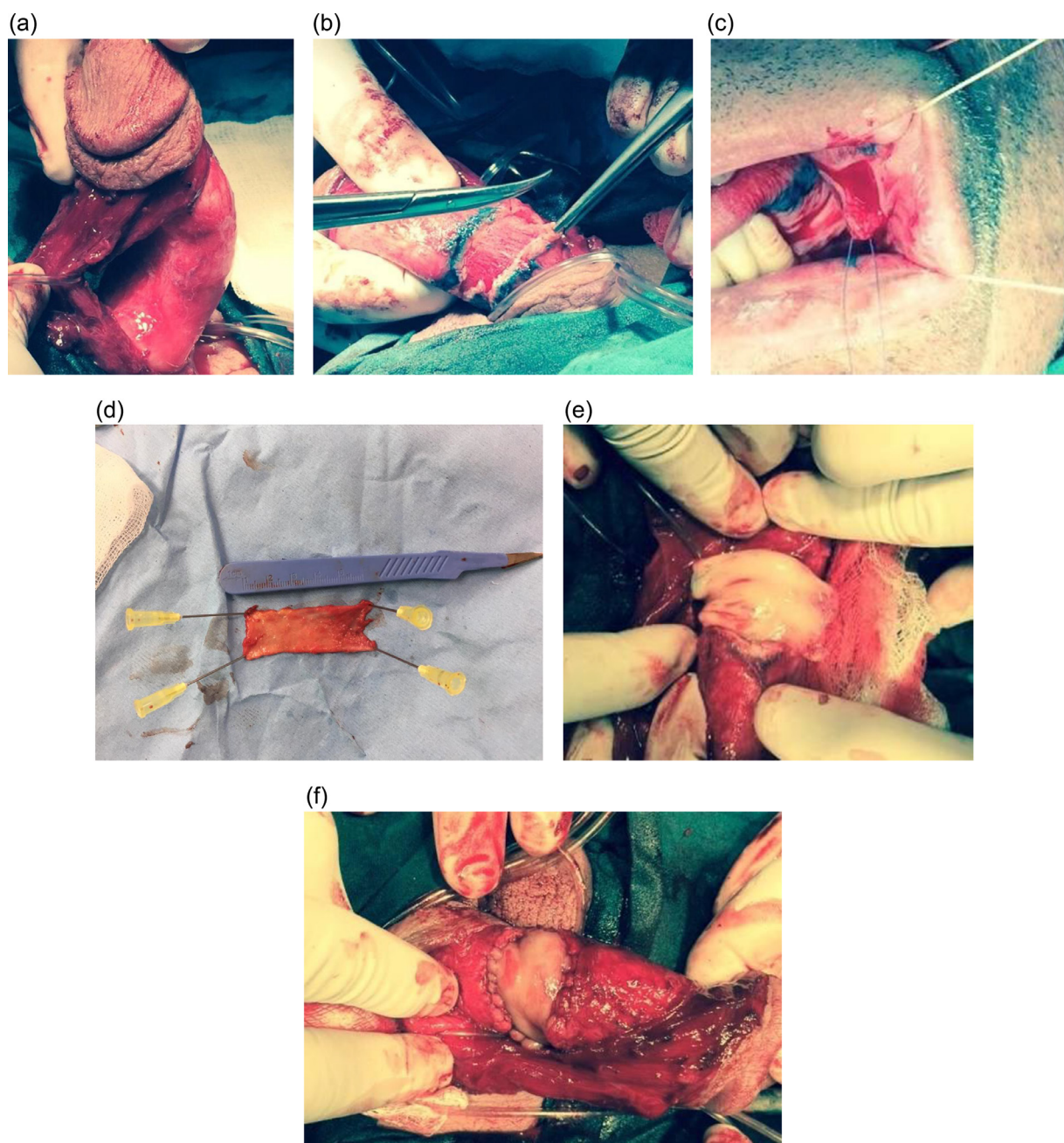
Figure 2. a-f. (a) Mobilization of Buck's fascia while induction of artificial erection by saline solution, (b) Marking the border of the fibrous plaque, and excision of fibrous plaque, (c) Excision of a buccal mucosa graft), (d) Buccal mucosa graft preparation (e) Transplantation of the buccal mucosa graft into the defect area, (f) Suturing the graft edges with continuous sutures.

