

Results of transurethral augmentation urethroplasty for stricture of fossa navicularis

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Abstract

Background: Stricture of the distal urethra is an actual problem due to the complexity of surgical correction methods capable of providing a high-level aesthetic and functional result. In this regard, we used a new method that meets the above requirements.

Methods: A prospective study of the treatment outcome was conducted in 12 patients with distal urethral stricture at the Moscow City State hospital V.M. Buyanov from 2021 to 2025. The inclusion criterion was the presence of isolated urodynamically significant narrowing of the urethra in the area of the fossa navicularis. All patients underwent transurethral ventral urethrotomy of the narrowed area with optical control of the depth of transection. Subsequently, a triangular fragment of the oral mucosa was taken and fixed in the urethra using the "inlay" technique using 4 sutures (4-0 monocryl) deep in the urethra and 5-7 sutures along the ventral semicircle of the external opening. Restoration of independent urination was achieved on the 12-14th day.

Results: The average age of the patients was 65.5 years. The observation period ranged from 7 to 54 months. The etiologic factor was lichen sclerosus in 8 cases and iatrogenic stricture in 4 patients. The labial mucosa was used as a graft in 9 patients, and the buccal mucosa in 3 patients. No intra and postoperative complications were noted. Average urination quality indicators before surgery: uroflowmetry Q_{max} 6.12 ± 3.62 ; IPSS 20.92 ± 6.22 . After surgery, Q_{max} 15.60 ± 4.63 ; IPSS $7 [4.00; 13.25]$. No patient reported urine splashing during urination. All patients were satisfied with the aesthetic result of the surgery. The surgeon's subjective assessment of the convenience of using grafts from the lip and cheek was in favor of the lip mucosa.

Conclusion: The method of transurethral augmentation plastic surgery of the distal urethral stricture using the oral mucosa is an effective and safe method for correcting obstruction of this etiology. The use of the labial mucosa is preferable because of the smaller thickness of the graft. It also preserves the buccal mucosa in patients with lichen sclerosus for possible future reconstruction.

Keywords: Urethral stricture, meatal stenosis, fossa navicularis stricture, augmented urethroplasty

Introduction

Urethral stricture (US) is a narrowing of the urethra due to scarring of the urethral mucosa with varying degrees of spongiofibrosis. This disease is one of the causes of the development of lower urinary tract symptoms in men and leads to deterioration in the quality of life (QoL). The

incidence of urethral stricture is 0.6% [1]. The possibilities of conservative treatment of dysuric symptoms in this disease are very modest. If a moderate effect on the symptoms of accumulation is possible, then the symptoms of emptying associated with stricture of the urethra do not change in any way against the background of drug treatment. The only effective method of treating patients with US is surgical intervention. The choice of surgical treatment method depends on the location, extent, etiology of the urethral stricture, as well as on the preservation of the urethral site.

The localization of urethral stricture in the fossa navicularis relative to other parts of the urethra is relatively low and amounts to 18% [2]. Nevertheless, this problem is especially relevant due to the need for the surgeon to solve two tasks during treatment: the formation of an adequate lumen of the urethra and ensuring a good cosmetic result.

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In addition, there are high requirements for the persistence of a positive result, including because lichen sclerosus is a common (42%) etiological factor of stricture of the fossa navicularis of the urethra. Being a progressive variant of corpus spongiosum damage, it causes a high incidence of US recurrence [3]. The purpose of the study is to evaluate the efficacy and safety of transurethral ventral augmentation of the urethra in men with fossa navicularis stricture.

Methods

A prospective study was conducted at the V.M. Buyanov Moscow City Clinical Hospital to evaluate the treatment results of 12 patients with fossa navicularis stricture of the urethra who underwent transurethral augmentation urethroplasty from 2021 to 2025. The criterion for inclusion in the study was the presence of a urodynamically significant narrowing of the urethra in the fossa navicularis. To determine the indications for surgery, standard methods of examination and evaluation of urination parameters were used: uroflowmetry, filling out IPSS and QoL questionnaires, determination of residual urine, retrograde and micturition urethrocytography. The control study 6 months after surgery included uroflowmetry and filling out the IPSS questionnaire, QoL.

