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## ORIGINAL ARTICLE

Operational Andrology

# Spongiosum-combined glanuloplasty reduces glans complications after proximal hypospadias repair

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We aim to design a new glanuloplasty procedure combined with spongiosum to reduce the incidence of glans dehiscence and coronal fistula after proximal hypospadias repair. Patients who underwent urethroplasty by dorsal preputial island flap for proximal hypospadias between January 2014 and December 2016 were reviewed in this retrospective cohort study. Those who underwent spongiosum-combined glanuloplasty comprised the new-maneuver group, whereas those who underwent conventional glanuloplasty comprised the control group. The incidence of complications was then compared. In the new-maneuver group, dysplastic corpus spongiosum alongside lateral Buck's fascia (0.3–0.4 cm wide) on both sides of the urethral plate was separated from the proximal normal spongy tissue, joining into the glans wings to increase tissue volume and covering the neourethra in the glans penis. In the control group, the neourethra was covered with superficial fascia under the coronal sulcus. As a result, the new-maneuver and control groups comprised 47 and 28 patients, respectively. In the new-maneuver group, no glans dehiscence was detected; however, two (4.3%) patients had coronal fistula, two (4.3%) had urethral stricture, and four (8.5%) had diverticulum. In the control group, two (7.1%) patients had glans dehiscence, eight (28.6%) had coronal fistula, four (14.3%) had urethral stricture, one (3.6%) had diverticulum, and one (3.6%) had penile curvature recurrence. The new-maneuver group had less incidences of coronal fistula ( $P < 0.001$ ), glans dehiscence ( $P = 0.033$ ), and urethral stricture ( $P = 0.008$ ) but had a higher incidence of diverticulum than the control group ( $P = 0.040$ ). It clearly demonstrates that spongiosum-combined glanuloplasty can significantly reduce the incidences of coronal fistula and glans dehiscence.

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**Keywords:** glans dehiscence; glanuloplasty; hypospadias; urinary fistula

## INTRODUCTION

According to the findings of the long-term follow-up of patients after urethroplasty for hypospadias repair, the incidence of complications and appearance of the glans indicates that the procedure requires further improvement.<sup>1–3</sup> Patients are satisfied with a cone-like glans with a coronal sulcus structure and a neourethral meatus at the tip of the ventral side. However, complications of glans dehiscence and coronal fistula often occur in hypospadias repair and pose surgical challenges because the tissue used to cover the neourethra at this area is difficult to locate. These complications are more difficult to repair than those involving other parts of the penis, usually requiring the patients to undergo glanuloplasty again.

Therefore, we designed a new maneuver in glanuloplasty combined with dysplastic corpus spongiosum to increase tissue volume and as a covering layer to avoid glans dehiscence and coronal fistula. We then investigated the surgical outcomes in a comparative study.

## PATIENTS AND METHODS

### Data collection

In this retrospective cohort study, all consecutive patients with proximal hypospadias who underwent spongiosum-combined glanuloplasty in the Urology Department of Shanghai Children's Hospital (Shanghai, China) between July 2015 and December 2016 and then were followed up for more than 1 year were categorized as the new-maneuver group. Meanwhile, all

patients who also had proximal hypospadias but underwent the conventional procedure in the same hospital between January 2014 and June 2015 (when the new method had not yet been applied) were categorized as the control group. All eligible patients did not receive preoperative testosterone and underwent surgery based on dorsal inner prepuce island flap (Duckett's or revised tubed flap procedures<sup>4</sup>). The inclusion criteria were as follows: (1) with proximal hypospadias (urethral meatus in the proximal penile body, penile scrotum junction, or perineum) and (2) with treatment experience of Duckett's or revised procedure. The exclusion criteria were as follows: (1) with hypospadias undergoing staged or other approach surgery; (2) with complex urogenital malformations or disorder of sexual development; and (3) with postoperative follow-up of shorter than 12 months.

Moreover, we performed routine clinical examinations preoperatively and excluded those with surgical contraindications. Senior pediatric urology physicians who had at least 10 years of experience of hypospadias repair performed all surgeries. This study has received ethics approval from the medical ethics committee of Shanghai Children's Hospital (approval number 2019R028-F01). Informed consent form was obtained from all patients and their families.