noted the larger size on the buccal mucosa. After that we placed buccal mucosa graft onto the ensuing defect. We applied stay sutures at the corners of the graft after which sutured with continuous running sutures with the Vykril No. 4. Afterward, control artificial erection was provoked again to assess the angle of curvature, and if deemed necessary, additional sutures were applied. In addition, separate interrupted catgut sutures were applied to the edges of the Buck's fascia (Figure 2 a-f). The skin was sutured with interrupted Vycril 4-0 sutures. A slightly compressive penile bandage was placed, and a Foley catheter was introduced. The catheter and penile bandage were removed 24 hours after surgery. Patients were discharged 7-10 days after the surgery.

Post-operative follow-up

In order to attain swift recovery of the corpus cavernosum function, we prescribed phosphodiesterase type-5 inhibitors to

all patients after surgery and instructed them to continue for at least one month, starting one week after surgery. Patients were allowed to have sexual intercourse beginning 30 days after the surgery.

Follow-up visits were scheduled at 3, 12, and 24 months after surgery. At 3- and 24-months visits, urological examination was performed, penile length and residual curvature were measured during an alprostadil-provoked erection, ability to perform sexual intercourse and pain during sex were assessed, and patients were asked to complete IIEF5 questionnaires. The erected penis length measured from the base to the tip of the penis. To assess the sexual function of patients, a validated questionnaire Russian-language version of EMAS-SFQ was used. To assess the sexual satisfaction of the partner, a validated in Russian language questionnaire was used "Index of female sexual functions "(The Female Sexual Function Index, FSFI) - self-checking questionnaire survey.

When there was no residual curvature of penis ≥15° at postoperative visits, we accepted that as successful penile straightening.[12] In addition, penile Doppler ultrasound examination was carried out at these visits to document peak systolic velocity (PSV), end-diastolic velocity (EDV), resistance index (RI) of penile artery (penile vascular system). All ultrasound examinations were performed by one of the investigators (I.A.S.) using an ultrasound machine (ES LOGIQ 7, GE Healthcare, USA). At the 12-month visit, only urological examination was performed, and patients were asked to complete IIEF-5 questionnaires. Patient and sexual partner satisfaction were also assessed at 24-month-visit using their answers to a question asking their subjective evaluation about sexual intercourse (very satisfied, satisfied, fairly satisfied, poorly satisfied, and not satisfied at all).

Penile length was measured with a flexible ruler at the midline between the short and long curvatures during provoked erection.

STATISTICAL ANALYSIS

The Shapiro−Wilk test, histograms, and Q-Q plots were used to test the normality of the variables. Categorical variables were presented as number and percentage. Numeric variables presented as mean ± standard deviation when normally distributed, and median and interquartile range or min-max if they were not normally distributed. The McNemar's test was used to compare categorical variables.

Since penile curvature variable was not normally distributed, we performed the Friedman test to compare preoperative and postoperative 3- and 24-month measurements. Other numerical parameters fulfilled all the assumptions; thus, we performed the repeated measures ANOVA was used to evaluate the dynamics of variables before and after surgery during the 0, 3 and 24 moths. The post hoc analysis with Bonferroni correction was used to determine significance between the repeated measurement in different time points.

Statistical software STATA v. 15 (Stata Corp. LLC, College Station TX, USA) was used for the data analysis. Two-tailed p-values less than 0.05 were considered statistically significant.

