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*Original Article*

# Therapeutic effects of Snodgrass urethroplasty in the treatment of distal hypospadias

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**Abstract:** Objective: The aim of this study was to evaluate the efficacy and complications of Snodgrass urethroplasty in the treatment of hypospadias of the coronary sulcus type and middle penile shaft type, providing evidence for clinical treatment of distal hypospadias. Methods: From May 2015 to April 2017, 48 patients with distal hypospadias were divided into a coronary sulcus group (n=28) and middle penile shaft group (n=20). All patients were treated with Snodgrass urethroplasty and were followed up for more than 6 months. Surgical indicators and treatment effects of the patients in the two groups were compared. Operative methods are described and postoperative complications and their management methods are summarized. Results: Patients in the coronary sulcus group had shorter operation times and urinary catheter retention times than those in the middle penis shaft group (both $P<0.01$). There were no significant differences in postoperative complications (urethral stricture, meatal stenosis, urinary fistula, penile edema) between the two groups. Postoperative satisfaction rates of patients in the coronary sulcus group and middle penis shaft group were 92.86% and 95.00%, respectively, with no significant differences. Follow up results showed that satisfaction rates for the appearance of the penis, glans penis, and urethral orifice in the coronary sulcus group were higher than those of the middle penis shaft group (all $P<0.01$). There were no significant differences between the two groups in urinary range, urinary line, low urethral orifice, and penis rotation. Conclusion: Snodgrass urethroplasty has good therapeutic effects in patients with hypospadias, specifically in the coronary sulcus and middle penile shaft. It has low complication rates and high patient satisfaction rates. It is worthy of clinical promotion.

**Keywords:** Hypospadias, Snodgrass urethroplasty, complications

## Introduction

Hypospadias is a common congenital malformation of the urinary system caused by abnormal development of external genitalia in the embryonic stage, with high incidence [1, 2]. In recent years, it has been reported that incidence of hypospadias in children has increased [3]. More than 75% of hypospadias occurring in children are of the distal type, including the coronary sulcus type and middle penile shaft type [4]. Surgical correction of this congenital malformation has been deemed the most effective therapeutic management of hypospadias.

Particularly, Snodgrass urethroplasty is one of the most widely used among these surgical procedures. The operation is simple and convenient with satisfactory results [5, 6]. Several research studies have reported the effectiveness of Snodgrass urethroplasty, mainly comparing success rates and satisfaction levels of patients undergoing surgery [7-9]. Studies comparing patients with the distal type of hypospadias are rare.

In this study, clinical data of patients with hypospadias undergoing Snodgrass urethroplasty, in Zhangjiajie People's Hospital, were collected and analyzed. This study compared surgical outcomes between patients with the coronary sulcus type and middle penile shaft type. It was proposed that there were differences in treatment effects of Snodgrass urethroplasty in different clinical pathological types of patients.

## Materials and methods

### *General data*

Forty-eight patients with hypospadias of the coronary sulcus type and middle penile shaft type, treated with Snodgrass urethroplasty in

Zhangjiajie People's Hospital, from May 2015 to April 2017, were collected and analyzed. Twenty-eight cases were of the coronal sulcus type while 20 cases were middle penile shaft type. Postoperative effects of the two types of patients were compared. All cases were treated with Snodgrass urethroplasty. This study was approved by the Ethics Committee of Zhangjiajie People's Hospital.

*Inclusion and exclusion criteria*

Inclusion criteria: 1) Patient undergoing urethroplasty for the first time; 2) Patient urethral plate was well-developed; 3) Patient clinical data was complete and patient was cooperative and compliant with the doctor's advice and follow up; and 4) Patient participated voluntarily and provided informed consent.

Exclusion criteria: 1) Patients with systemic infections; 2) Patients with diseases of the immune system, blood system, or other vital organs; and 3) Patients with severe illness, such as severe mental illness.