### Data measurement

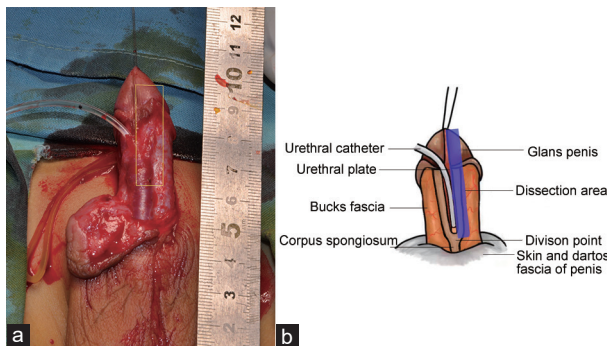
We evaluated surgical notes such as the preoperative glans width, penile chordee degree and penile length after degloving, pre- and

postoperative anteroposterior diameter (APD) of the coronal sulcus, and neourethral length. In the new-maneuver group, we additionally assessed the length of the dysplastic corpus spongiosum (the distance between the division of spongiosum and the coronal sulcus), the average width of the dysplastic corpus spongiosum on one side of the urethral plate, and the length and width of the combined spongiosum alongside Buck's fascia after midline approximation.

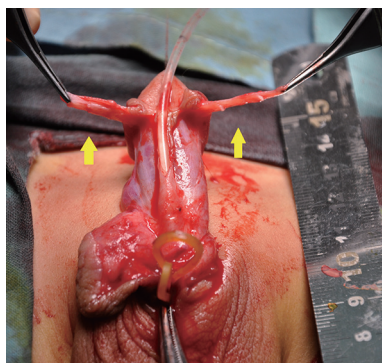
**Technique**

After penile degloving, the dysplastic corpus spongiosum on both sides of the urethral plate was divided with the proximal normal spongiosum and mobilized with 0.3–0.4 cm-wide lateral alongside Buck's fascia together on tunica albuginea surface. This procedure was generally performed with a tourniquet (Figure 1). Next, the external border of the urethra plate was dissected toward the bottom of the glans penis with spongiosum attached to it (Figure 2).

Then, the urethroplasty was performed using dorsal inner prepuce island flap-based surgery. When creating and mobilizing the glans wings, care must be taken to keep the distal spongiosum attached to the glanular tissue (Figure 3). This maneuver increased the tissue volume around coronal sulcus, and the glans wing would be approximated easily in the midline with a two-layer suture. The deep layer comprised glanular tissue with spongiosum, while the upper layer comprised superficial fascia and skin. Considering that the glans in proximal hypospadias is usually small, the glans wings were difficult to develop and approximate. The proximal part of the approximated spongiosum outside the glans bottom would cover the neourethra



**Figure 1:** (a) Hypospadias penis with skin degloved. A dysplastic corpus spongiosum along urethra plate on the left side (displayed in the yellow frame). (b) Schematic diagram of the dysplastic corpus spongiosum.



**Figure 2:** Bilateral distal corpus spongiosum with alongside 0.3–0.4 cm-wide lateral Bucks fascia was mobilized on the surface of tunica albuginea. Their connection with glans penis was kept (indicated by the arrows).

(Figure 4). After glanuloplasty and meatoplasty, the surgery ended with preputial reconstruction.

In the control group, the spongiosum and Buck's fascia were not mobilized; moreover, the neourethra at the coronal sulcus was only covered with superficial fascia and skin.

**Postoperative treatment and follow-up**

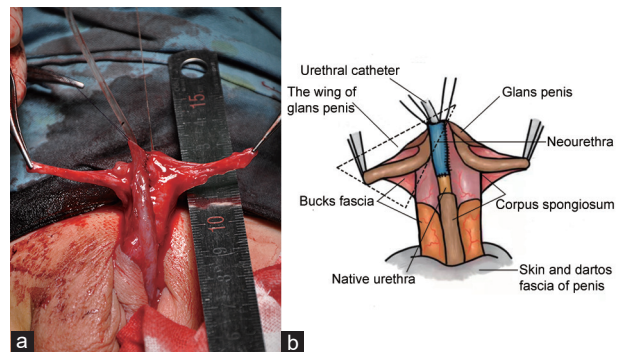
Urethral catheter was kept for 2 weeks postoperatively. Each patient was followed up every 3 months in the first year and then every 6 months. The complications, including urinary fistula (UF), glans dehiscence, urethral stricture, and diverticulum, were examined during follow-up by an attending physician (excluding the surgeons).