The technique of performing transurethral augmentation plastic surgery of the fossa navicularis of the ure-

thra

The patient is placed on the operating table in a supine position. Under endotracheal anesthesia, suture holders are applied on the sides of the external opening of the urethra to open the meatus. A spear-shaped scalpel inserted through the external opening of the urethra is used to longitudinally dissect the stricture of the fossa navicularis of the urethra at 6 o'clock on the conventional dial from the external opening of the urethra to the proximal border of the stricture. The lumen of the urethra during dissection is supported by vascular tweezers inserted into its distal part. An endoscope is used to perform urethroscopy, which evaluates the depth and length of the incision, as well as the size of the required graft. The urethra is calibrated by passing a 26 Ch metal urethral bougie through the area of the dissected urethra to a depth of 4-5 cm.

After marking and hydrotreating with a 1:200,000 epinephrine solution in a volume of 10 mL, a triangular graft of the required size is taken from the mucous membrane of the inner surface of the lower lip or cheek according to the standard procedure. Hemostasis of the graft bed is performed.

Under the control of an endoscope, by puncturing the skin from the ventral surface of the penis, a needle with a thread (17 mm, ½, Monocryl 4-0) is inserted into the lumen of the urethra along the proximal border of the urethrotomy incision, captured by a needle holder and removed from the urethra. The tip of the triangular flap