RESULTS

Patients

Overall, 22 patients were enrolled in the study during the specified period. The study was completed with 20 patients (mean age 46.5 ± 9.9 years) because 2 patients were lost to follow-up. All patients had stable-phase PD with penile curvatures making satisfactory and painless intercourse impossible, at least for the preceding 12 months. Every study participant received failed medical/conservative treatments previously for PD. Moreover, none of the patients reported severe erectile dysfunction necessitating a PDE-5 inhibitor use. Individual patient characteristics are provided in **table 1**. Data regarding clinical features of the enrolled patients are shown in **table 2**.

Penile curvature reconstruction

None of the study participants had a secondary penile curvature. Dorsal curvature was the most frequent site of curvature (45%). The median curvature at preoperative evaluation was 45° (range 40-90°). The postoperative median curvatures were 5° (5-10, Interquartile range (IQR)) and 7° (5-10, IQR) at 3 and 24 months postoperatively, respectively. The success rate, which was defined as residual penile curvature <15°, was 95% at 3 months and 90% at 24 months. The penile curvature was increased in 7 patients (35%) at 24 months visit compared with 3 months visit. On the other hand, 12 patients (60%) had stable curvature at two postoperative visits. **Table 3** summarizes pre- and post-operative penile curvature values.

Penile length

Mean erect penile length at preoperative evaluation was found to be 110.0 ± 15.5 mm. The mean erect penile length values were 123.1 ± 12.8 and 122.6 ± 12.6 mm at 3 months and 24 months evaluations, respectively. Maximum acquisition of penile length was 10 mm, while the maximum penile length loss was 6 mm. We determined penile length increase at 24 months in 14 patients (70%) relative to the preoperative penile length. Although there was a trend of increasing penile length after surgery, it was not statistically significant (**table 3**).

Erectile function, pain during erection and intercourse capability

The mean IIEF-5 score was 17.5 ± 2.2 at preoperative evaluation. The median IIEF-5 scores were calculated as 20.1 ± 2.2 and 21.3 ± 2.2 at 3 months and 24 months visits, respectively (p<0.0001). Compared with the baseline IIEF-5 score, postoperative IIEF-5 scores at 3 and 24 months were significantly higher.

Table 1. Pre- and post-operative characteristics of study participants.

Patient no	Age (years)	Duration of disease (months)	Site of curvature	Preoperative degree of curvature (º)	Postoperative degree of curvature (º)		Preoperative erect penile length (mm)	Postoperative erect penile length		Preoperative IIEF-5 score	Postoperative IIEF-5 score	
					3-month	24-month		3-month	24-month		3-month	24-month
1	52	12	Lateral	40	5	7	130	132	132	17	21	22
2	49	12	Dorsolateral	45	5	7	130	127	127	15	21	21
3	55	12	Lateral	45	5	5	130	128	127	16	21	21
4	57	24	Dorsal	60	5	5	115	112	112	18	22	22
5	32	18	Ventrolateral	45	5	5	120	114	112	16	20	17
6	56	12	Lateral	45	5	5	125	125	120	18	21	20
7	43	16	Dorsolateral	45	10	10	120	118	117	22	25	25
8	37	24	Dorsal	50	10	10	115	125	125	17	20	21
9	35	36	Ventral	40	10	15	105	102	100	17	18	17
10	35	12	Dorsolateral	45	5	5	120	125	125	20	20	24
11	58	18	Dorsal	45	5	7	103	108	110	18	18	22
12	45	12	Dorsal	40	0	5	110	115	115	20	22	23
13	50	18	Dorsal	65	10	10	90	95	95	15	17	20
14	51	14	Lateral	45	0	10	100	105	105	17	19	20
15	30	12	Ventral	45	5	0	110	115	115	20	22	23
16	35	14	Ventrolateral	50	0	5	110	115	115	21	23	24
17	40	18	Dorsal	50	10	10	112	115	115	18	20	24
18	51	20	Dorsal	55	10	10	100	110	110	15	18	20
19	58	18	Dorsal	60	10	10	80	90	90	15	17	20
20	61	24	Dorsal	90	15	15	75	85	85	15	17	20

IIEF-5: International Index of Erectile Function

Table 2. Clinical characteristics of the study participants.