*Operative methods*

All patients received Snodgrass urethroplasty under combined intravenous anesthesia and caudal anesthesia. A 4-0 prolene line was used for traction of the glans of the penis while the condition of the urethral orifice was probed and assessed. The dysplastic membranous urethra was cut off from the normal urethral mucosa. A U-shaped incision was made around the urethral orifice (2-3 mm proximal to the urethral orifice) and the two sides were extended parallel to the top of the urethral plate of the glans penis. Width of the urethral plate was maintained for about 8-10 mm. At a distance of 0.8 to 10 mm from the coronary sulcus, a circular incision was made. Close to the skin at the proximal end of the urethral orifice, the foreskin was dissected and separated. A part of the basal subcutaneous fascia of the urethral orifice was preserved and the foreskin was dejacketed to the root of the penis along the tunica albuginea. Fibrous cords on the ventral side of the penis were fully loosened and the fascial roots of the basal portion of the proximal urethral orifice were loosened upwards. The blood supply was maintained and the penis was held straight. Penile erection test was also done. If the penis was still bent, to extend the penis sufficiently, a 4-0 prolene line was utilized to sew up two stitches under the tunica albuginea on the midline of the dorsal penile surface by using plication sutures. The urethral plate was longitudinally cut into the tunica albuginea with the F8 silicone catheter wrapped without tension. The new urethra was continuously sutured to the glans of the penis full-thickness or subcutaneous with 6-0 absorbable suture under no tension. For some patients with the coronary sulcus type, the urethra was formed by overturning the urethral orifice basilar fascia. In other patients, the basement membrane of the urethral orifice was upwardly overturned and the vascularized portion of the dorsal subcutaneous fascia was transferred to the ventral side to form the urethra with the fascia overlapping in the middle part. The two wings of the glans penis were fully separated to the level of the tunica albuginea to wrap around the urethral orifice. Double suture was performed in the center and the external urethral orifice was shaped. Dorsal foreskin was split from the midline and a stitch was sutured to fix the middle albuginea at the root of the penis and the corresponding subcutaneous tissue. V-Y flaps were performed by displacing the foreskin to the ventral side and the skin was sutured by layer-layer intermittent suturing or intradermal suture. The penis was bandaged under pressure. Postoperative catheterization was based on the diameter of the urethra. Second-generation cephalosporin antibiotics were used continuously for three days. Urethral exploration was then performed 10 days after removal of the indwelling catheterization.

*Observation indicators*

Urinary flow rate was measured using a urinary flowmeter (Wanhan Hanle Kang Healthcare ZNC961A). Urine flow curve, waiting time for urination, urination time, urine flow time, maximum urinary flow rate, and average urinary flow rates were recorded. According to urodynamics specifications, a bell-shaped urine flow curve was the normal urine line [10]. Urinary range was calculated based on average urinary flow rate and urine flow time. Urinary range was considered normal when there was no urinary drip and urine range exceeded 20 cm. Patients also received B-ultrasound before and after surgery. Three senior doctors performed a discriminative diagnosis of B-ultrasound results and judged whether the urethra was narrowed by anatomical signs of urethral stricture. Follow up

**Table 1.** General data comparison of patients

| Item | Coronary sulcus type | Middle penile shaft type | $t/\chi^2/U$ | P |
|---|---|---|---|---|
| Average age (year) | 5.24±1.71 | 4.94±1.44 | 0.639 | 0.526 |
| Urinary tract loss (cm) | 4.34±1.14 | 4.12±0.83 | 0.734 | 0.467 |
| Appearance of the penis | | | | |
| Normal | 20 | 13 | 0.220 | 0.640 |
| Abnormal | 8 | 7 | | |
| Urethritis | | | | |
| Absence | 27 | 18 | 262.000 | 0.370 |
| Mild | 1 | 2 | | |
| Severe | 0 | 0 | | |

observations were made by senior urologists in Zhangjiajie People's Hospital to assess the appearance of the penis and glans of the penis, position of the urethra, and rotation of the penis.

*Statistical methods*

SPSS 13.0 statistical software was used for data analysis. Measurement data are represented by mean ± standard deviation ($\overline{x}$ ± sd) and were tested by t-test. Quantitative data are expressed as percentage or rate, using Chi-square test and Fisher's exact probability method. Non-parametric statistical data were analyzed using Mann-Whitney U-test. P<0.05 indicates a statistical difference.