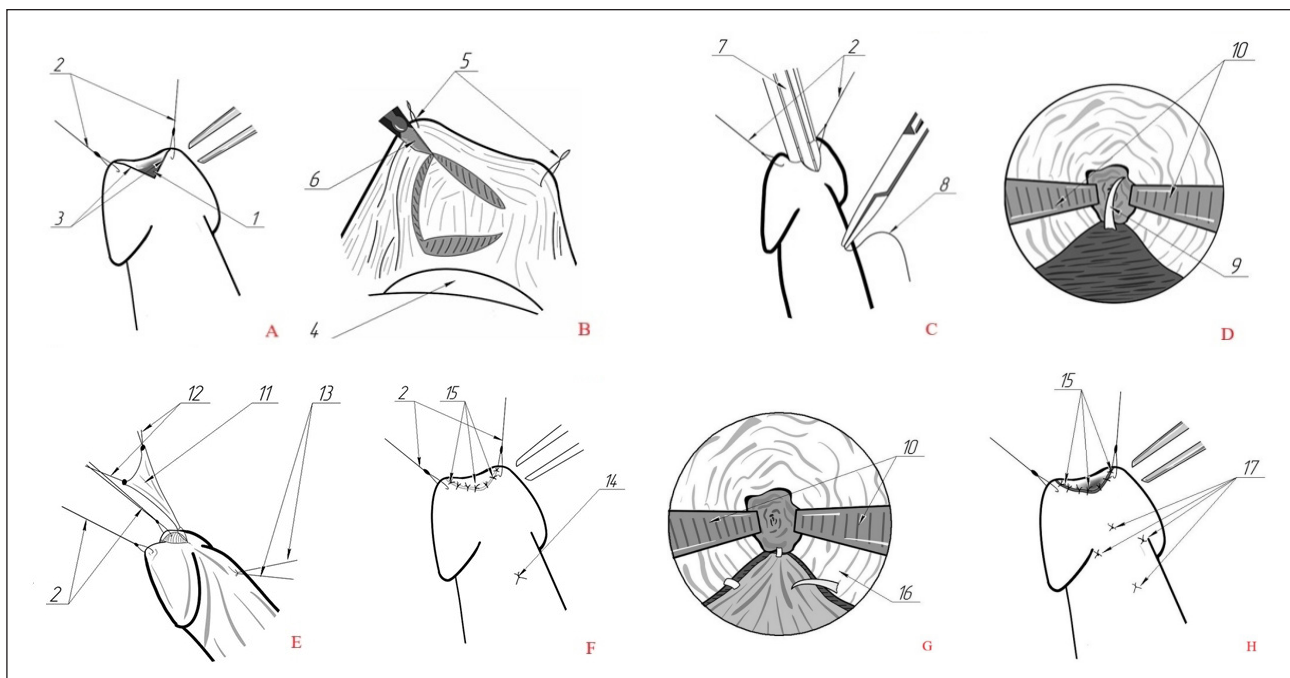


Figure 1. Stages of transurethral augmentation urethroplasty of the fossa navicularis of the urethra. (A) ventral urethrotomy, formation of an augmentation site. (B) the labial graft fence. (C) needle injection for subsequent ligation. (D) optical control of the injection point in the area of the proximal angle of the urethrotomy incision. (E) insertion of the graft into the urethra onto the formed site by traction of the ligature. (F) the final appearance of the penis after surgery. 1: ventral meatotomy. 2: stitches-holders. 3: the edges of the dissected urethra. 4: a gauze cloth placed at the base of the lower lip to push back the tongue. 5: stitches-holders. 6: scalpel. 7: endoscope. 8: application of the first suture on the proximal edge of the dissected urethra. 9: visualization of the needle during endoscopic examination. 10: tweezer branches. 11: labial graft. 12: stitches-holders at the corners of the triangular graft. 13: threads superimposed on the proximal edge of augmentation. 14: node on the proximal edge of augmentation. 15: nodular sutures on the distal edge of augmentation (meatus). 16: the edge of the urethral mucosa. 17: fixing seams on the top and sides of the triangular graft from the outside.

is stitched with a needle removed from the urethra, after which the needle is reinserted into the urethra and punctured from the inside out at the point of primary injection. Further, by light traction for the applied thread, the flap is immersed into the formed area, while the flap is maintained in a straightened state due to the threads previously applied to its corners. After immersion in the urethra, the ligature is tied. The wide part of the graft is compared with the external opening of the urethra along the ventral semicircle in the dissection area by applying 5-7 nodular sutures (Monocryle 5-0). According to a technique similar to the one described above, the center and sides of the triangular graft are fixed under optical control of the needle being guided from the outside into and out of the urethra. A silicone urethral catheter 12-16 Ch is inserted into the bladder (Figure 1).

Statistical analysis

The organization and statistical data processing were performed using Microsoft Office Excel 2010 (Microsoft Corp., Redmond, WA, USA) and the STATISTICA v.7.0 program (StatSoft Inc., Tulsa, OK, USA). All anamnestic, clinical, laboratory, and instrumental data were entered into a Microsoft Excel database developed by the author and processed using variational statistics. The data was analyzed for compliance with the normal distribution law using the Kolmogorov-Smirnov criterion. For quantitative data with a normal distribution, the arithmetic mean (M) and standard deviation (SD) were used, which were represented as $M \pm SD$. If the quantitative data did not follow the law of normal distribution, the median (Me), lower and upper quartiles (Q1 – Q3) were used to describe them. The indicators were compared using the Student t-test for data with a normal distribution. In the absence of a normal distribution, the Mann-Whitney U-test was used. A threshold of $P = 0.05$ was used to determine statistically significant differences. Sensitivity and specificity were calculated with a 95% confidence interval.

Results

All 12 patients underwent transurethral augmentation urethroplasty of the fossa navicular using the “ventral inlay” technique. The material for augmentation in 3 cases was the mucous membrane of the cheek and in 9 cases the mucous membrane of the lip. The median age of the patients was 65.5 years. The etiological factor of urethral stricture

in 8 cases was lichen sclerosus, in 4 cases the stricture was of an iatrogenic nature (underwent TUR of the prostate gland/catheterization of the bladder). The average length of the urethral stricture was 20.83 ± 7.93 mm. The maximum length of the urethral stricture is 35 mm. There were no intra and postoperative complications. All patients had a urethral catheter inserted for 14 days to drain the lower urinary tract. The follow-up period ranged from 7 to 54 months.

The results of the surgical intervention are shown in Table 1. The average value of the maximum urination rate (Q_{max}) before surgery according to uroflowmetry was 6.12 mL/s. The median of score on the IPSS questionnaire before surgery was 21.5 points, and the average value of QoL was 4.67 points. The median of volume of residual urine (VRU) before surgery was 35 mL. After surgery, the average Q_{max} value was 15.6 mL/s; the median of IPSS score was 7; the average QoL score was 1.92; the median of volume of residual urine value was 5 mL.

Splashing of urine during miction after surgery was not noted by any patient. All patients were satisfied with the aesthetic result of the operation.

During the follow-up period, we recorded a recurrence of urethral stricture in one case. In a patient with lichen sclerosus as an etiological factor, a recurrence of stricture of the same localization and extent was detected 16 months after the initial surgical intervention. In this case, dorsal inlay buccal grafting of the navicular fossa was performed. At the time of writing, three months after the second surgical intervention, there was no recurrence of urethral stricture in this patient.