Parameters	Patients (n=20)
Age (years)	46.5 ± 9.9
Duration of Peyronie's disease (months)	17 (12-36)*
Preoperative penile curvature (º)	45 (40-90)*
Site of curvature (n, %)	
Dorsal	9 (45%)
Ventral	2 (10%)
Lateral	4 (20%)
Dorsolateral	3 (15%)
Ventrolateral	2 (10%)
Plaque length (mm)	21.8 ± 6.9
Operative time (minutes)	145.75 ± 44.2
Length of postoperative hospital stay (days)	8 (7-18)*

*median (min-max)

Erectile function was stable between the 3 months and 24 months evaluations (**table 3**).

Nineteen out of 20 patients (95%) had IIEF-5 scores <22 at the preoperative evaluation. However, none of the study participants was using PDE-5 inhibitors at the time of the preoperative evaluation. Of all patients with lower-than-normal IIEF-5 score, 12 patients (63%) had mild erectile dysfunction based on IIEF-5 scores, whereas 7 patients (36.8%) had mild-to-moderate erectile dysfunction. Eleven out of 12 patients (91.6%) with mild erectile dysfunction showed an improvement in their IIEF-5 scores at 24 months visit. All patients with mild-to-moderate erectile dysfunction preoperatively showed improvement in their IIEF-5 scores at 24 months evaluation. At 24 months visit, nine patients had normal erectile function (with an IIEF-score 22 or higher), and the rest of the patients had only mild erectile dysfunction, none of whom had IIEF-5 scores below 17.

At preoperative evaluation, 13 patients (65%) reported penile pain during erection. This figure significantly reduced to 4 patients (20%) at 3 months visit after the surgery (p=0.0003). At 12 months visit, none of the study patients reported pain during erection.

During the preliminary evaluation of patients before reconstruction, 12 patients (60%) reported that they were not able to perform sexual intercourse because of penile curvature and/or pain during erection. Fortunately, this figure reduced to zero at 3 months visit after the surgery, and all patients reported successful intercourse.

Adverse events

There were no serious complications during and after the surgery. Seroma and hematoma were seen in 2 and 5 patients, which resolved spontaneously.

Penile Doppler ultrasound

Mean peak systolic velocity (PSV) significantly increased, whereas mean end-diastolic velocity (EDV) significantly reduced after surgery (p=0.0368, p=0.0001, respectively) relative to the preoperative measurements. On the other hand, the mean resistance index (RI) did not change significantly with surgery (**table 4**).

Patient and sexual partner satisfaction

At the 24-month visit, 9 patients were very satisfied, 9 patients were satisfied, and 2 patients were poorly satisfied with the overall results of the surgery. Two patients who were poorly satisfied complained that they expected a longer penis with the operation. On the other hand, all sexual partners of the study participants were satisfied (**table 5**).

Table 3. Postoperative changes in penile curvature, IIEF-5 score, penile length, pain during erection and hypoesthesia (n=20).

Parameters	Before surgery	Post-operative observation			p-value
		3 months	12 months	24 months	
Penile curvature (º)	45 (45-53.8)	5 (5-10)[a]	-	7 (5-10)[a,b]	<0.0001
IIEF-5 score	17.5 ± 2.2	20.1 ± 2.2[a]	20.7 ± 2.2[a]	21.3 ± 2.2[a]	<0.0001
Relaxed penile length (mm)	83.8 ± 5.4	87.1 ± 5.4	-	87.1 ± 5.4	0.2537
Erect penile length (mm)	110 ± 15.5	123.0 ± 12.7	-	122.6 ± 12.5	0.0572
Pain during erection				-	0.0003
Yes	13 (65%)	4 (20%)[a]	0[a]		
No	7 (35%)	16 (80%)	20 (100%)		
Capability of Intercourse				-	0.0047
Yes	12 (60%)	20 (100%)[a]	20 (100%)[a]		
No	8 (40%)	0 (0%)	0 (0%)		
Hypoesthesia	-				0.0002
Yes		10 (50%)	2 (10%)	0	
No		10 (50%)	18 (90%) [a]	20 (100%) [a]	

[a]Compared with before surgery p<0.05 [b]Compared with post-surgery 3 months p<0.05, IIEF-5: International Index of Erectile Function

Table 4. Comparison of the baseline and postoperative color Doppler ultrasound parameters.