## Results

*General data comparison*

A total of 48 patients were included in the study and divided according to type of hypospadias, specifically into a coronary sulcus group (n=28) and middle penile shaft group (n=20). Age, sex, urinary tract loss, appearance of the penis, and presence or absence of urethritis were compared between the two groups with P>0.05 for all indexes. Differences were not statistically significant and data were comparable (**Table 1**).

*Comparison of surgical indexes*

Operation time, amount of blood loss during the operation, duration of urinary catheter retention, and hospitalization times were compared between the two groups. Results showed that operation and urinary catheter retention times were shorter in the coronary sulcus group than the middle penile shaft group (both P< 0.01), with statistically significant differences. There were no significant differences in amount of blood loss and hospitalization times between the two groups (**Table 2**).

*Comparison of operative complications*

After the operation, patients were observed and complications were compared. Results showed that urethras of the coronary stenosis type were narrower than that of penile middle type while differences in meatal stenosis, urinary fistula, and penile edema between the two groups were not statistically significant (all P>0.05). See **Table 3**.

*Comparison of postoperative satisfaction of patients*

Degrees of postoperative satisfaction of the patients were compared and divided into three grades: very satisfied, generally satisfied, and dissatisfied. Patients satisfied with overall postoperative results were classified as "very satisfied" and "generally satisfied". Satisfaction rates were calculated by the formula: (number of patients (very satisfied + generally satisfied)/ number of patients with the specific type of hypospadias) * 100%. Results showed no significant differences in degrees of postoperative satisfaction between the patients with hypospadias of the coronary sulcus type and middle penile shaft type (**Table 4**).

*Comparison of follow up results*

Patients were followed up for six months after the operation. Urinary range, urinary line, low urethral orifice, and penis rotation were compared between the two groups (all P>0.05), with no significant differences found in these variables. Patients with hypospadias of the coronary sulcus type were more satisfied with the appearance of the penis, glans penis, and urethral orifice (all P<0.01). Differences were statistically significant (**Table 5**).

## Discussion

The coronal sulcus and middle penile shaft are the most common locations or types of hypospadias, accounting for about 75% [11]. Increa-

**Table 2.** Comparison of surgical indexes

| Item | Coronary sulcus type | Middle penile shaft type | t | P |
|---|---|---|---|---|
| Operation time (h) | 64.2±2.8 | 69.6±2.5 | -6.882 | <0.001 |
| Amount of blood loss during operation (mL) | 70.5±5.7 | 73.4±6.2 | -1.676 | 0.101 |
| Duration of urinary catheter retention (day) | 9.0±1.2 | 10.2±0.9 | -3.774 | <0.001 |
| Hospitalization time (day) | 13.5±0.7 | 13.0±1.2 | 1.818 | 0.076 |

**Table 3.** Comparison of operative complications

| Item | Coronary sulcus type | Middle penile shaft type | $\chi^2$ | P |
|---|---|---|---|---|
| Urethral stricture | 1 | 2 | 0.091 | 0.762 |
| Meatal stenosis | 2 | 1 | 0.991 | 0.762 |
| Urinary fistula | 2 | 2 | 0.031 | 0.860 |
| Penile edema | 1 | 3 | 0.779 | 0.377 |

sed success rates of one-stage surgery, reduced complications, and increased appearance satisfaction rates have played important roles in the treatment of hypospadias. Snodgrass urethroplasty is currently one of the most effective surgical procedures for treatment of hypospadias of the coronary sulcus and middle penile shaft types, locally and internationally [12-14]. Since the urethra is completely made of the original urethral plate, the material is easily obtained. The urethra also has good continuity and no circular anastomosis. Snodgrass urethroplasty has a wide range of application. It is a simple operation that generally shortens operation times, with few complications and high satisfaction rates of postoperative appearance [15].

Postoperative reexamination results showed six cases of patients with the coronary sulcus type and eight cases of the middle penile shaft type that resulted in postoperative complications. Complications mainly included urethral and urethral orifice stenosis, urinary fistula, and penile edema. Incidence of complications in the two groups was low and differences were not statistically significant (P>0.05). Low incidence of complications may be related to well development of the glans penis and urethra, short urethral defect, easy correction of penile curvature, and adequate dorsal foreskin tissue, all of which are beneficial in the treatment with Snodgrass urethroplasty. Therefore, therapeutic effects are favorable.