Even despite the identified recurrence of urethral stricture in a single case, when conducting a statistical analysis of the results obtained among all patients who underwent surgery, we revealed a statistically significant improvement in the quality of urination. 6 months after urethroplasty, an endoscopic assessment of the surgical area was performed by urethroscopy with a rigid urethrocystoscope 16 Ch. According to the results of the study, the surgical intervention area was freely passable for the instrument in all but one patient. In a single case of recurrence, we noted a narrowing of the fossa navicularis to 6 Ch.

Discussion

Currently, there are many different methods of surgical treatment of stricture of the distal urethra, which include

Table 1. Urodynamic and clinical results of transurethral ventral inlay augmentation urethroplasty of the fossa navicularis.

Indicator	Before urethroplasty	After urethroplasty	P
Q_{max} , mL/s*	6.12 ± 3.62	15.10 ± 4.89	< 0.001
IPSS, point*	20.92 ± 6.22	11.00 ± 7.08	0.003
QoL, point*	4.67 ± 0.98	2.17 ± 1.47	< 0.001
VRU, mL**	35 [18,75; 59,5]	0 [0; 20]	0.092

Note: Q_{max} : maximum urination rate; IPSS: International Prostate Symptom Score; QoL: quality of life; VRU: volume of residual urine. *Average value, standard deviation. **Median, lower and upper quartiles.

various options for urethroplasty, as well as meatotomy and urethral dilatation.

Minimally invasive techniques such as urethral dilatation and internal optical urethrotomy cannot be considered radical treatment methods and often lead to relapse. During urethral dilatation, the narrowed area expands due to lacerations of scar tissue and healthy mucosa, which leads to an aggravation of the process and an increase in the degree of narrowing of the urethra and the length of the urethral stricture. Performing an internal optical urethrotomy in the penile urethra is technically difficult due to the difficulty of providing a lever for manipulating the instrument. In addition, such an operation carries a potential risk of unintentional injury to the corpus cavernosum and glans penis, which can lead to intraoperative bleeding, and in the long term to erectile dysfunction [4]. We have not been able to find studies in the modern literature evaluating the effectiveness of urethral dilatation and internal optical urethrotomy in penile stricture of the urethra. A systematic review published by Veeratterapillay R. *et al.* shows that for urethral strictures of all localizations, the effectiveness of urethral dilatation and internal optical urethrotomy ranges from 10% to 90% [5]. According to available data, the effectiveness of internal optical urethrotomy is most effective in carefully selected patients with primary non-tensioned stricture of the bulbous urethra [4, 6].

Meatotomy is a common, effective and long-used method of treating distal strictures of the urethra. However, this technique is used only in cases of narrowing of the urethra limited by the external opening of the urethra. J. Meeks *et al.* presented the results of meatotomy performed in 74 patients, among whom 86% of operations were considered successful [3]. Despite satisfactory postoperative urination parameters, this technique has a number of disadvantages: due to ventral meatotomy, a meatus similar to hypospadias is formed, which is a cosmetic defect; when performing dorsal meatotomy, there is a risk of intraoperative bleeding; a number of patients experience urine splashing during injection in the postoperative period [7].

For fossa navicularis stricture in combination with meato stenosis, it is possible to perform an extended meatomy (stage I of the Johanson operation), during which the skin of the penis and urethra is dissected along the ventral surface, followed by a comparison of the mucous membrane of the urethra and the skin of the penis. The effectiveness of this method reaches 87% [8]. In addition, this technique allows not only to enlarge the lumen of the urethra, but also to simultaneously excise the fibrotic tissue of the urethra. This fact allows the use of extended meatotomy as the first stage of complex treatment and allows for further augmentation urethroplasty. The literature also describes the opinion that extended meatotomy for lichen sclerosus allows access to the disease site for topical corticosteroid therapy, which can potentially reduce the likelihood of lichen sclerosus progression [7]. However, due to the similar standard ventral meatotomy technique, the described technique has the same disadvantages [8].