Parameters	Before surgery	Post-operative observation		p-value
		3 months	24 months	
Peak systolic velocity (PSV) (cm/s)	36.4 ± 11.3	37.4 ± 9.51	41.0 ± 9.57[a,b]	0.0001
End-diastolic velocity (EDV) (cm/s)	1.29 ± 2.33	1.02 ± 1.62[a]	0.45 ± 1.09[a,b]	0.0368
Resistance index (RI)	0.82 ± 0.2	0.87 ± 0.1	0.84 ± 0.08	0.6252

[a]Compared with before surgery p<0.05
[b]Compared with post-surgery 3 months p<0.05

Table 5. Subjective evaluation of patient and partner sexual satisfaction at 24 months after surgery.

Patient no	Patient Satisfaction	Partner Satisfaction
1	Very satisfied	Satisfied
2	Very satisfied	Satisfied
3	Very satisfied	Satisfied
4	Satisfied	Satisfied
5	Satisfied	Satisfied
6	Very satisfied	Satisfied
7	Satisfied	Satisfied
8	Satisfied	Satisfied
9	Satisfied	Satisfied
10	Very satisfied	Satisfied
11	Very satisfied	Satisfied
12	Poorly satisfied	Satisfied
13	Satisfied	Satisfied
14	Very satisfied	Satisfied
15	Very satisfied	Satisfied
16	Satisfied	Satisfied
17	Very satisfied	Satisfied
18	Satisfied	Satisfied
19	Poorly satisfied	Satisfied
20	Satisfied	Satisfied

DISCUSSION

The most notable findings of the present study were as follows: First, plaque incision and buccal mucosa grafting was an effective and safe penile reconstruction procedure in patients with PD. The success rate was 95% at 3 months and 90% at 24 months without a major adverse event. Second, the rate of de novo erectile dysfunction was zero. In contrast, most of the patients with lower IIEF-scores (patients with mild and mild-to-moderate erectile dysfunction) improved after the surgery. All patients except two and all of their sexual partners were satisfied with the results attained by the surgery. Third, none of the patients underwent the surgery experienced loss of penile length. On the contrary, 70% of patients had increased penile length at the 24 months visit relative to their baseline values with a mean 12.6 mm literal increase in length in the whole group. Our results, in general, confirmed the findings of the previous studies that utilized buccal mucosa in repair of the penile curvature reconstruction.

In addition to medical therapy options, surgical armamentarium comprises several surgical treatment modalities.[19] As it is relatively easy to perform, tunica albuginea plication is commonly performed, in which convex side of the penile curvature is shortened. This technique has esthetically unsatisfying results. Moreover, more disappointing for the part of the patients is inevitable shortening of the penile length with this technique. Thus, it is more appropriate for patients with long penile length and patients with high surgical risk.[20] Other methods deal with the concave side of the curvature, which include plaque incision, not excision, and grafting of synthetic or autologous materials.[21] This repair technique is more cumbersome for the surgeons and reserved for severe curvatures in patients with intact erectile function. This surgical technique enables more satisfaction in terms of penile length and esthetics. A number of grafting materials are used to patch the defect on the concave side of the curvature. Synthetic and autologous grafts have their own advantages and disadvantages.