The incidence of complications was compared between the two groups. All statistical data were analyzed using the statistical software SPSS19.0 (SPSS Inc., Chicago, IL, USA), and the count data were examined by *t*-test. Furthermore, *P* < 0.05 was considered statistically significant.

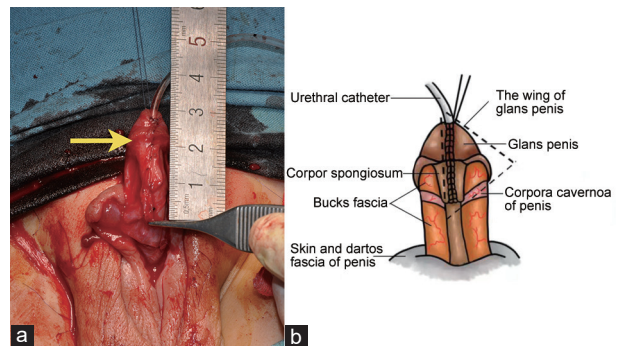
**RESULTS**

The new-maneuver group had 47 patients, whereas the control group had 28 patients. Most demographic data between the two groups had no statistically significant difference (Table 1). However, the increased postoperative values of the coronal sulcus APD were higher in the new-maneuver group than that in the control group (*P* = 0.047).

In the new-maneuver group, the mean distance between the division of spongiosum and the coronal sulcus was 2.39 (standard deviation [s.d.]: 0.85) cm, the average width of the dysplastic spongiosum on one side of the urethral plate was 0.37 (s.d.: 0.18) cm,



**Figure 3:** (a) After long segment of neourethra has been reconstructed by dorsal prepuce island flap, the glans wing was developed on both sides with combined spongiosum and Bucks fascia connected upon. They would increase the tissue volume on the coronal sulcus area. (b) Schematic diagram of the mobilized corpus spongiosum and Bucks fascia.



**Figure 4:** (a) With more tissue around coronal sulcus, glans penis was reconstructed with two layers. The combined spongiosum and Bucks fascia was approximated in midline and covered neourethra without tension (indicated by the arrow). (b) Schematic diagram of the combined spongiosum and Bucks fascia.

and the average length and width of the combined spongiosum and Buck's fascia after midline approximation were 1.74 (s.d.: 0.36) cm and 0.87 (s.d.: 0.29) cm, respectively.

All patients underwent postoperative follow-up of 12–34 months, and all complications observed were recorded (Table 2). One case had urethral stricture and diverticulum simultaneously in the new-maneuver group, and one case had urethral stricture and UF in the control group.

The new-maneuver group had less incidences of coronal fistula ( $P < 0.001$ ), glans dehiscence ( $P = 0.033$ ), and urethral stricture ( $P = 0.008$ ) but had a higher incidence of diverticulum ( $P = 0.040$ ) than the control group.

## DISCUSSION

The rate of complications around the glans after hypospadias repair is high. Therefore, we designed this maneuver to strengthen the glans and coronal sulcus by mobilizing the spongiosum and Buck's fascia, dissecting the external border of the urethral plate toward the bottom of glans penis, and keeping the spongiosum attached to the glans. This maneuver followed the basic anatomy of both the spongiosum and glans penis and tried to cover the neourethra with these inherent tissues.

According to Mouriquand *et al.*,<sup>5</sup> hypospadias is a lesion in an inverted triangle area, with the division of spongiosum as the top point, the front of glans penis as the lower edge, and dysplastic corpus spongiosum as the two lateral sides; the tissue in this area is dysplastic. Hence, the whole ventral tissue of the glans is dysplastic wherein the following are observed: absent frenulum and coronal sulcus structure on the ventral side, thin skin, and absent subcutaneous tissue. Meanwhile, the corpus spongiosum, which normally surrounds the closed urethra, can be divided into two branches at the site proximal

to the ectopic urethral opening and extend along the both sides of the urethral plate in a fan-shaped manner until merging with the glans wing.<sup>6,7</sup>

All these anomalies lead to the high incidence of complications such as glans dehiscence and coronal fistula after hypospadias repair. Snodgrass *et al.*<sup>8</sup> reported that the incidence of complete glans dehiscence after tubularized incised plate (TIP) urethroplasty for distal and proximal hypospadias was as high as 4% and 15%, respectively, consistent with the common belief that proximal hypospadias is worse than distal hypospadias. They added that in their study, complete glans dehiscence was the most common complication that required repeat glanuloplasty.