The most effective ways to treat patients with fossa navicularis stricture of the urethra are various urethroplasty techniques. There are two fundamentally different types of

urethroplasty: replacement and augmentation. In the first case, a complete excision of the altered section of the urethra is performed and the urethral pad is formed using a graft or flap, followed by tubularization of the urethra in a delayed period. Augmentation urethroplasty involves enlarging the lumen of the urethra using “insertion” or “lining” techniques. Reconstructive materials for performing urethroplasty surgery are most often: the mucous membrane of the oral cavity, the skin of the preputial sac or the skin of the penis. They may have a vascular pedicle as a source of blood supply (flap), or they may not have their own source of blood supply (graft). Currently, the cheek mucosa is considered a universal transplant [7], however, to date, no studies have been conducted comparing the results of reconstruction of distal strictures of the urethra using various oral cavity transplants, such as the mucous membrane of the cheek, lip or tongue.

The methods of urethral skin grafting are well known to the world urological community. B. Cohnen can be considered a pioneer of this approach. In 1963, he described the technique of augmentation urethroplasty of the fossa navicularis of the urethra with a skin flap of the penis, during which a flap formed from the skin of the inferior lateral surface of the penis is transposed onto the lower surface of the dissected urethra [9]. In 1967, J. Blandy *et al.* demonstrated a new technique of Y-V skin meatoplasty [10]. With the accumulation of experience and long-term results, it became obvious that these techniques do not provide patients with the desired cosmetic and functional results [7]. The technique to avoid the disadvantages inherent in the methods described above was developed and presented to the world community by G. Jordan in 1987. A distinctive feature of this technique is the use of a distal skin fascial islet flap of the penis. This approach made it possible to augmentation of the entire stricture zone up to the external opening of the urethra, which made it possible to avoid significant cosmetic defects of the penis [11]. R. Virasoro *et al.* conducted a prospective study of a group of patients who underwent Jordan meatoplasty. The work showed that of the 39 patients under observation, 29 (83%) had an excellent result with a median follow-up of 10.2 years. Recurrence of urethral stricture was recorded in 6 cases, and all of these patients had lichen sclerosus [12]. These data confirm the generally accepted opinion about the low effectiveness of skin urethroplasty among patients with lichen sclerosus. These data confirm the generally accepted opinion about the low effectiveness of cutaneous urethroplasty among patients with sclerotropic lichen. In another study performed by Morey *et al.* the effect of the length of the urethral stricture on the recurrence rate after undergoing a single-stage skin graft surgery was analyzed. According to the data published by the authors, the desired result was achieved in 91% of patients with a distal urethral stricture of less than 2.5 cm, while with a stricture of more than 2.5 cm, a recurrence was registered in 54% [8].

The best long-term results are demonstrated by various variants of augmentation urethroplasty with a buccal graft. The classic technique for correcting the stricture of the fossa navicularis of the urethra is the “dorsal insert” tech-

nique, in which the skin of the penis and urethra is longitudinally dissected along the ventral surface from the external opening of the urethra proximally to healthy tissues. Next, a longitudinal dissection of the dorsal surface of the urethra is performed in order to form a graft site. After graft fixation, the ventrally dissected urethra is sutured, then the skin of the penis above it is sutured [13]. According to the results of a series of such operations, D. Dubey *et al.* demonstrated 88% success among 24 patients with fossa navicularis stricture with an average follow-up time of 26.6 months [13]. Another surgical treatment method is buccal ventral onlay urethroplasty of the fossa navicularis. Similarly to the first stage of the dorsal inlay technique, a longitudinal dissection of the urethra is performed along the ventral surface, after which a rectangular graft is fixed to the edges of the dissected urethra, and the skin incision is sutured [14]. P. Chowdhury *et al.* demonstrated the results of treating 6 patients with fossa navicularis stricture using this method. In half of the cases, lichen sclerosus was the etiological cause of US, while the other 50% were iatrogenic in nature. The average length of the stricture was 1.5 cm. With a median follow-up of 37 months in 83% of patients, the result was considered successful based on improved urodynamic parameters [14].

To date, there is no consensus among specialists on which approach to reconstruction is preferable for distal urethral strictures. A lot of data from various studies with varying effectiveness of one- and two-stage reconstructive interventions with various grafts and flaps have been published in the medical literature. For example, D. Dubey *et al.* analyzed the incidence of recurrence of urethral stricture after buccal urethroplasty in patients with lichen sclerosus. In the course of the study, the authors revealed that performing two-stage urethroplasty is associated with a higher recurrence rate (21.4%) compared with single-stage (12%) [15]. However, it is worth noting that the implementation of augmentation techniques is possible only if the urethral pad is preserved. In case of urethral obliteration or significant spongiofibrosis, two-stage urethroplasty is justified. D. Dubey *et al.* also compared the effectiveness of buccal urethroplasty using the dorsal onlay technique with skin graft urethroplasty using the dorsal onlay technique. The authors obtained comparable data on the recurrence rate: 10.1% for buccal and 14.4% for cutaneous urethroplasty. However, patients' satisfaction with the treatment results was higher in the buccal urethroplasty group (89% to 65%) [15].