The use of buccal mucosa as grafting material in Peyronie's disease is a latecomer among other autologous biologic materials, including dermis, dura mater, saphenous vein, tunica vaginalis, and fascia patches.[9] Understandably, the experience is much limited with buccal mucosa compared to these autograft materials. First suggested by Kakonashvili and Shioshvili as an appropriate biologic grafting material to be used in penis based on their evaluation in an experimental study,[10] the clinical performance of the buccal mucosa graft was also assessed by the same group in 2005.[11]

Buccal mucosa was favored primarily by its swift graft take, most possibly due to its unique vascular pattern in that the submucosa layer contains large- and middle-sized vessels as well as capillaries. This fast adaptation and shunning of ischemia-reperfusion injury enables healing without causing further increase in levels of TGF-beta, which itself may lead to the development of plaque re-formation, reemergence of curvature, and de novo erectile dysfunction.[11] Actually, the results of available clinical studies have, to some extent, confirmed these hypothetical assumptions. In addition to good revascularization and adaptability, buccal mucosa grafting of Peyronie's disease was found to have superior results in terms of curvature correction success rate and postoperative ED rates compared to other autografts and synthetic grafts.[9] Moreover, buccal mucosa grafts are quite easy

to take and without any prolonged morbidity at the buccal graft site.

One of the foremost aims of the surgical repair of PD is to be able to attain as straight a penis as possible. The success rate of correction of penile curvature was 90% at 24 months at our study. In this regard, our results were in line with the previous studies. The mean curvature was 45° in our patients. However, the mean penile curvature in previous studies was higher compared to ours, ranging between 57° and 72°.[12-15] Curvature relapse was evident only in one of our patients at 24 months; whose relapsed curvature was only 15°. Although we had only a 24-month follow-up, the largest study to date by Cormio et al.[12] reported successful results in terms of curvature correction and lack of curvature relapse with a mean follow-up of 62 ± 34 months by using buccal mucosa graft.

Another important aim of Peyronie's disease surgery is to maintain successful erection as preventing de novo erectile dysfunction. Although it was not formally validated to assess erectile dysfunction in patients with PD,[9] almost all studies using buccal mucosa grafts to date have used IIEF or its shortened version IIEF-5 to evaluate baseline and postoperative erectile status of the patients.[13-16] The mean IIEF-5 score in our study was 17.5 ± 2.2 though none of the patients had severe erectile dysfunction. While most of the studies investigated buccal mucosa graft in PD had patients with mean IIEF-5 scores higher than ours (which means less severe erectile dysfunction at baseline), the seminal work of Shioshvili et al. reported the mean IIEF-5 score as 8.1±1.1.[11] We found a significant increase in the mean IIEF scores of our patients after surgery. This was the case in other studies as well, including the Shioshvili's patients who had more severe erectile dysfunction.[11-13,15] Generally, de novo ED rate was below 10% across the previous studies. None of the patients developed de novo ED within 24 months of surgery in our study.

Although tunical wedge resection and plication are considered standard surgical techniques in PD, these shortening procedures are not appropriate in severe and complex deformities and patients who are concerned with their penile length.[22] With plaque incision/partial excision and grafting, penile length could be reserved; even penile length increase can be obtained in many occasions. In this respect, plaque incision and buccal mucosa grafting studies have reported favorable results so far. None of our patients had penile shortening after surgery. In fact, the mean penile length has increased with a mean of 12.6 mm at 24-month visit. In similar to our results, Cormio et al.[12] did not report any penile shortening. In the study of Shioshvili et al.,[11] the penile shortening rate was reported as 15.4%.

Although the success of PD surgery is evaluated most of the time by rates of penile straightening and lack of erectile dysfunction, patient satisfaction can be seen as the ultimate goal of PD treatment. Patient expectations are affected by straightness and length of the newly reconstructed penis as well as sufficient erection enabling a satisfying intercourse. The means by which patients and partner satisfaction are assessed vary from study to study, thus, making generalizations regarding patient satisfaction with a particular kind of grafting material difficult. We evaluated patient satisfaction by means of a graded scale. At 24 months, all of our patients except two and all partners were found to be satisfied with the results of the surgery. Two patients were poorly satisfied, largely due to their expectation of a longer penis. In the study of Cormio and colleagues,[12] 86% of the patients underwent surgery were satisfied with the overall sexual experience. Chief reasons for dissatisfaction were subjective perceptions of insufficient length and rigidity. Other previous studies reproduced satisfaction rates and dissatisfaction reasons similar to our and Cormio et al.'s studies.[13-15]