Yerkes *et al.*<sup>9</sup> proposed a method that mobilizes the originally Y-shaped spongiosum to cover the ventral side of neourethra in an I-shaped manner ("Y to I" technique), because they believe that the spongiosum is relatively thicker, denser, and more vascular than the dartos fascia. They concluded that the spongiosum acts as "a third layer" of the tissue to decrease the incidence of UF. However, as verified by Bhat *et al.*,<sup>10</sup> the covering by dysplastic spongiosum or the dartos fascia performed similarly in lowering UF incidence. Conversely, in TIP surgeries for scrotal or perineal hypospadias, Hafez and Helmy<sup>11</sup> found that the success rate of preventing UF achieved using spongiosum to cover the neourethra was considerably lower than that using the dartos fascia (68% vs 92%). Snodgrass and Yucel<sup>12</sup> used spongiosum added with the dartos fascia to cover the neourethra in TIP surgeries for proximal hypospadias; unfortunately, the UF incidence did not attenuate, consistent with the findings of Hayashi *et al.*<sup>13</sup> Furthermore, this method was rarely applied on proximal hypospadias repair, especially on those who need urethral plate transection.

Yerkes's method cannot achieve an ideal result because the spongy tissue is usually dysplastic and the amount of tissue is often insufficient, causing difficulties in approximating and suturing bilateral spongy tissue at the midline and negatively affecting the covering over the neourethra.<sup>13</sup> In the present study, the average width of spongiosum on one side was only 0.37 cm, which was insufficient to prevent fistula formation. Therefore, we designed this method using both spongy tissue and alongside 0.3–0.4 cm-wide Buck's fascia on the lateral side of spongiosum together to provide sufficient tissue amount to cover the ventral side of the neourethra. Moreover, those tissues are generally thought as "useless" or "curvature-creating" and are removed during the proximal hypospadias repair to straighten the penis; however, the tissues can currently be utilized as an additional layer without interfering other procedures during the repair. Consequently, the UF incidence in the new-maneuver group was significantly lower than that in the control group (10 cases, 21.3% vs 15 cases, 53.6%). Coincidentally, Baba *et al.*<sup>14</sup> also reported in 2017 that using Buck's fascia as an intermediate layer along with glanuloplasty was simple and effective in preventing UF formation and glans dehiscence.

When mobilizing the spongiosum toward the glans, we ensured that the spongiosum was attached to the glans penis. The spongiosum can not only increase the tissue amount but also reconstruct the anatomy of glans penis; the septum gland is between the glans wings, as Özbey and Kumbasar described.<sup>7</sup> Although the preoperative width of glans was only 0.75 ± 0.10 cm (mean ± s.d.) in the new-maneuver group and was considerably smaller than the 1.4 cm recommended by Snodgrass and Bush,<sup>15</sup> no complication of glans dehiscence occurred in this group.

In mobilizing the spongiosum and Buck's fascia, we need to keep the dissection on the surface of the tunica albuginea. When this surface is followed up clearly and cautiously, sufficient tissue can be

**Table 1: Demographic data of surgery patients**

Variable	New maneuver	Control	P
Case (n)	47	28	
Age (month), mean±s.d.	32.65±15.75	32.05±17.26	0.139
Width of glans (cm), mean±s.d.	0.75±0.10	0.79±0.11	0.088
Penile chordee (degree), mean±s.d.	46.08±16.63	46.35±15.62	0.120
Penile length (cm), mean±s.d.	4.14±0.71	4.17±0.79	0.073
Length of the neourethra (cm), mean±s.d.	3.95±1.04	4.11±1.26	0.059
APD before surgery (cm), mean±s.d.	0.79±0.12	0.82±0.07	0.061
APD after surgery (cm), mean±s.d.	0.83±0.07	0.84±0.23	0.106
APD increased after surgery (cm), mean±s.d.	0.04±0.02	0.02±0.01	0.047*