In 2022, R. Farrell *et al.* published an analysis of a five-year experience of transurethral dorsal augmentation urethroplasty for fossa navicularis stricture. The intervention consisted in the fact that after dorsal dissection of the external opening of the urethra, a triangular buccal graft was placed in the formed incisional defect, fixing its tip to the proximal border of the incision, and the distal face to the edge of the dissected external opening. A total of 16 patients were operated on by the authors using this technique, all of them achieved a good functional result and in 94% of cases the anatomical result was also regarded as good [16]. The disadvantage of the technique is the difficulty of correcting stricture, the length of which exceeds

1.5 cm, since full-fledged fixation of the graft in the depth of the urethra along the dorsal surface is technically difficult.

A similar method of transurethral buccal urethroplasty using the ventral insertion technique is described by M. Daneshvar *et al.* The essence of the technique is to dissect the external opening of the urethra and the stricture of the fossa navicularis from the urethra, during which a wide lumen is formed without dissecting the skin of the penis. The next step is to take a triangular buccal graft and place the latter in the area of the dissected urethra. To do this, a suture is applied to the tip of the triangular graft and the proximal edge of the dissected urethra is stitched through with the same thread under endoscopic control. By traction by the thread, the graft is delivered to the site formed during dissection, the knot is tied and the graft base is fixed to the external opening of the urethra [17]. The absence of a cutaneous incision provides a number of advantages: maximum preservation of blood supply in the reconstruction area, elimination of the risk of ventral urethrocutaneous fistula formation, and excellent cosmetic results. The absence of a skin incision is especially important in the treatment of patients with the etiological factor of lichen sclerosus, since it is generally believed that this disease is characterized by the presence of the Koebner phenomenon, which consists in the appearance of new lesions and progression at the sites of skin injury [18, 19]. The authors of the technique describe the results of treatment of 68 patients with stricture of the fossa navicularis of the urethra. In the study, surgeons performed an operative manual according to the original technique for a patient with a median length of urethral stricture of 2 cm. In 34% of cases, the etiology of the disease was lichen sclerosus. With a median follow-up of 17 months, the absence of relapse was noted in 95% of cases [17].

Based on the above-described technique of transurethral buccal urethroplasty of the fossa navicularis [17], we performed urethroplasty of the fossa navicularis of the urethra in 12 patients. For the first three patients, the cheek mucosa served as an augmentation material. In the course of our research, we suggested greater ease of operation and, possibly, better long-term results when using a labial graft. In this connection, it was decided to perform urethroplasty of the fossa navicularis of the urethra in subsequent patients using the lip mucosa. According to the authors of this publication, the labial graft, in comparison with the buccal graft, due to a thinner layer of the submucosal base, makes it easier to straighten the graft in the reconstruction area and provides a better cosmetic result. An additional factor in favor of labial graft is the preservation of the cheek mucosa, which may be required for further reconstruction in case of recurrence or progression of US. Another important feature of our technique, which distinguishes it from the original one, is the application of additional fixing sutures along the lateral edges of the graft, which allows us to be sure of the straightening and corrects orientation of the graft in the urethra.

Conclusions

The technique of transurethral augmentation urethroplasty of the fossa navicularis of the urethra is an effective, safe and relatively easily reproducible method of stricture correction, which allows achieving excellent functional results. The mucous membrane of the lower lip is a convenient and reliable material for transurethral augmentation of distal strictures of the urethra. It provides excellent cosmetic results and allows you to preserve the buccal mucosa in case subsequent reconstructions are necessary.

Declarations

Author contributions: Mamaev I.: study concept, study design development, data acquisition, data analysis, scientific editing, supervision; Alekberov E.: literature review, data acquisition, data analysis, statistical data processing; Kotov S.: study concept, study design development, critical review, scientific editing, supervision.

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Ethical approval and informed consent: The study was approved by the Local Independent Ethics Committee of Pirogov Russian National Research Medical University (RNRMU) (Protocol No. 234 dated November 20, 2023).

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