Urinary fistula is one of the most frequent postoperative complications with an incidence of 1.00%-10.00% [16]. Main factors affecting occurrence of urinary fistula include the presence of urethral orifice stricture, degree of development and width of the urethral plate, surgical methods for forming the urethra, and presence of a good blood supply for the new urethra fascia. This study found that the combined incidence of urinary fistula with complications was 8.33%, basically consistent with other research reports [17, 18].

After Snodgrass urethroplasty, urethral orifice stenosis is prone to occur. Main reasons for occurrence of urethral orifice stenosis are as follows: 1) The longitudinal cutting position of the urethral plate exceeds the tip of the penis with the formed scar causing stenosis; 2) Insufficient longitudinal cutting depth of the narrow urethral plate and over-high and over-tight winding tube may cause stenosis; and 3) In a small number of cases, the glans penis is small and the separation of the wings of the penis is not deep enough to reach the penile tunica albuginea causing the suture to be too tight, causing stenosis [19, 20]. In this study, there were three patients with complications of urethral orifice stenosis (6.30%). To reduce incidence of urethral orifice stenosis, the following treatment measures can be done: 1) The longitudinal cutting position of the urethral plate should not exceed the tip of the penis; 2) Full separation of the urethral plate and the two wings of the glans penis must be done to reach the tunica albuginea which reduces tension; 3) Cases of mild stenosis should receive urethral dilatation therapy twice a week for 1 month; and 4) Urethral orifices should be regularly examined.

Results of postoperative follow ups showed that a total of 43 (89.58%) patients were satisfied with overall appearance. Surgery on the coronary sulcus type resulted in higher patient satisfaction than the penis middle type, which might be associated with the development of

**Table 4.** Comparison of postoperative satisfaction of patients

| Item | Very satisfied (%) | Generally satisfied (%) | Dissatisfied (%) | Satisfaction rate (%) | $\chi^2$ | P |
|---|---|---|---|---|---|---|
| Coronary sulcus type (n=28) | 19 (67.86) | 7 (25.00) | 2 (7.14) | 26 (92.86) | 0.091 | 0.762 |
| Middle penile shaft type (n=20) | 13 (65.00) | 6 (30.00) | 1 (5.00) | 19 (95.00) | | |

**Table 5.** Comparison of postoperative follow-up results

| Item | Coronary sulcus type (n=28) | Middle penile shaft type (n=20) | $\chi^2$ | P |
|---|---|---|---|---|
| Normal urinary range and urinary line | 27 | 18 | 0.091 | 0.762 |
| Satisfied appearance of the penis, glans penis and urethral orifice | 25 | 11 | 7.314 | 0.007 |
| Low urethral orifice | 4 | 6 | 0.924 | 0.336 |
| Penis rotation | 6 | 8 | 1.948 | 0.163 |

the glans penis and amount of dorsal foreskin. Among patients in the coronary sulcus group, low urethral orifice and penis rotation were common problems. There were 45 (93.75%) cases with normal urinary range and urinary line. Other patients had slightly skewed urination and slightly shorter urine line, but without any associated discomfort. Therefore, they needed continual observation and follow ups with no need for treatment. However, for patients with small urine stream associated with micturition difficulty, urodynamics and urethroscopy should be performed to determine causes.

There are limitations to this present study. The sample size was quite small, possibly leading to a deviation of results. A follow up study with a larger sample size is recommended. Also, this study only compared effects of the Snodgrass operation in the treatment of hypospadias of the coronary sulcus type and middle penile shaft type. Comparisons of the other types of hypospadias should be considered to fully assess therapeutic effects of the surgery.

In conclusion, Snodgrass urethroplasty is a simple operation with shorter operation time, less postoperative complications, higher satisfactory rates of penis appearance, and good urethral function. It is a suitable surgical method for treatment of distal hypospadias.

## Disclosure of conflict of interest

None.

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