\* $P < 0.05$  was considered statistically significant. APD: anteroposterior diameter; s.d.: standard deviation

**Table 2: Postoperative complications**

Variable	New maneuver, n (%)	Control, n (%)	P
Glans dehiscence	0 (0)	2 (7.1)	0.033*
UF	10 (21.3)	15 (53.6)	
Coronal sulcus	2 (4.3)	8 (28.6)	<0.001*
Penile body	4 (8.5)	3 (10.7)	0.098
Penile root	4 (8.5)	4 (14.3)	0.074
Urethral stricture	2 (4.3)	4 (14.3)	
Coronal sulcus	0 (0)	2 (7.1)	0.008*
Penile root	2 (4.3)	2 (7.1)	0.141
Diverticulum	4 (8.5)	1 (3.6)	0.040*

\* $P < 0.05$  was considered statistically significant. UF: urinary fistula



obtained with minimal bleeding. Further, if bleeding occurs during the dissection, compression can be applied for 3–5 min.

In the new-maneuver group, the average length of the original spongiosum was 2.39 cm; the average length was only 1.74 cm after mobilization because of tissue retraction. However, the average length of the reconstructed urethra was 3.95 cm. Hence, the spongy tissue and Buck's fascia can only cover the distal neourethra. Nonetheless, our main goal is to reduce the complications around the glans penis and coronal sulcus. In our study, the incidence of coronal fistula was different between the new-maneuver and control groups (two cases, 4.3% vs eight cases, 28.6%;  $P < 0.001$ ). The increased postoperative values of the coronal sulcus APD also differed in the two groups ( $P = 0.047$ ), and no glans dehiscence occurred in the new-maneuver group compared with that in the control group ( $P = 0.033$ ). Therefore, our method is effective in increasing local tissue thickness and preventing glans dehiscence.

Another possible advantage of our approach is that recurrence of curvature was prevented. Grosos *et al.*<sup>16</sup> evaluated the long-term outcomes of Duplay urethroplasties and found significant late complications, including progressive curvature. A possible explanation is the poor growth capacity of the dysplastic tissues located beyond the division of the spongiosum because they may not grow with the rest of the genital tubercle. While we disconnected the spongiosum from the proximal tissues, we also eliminated the possibility of curvature recurrence. However, we still need to observe long-term outcomes to prove our hypothesis.

Meanwhile, our results showed that the new-maneuver group had higher postoperative diverticulum occurrence than the control group (8.5% vs 3.6%;  $P = 0.040$ ). The reason is that the amount and density of the tissue covering the distal urethra were higher than those at the proximal urethra during the application of this method. In addition, considering the features of the Duckett's approach, the urethral plate and corpus spongiosum were unsupportive, which caused diverticulum to occur more easily in the tubularized urethra in the penile body than in other parts.<sup>17,18</sup> This finding is noteworthy and requires solutions for improvement.

This study has some limitations. First, it had a relatively short follow-up period, which raises the possibility that later complication occurrence was missed. Meanwhile, considering that the size of the glans was generally small, some glans dehiscence may have been hidden because the location of the new meatus was close to the coronal sulcus. Second, the grouping had no strict randomization, even though the basic demographic data such as penis size, glans diameter, curvature, and neourethral length did not differ between the two groups, which may have inevitably led to selection bias. Third, the two groups underwent surgeries at different times. Although the surgeons were all experienced pediatric urologists, the bias of the learning curve could be decreased, which possibly affected our results. Therefore, our results must be confirmed with a larger sample size in future research.

In conclusion, we designed a glanuloplasty procedure with dysplastic corpus spongiosum combined with its lateral alongside Buck's fascia. This method can significantly increase the tissue amount of the glans and coronal sulcus and markedly decrease the incidences of UF and glans dehiscence. However, it may also increase the occurrence of diverticulum.

## AUTHOR CONTRIBUTIONS

FC initiated the maneuver and designed the study. YQL carried out the study and wrote the first draft. LY and FC also carried out the study, performed the surgery, and drafted the manuscript. HX, YCH, XXL, and LS participated in collecting data. YL helped to statistical analysis and draft the figures. All authors read and approved the final manuscript.

## COMPETING INTERESTS

All authors declare no competing interests.

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