As far as we know, we reported for the first time Doppler changes in the reconstructed penis in buccal mucosa grafting. Peak systolic velocity and end-diastolic velocity showed significant changes relative to preoperative values, whereas the resistance index was stable throughout the follow-up period. And we think that favorable results in terms of erectile function in part results from this positive change in penile vasculature.

During and following the operation, we did not observe a major adverse event. Only seroma and small hematomas occurred in 2 and 5 patients, which spontaneously resolved. Besides, buccal mucosa harvesting was not associated with any morbidity.

Some limitations of the current study deserve mention. First, this was a descriptive study in that we did not use a comparison group with another grafting material. Second, we did not use dedicated PD questionnaires. Third, although frequently used in the literature for this purpose,[11,13,15,23,24] IIEF has not been designed to evaluate erectile function in patients with PD.[9] However, we also utilized Doppler ultrasound findings as a means of objective reflection of erectile function in our study.

In conclusion, despite its aforementioned limitations, our study contributes to the current state of knowledge regarding the safety and efficacy of buccal mucosa grafting in PD. Our study confirmed the results of the previous studies and showed that corporoplasty with buccal mucosa led to excellent structural, functional, and patient satisfaction results. At 24 months, we demonstrated that the vast majority of PD patients were afforded to maintain their lives with a straight, sufficiently rigid, and satisfying penis. We think, based on our and previous studies' results, that plaque incision and buccal mucosa grafting seems as an effective and safe correction procedure in patients with Peyronie's disease, which is worthy of further research. The success of this surgical approach in terms of ED should be further evaluated with dedicated questionnaires validated for use in patients with PD.

Corresponding Author: Dr. Yernur Ainayev, Department of Urology and Andrology, Astana Medical University, Beybitshilik Street 49a., 010000, Nur-Sultan, Kazakhstan. Phone +77014429198; E-mail: ernur.ainaev@mail.ru

STATEMENT OF AUTHORSHIP

REFERENCES

1. Chung E, Gillman M, Tuckey J, La Bianca S, Love C. A clinical pathway for the management of Peyronie's disease: integrating clinical guidelines from the International Society of Sexual Medicine, American Urological Association and European Urological Association. **BJU Int** 2020;126(Suppl 1):12–17.

2. Chung E, Gillman M, Rushton D, Love C, Katz D. Prevalence of penile curvature: a population-based cross-sectional study in metropolitan and rural cities in Australia. **BJU Int** 2018;122 (Suppl 5):42–49.

3. Stuntz M, Perlaky A, des Vignes F, Kyriakides T, Glass D. The Prevalence of Peyronie's Disease in the United States: A Population-Based Study. **PLoS One** 2016;11(2):e0150157.

4. Segundo A, Prevalence Glina S. Risk Factors, and Erectile Dysfunction Associated With Peyronie's Disease Among Men Seeking Urological Care. **Sex Med** 2020;8(2):230–236.

5. Kadioglu A, Dincer M, Salabas E, Culha MG, Akdere H, Cilesiz NC. A Population-Based Study of Peyronie's Disease in Turkey: Prevalence and Related Comorbidities. **Sex Med** 2020;8 (4):679–685.

6. Milenkovic U, Ilg MM, Cellek S, Albersen M. Pathophysiology and Future Therapeutic Perspectives for Resolving Fibrosis in Peyronie's Disease. **Sex Med Rev** 2019;7(4):679–689.

7. Ziegelmann MJ, Bajic P, Levine LA. Peyronie's disease: Contemporary evaluation and management. **Int J Urol** 2020;27 (6):504–516.

8. Hatzichristodoulou G, Osmonov D, Kubler H, Hellstrom WJG, Yafi FA. Contemporary Review of Grafting Techniques for the Surgical Treatment of Peyronie's Disease. **Sex Med Rev** 2017;5(4):544–552.

9. Garcia-Gomez B, Ralph D, Levine L, Moncada-Iribarren I, Djinovic R, Albersen M, et al. Grafts for Peyronie's disease: a comprehensive review. **Andrology** 2018;6(1):117–126.

10. Kakonashvili AP, Shioshvili TJ. Substitution of tunica albuginea penis by different autotransplants: an experimental study. **Georgian Med News** 2003;10:38–42.

11. Shioshvili TJ, Kakonashvili AP. The surgical treatment of Peyronie's disease: replacement of plaque by free auto-graft of buccal mucosa. **Eur Urol** 2005;48(1):129–133 discussion 34-5.

12. Cormio L, Mancini V, Massenio P, d'Altilia N, Selvaggio O, Di Fino G, et al. Combined Plaque Incision, Buccal Mucosa Grafting, and Additional Tunica Albuginea Plication for Peyronie's Disease. **Sex Med** 2019;7(1):48–53.

13. Cormio L, Zucchi A, Lorusso F, Selvaggio O, Fioretti F, Porena M, et al. Surgical treatment of Peyronie's disease by plaque incision and grafting with buccal mucosa. **Eur Urol** 2009;55 (6):1469–1475.

14. Fabiani A, Servi L, Fioretti F, Maurelli V, Tombolini F, Filosa A, et al. Buccal mucosa is a promising graft in Peyronie's disease surgery. Our experience and a brief literature review on autologous grafting materials. **Arch Ital Urol Androl** 2016;88(2):115–121.

15. Zucchi A, Silvani M, Pastore AL, Fioretti F, Fabiani A, Villirillo T, et al. Corporoplasty using buccal mucosa graft in Peyronie disease: is it a first choice? **Urology** 2015;85(3):679–683.

16. Molina-Escudero R, Alvarez-Ardura M, Redon-Galvez L, Crespo-Martinez L, Otaola-Arca H, Paez-Borda A. Cavernoplasty with oral mucosa graft for the surgical treatment of Peyronie's disease. **Actas Urol Esp** 2016;40(5):328–332.

17. Rhoden EL, Teloken C, Sogari PR, Vargas Souto CA. The use of the simplified International Index of Erectile Function (IIEF-5) as a diagnostic tool to study the prevalence of erectile dysfunction. **Int J Impot Res** 2002;14(4):245–250.

18. Eppley BL, Keating M, Rink R. A buccal mucosal harvesting technique for urethral reconstruction. **J Urol** 1997;157 (4):1268–1270.

19. Levine LA, Larsen SM. Surgery for Peyronie's disease. **Asian J Androl** 2013;15(1):27–34.

20. Barbosa ARG, Takemura LS, Cha JD, Carneiro A, Lemos GC, Glina S, et al. Surgical Treatment of Peyronie's Disease: Systematic Review of Techniques Involving or Not Tunica Albuginea Incision. **Sex Med Rev** 2020;8(2):324–332.

21. Kadioglu A, Sanli O, Akman T, Ersay A, Guven S, Mammadov F. Graft materials in Peyronie's disease surgery: a comprehensive review. **J Sex Med** 2007;4(3):581–595.

22. Pryor J, Akkus E, Alter G, Jordan G, Lebret T, Levine L, et al. Peyronie's disease. **J Sex Med** 2004;1(1):110–115.

23. Breyer BN, Brant WO, Garcia MM, Bella AJ, Lue TF. Complications of porcine small intestine submucosa graft for Peyronie's disease. **J Urol** 2007;177(2):589–591.

24. Fabiani A, Fioretti F, Pavia MP, Lepri L, Principi E, Servi L. Buccal mucosa graft in surgical management of Peyronie's disease: Ultrasound features and clinical outcomes. **Arch Ital Urol Androl** 2021;93(1):107–110.