

The Role of Glans Size, Urethral Plate Width, and Ventral Curvature in Predicting Surgical Success of Hypospadias repair at Jinnah teaching hospital, Peshawar

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ABSTRACT

Background: Hypospadias repair is influenced by multiple anatomical factors, and postoperative outcomes may vary despite appropriate surgical technique.

Objective: To evaluate the role of glans size, urethral plate width, and ventral curvature in predicting surgical success after primary hypospadias repair.

Methods: This prospective observational study was conducted at Jinnah teaching hospital Peshawar from June 2023 to June 2025 included 95 patients with hypospadias who underwent primary surgical repair. Preoperative assessment included documentation of hypospadias type, glans width, urethral plate width, and degree of ventral curvature. Surgical technique was selected according to anatomical findings and included tubularized incised plate urethroplasty, Mathieu repair, onlay flap repair, or staged repair where indicated.

Results: The mean age of patients was 5.2 ± 2.8 years. Distal hypospadias was the most common type, seen in 54 (56.8%) patients, followed by mid-penile hypospadias in 26 (27.4%) and proximal hypospadias in 15 (15.8%). Overall surgical success was achieved in 78 (82.1%) patients, while 17 (17.9%) developed surgical failure or major complications. Patients with successful repair had significantly larger glans width, 14.8 ± 2.5 mm versus 11.6 ± 2.4 mm, and wider urethral plate, 7.6 ± 1.6 mm versus 4.9 ± 1.2 mm.

Conclusion: Glans size, urethral plate width, and ventral curvature were important predictors of surgical success after hypospadias repair. Smaller glans width, narrow urethral plate, and moderate to severe ventral curvature were associated with higher risk of complications and surgical failure.....

Keywords: Hypospadias, glans width, urethral plate width, ventral curvature, surgical success.

INTRODUCTION

Hypospadias is a very common congenital anomaly of the male external genitalia, in which the urethral meatus is located abnormally on the underside of the penis, the ventral foreskin may vary in its deficiency, and the degree of the ventral penile curvature may vary [1]. The condition is caused by incomplete fusion of the urethral folds in the embryo and can be distal (glandular) or more proximal (penile shaft, penoscrotal or perineal). Surgical correction is generally carried out in early childhood to obtain a functionally straight penis, terminal or near terminal meatus, good urinary stream with acceptable cosmetic appearance [2]. Although significant strides in paediatric urology and reconstructive surgery have been made, correction of hypospadias is still a difficult operation to perform due to myriad anatomical and technical considerations. Routine complications of the surgery include urethrocutaneous fistula, meatal stenosis, glans dehiscence, urethral stricture, chordee (residual), wound infection, and poor cosmetic appearance [3]. There are a couple of surgical techniques that are

used depending on the type and severity of hypospadias, including tubularized incised plate, onlay flap, Mathieu repair and staged repair; however, none of these techniques is successful in all patients. Thus, it is critical to recognise the potential surgical success and failure cases preoperatively to plan the repair, to discuss the surgery with parents, and to minimise the risks [4].

Of the anatomical factors, glans size is an important one which has been studied as a determinant for surgical success [5]. If the glans is small, glans closure may be difficult, the tension across the neourethra will be greater and this will increase the risk of glans dehiscence or a urethrocutaneous fistula. When dealing with urethral reconstruction, adequate glans width will facilitate better approximation of tissue and give more support for reconstruction [6]. On the other hand, a poorly developed glans or narrow glans can affect both the functionality and aesthetics of repair, particularly in distal and mid-penile hypospadias surgery where glansplasty is an essential step. Another crucial aspect that can affect the selection of the surgical approach and the postoperative outcome is the width of the urethral plate. In many of the most common urethral repairs, such as tubularized incised plate urethroplasty, the urethral plate serves as the basis for urethral reconstruction [7]. The urethral plate is usually wide and healthy and well vascularised and tubularisation is easier and the healing is good, whereas a narrow, scarred or underdeveloped plate is more likely to lead to urethral narrowing and fistulisation and to cause urethral repair to fail [8-10]. Therefore, the width of the urethral plate can be assessed preoperatively, which could help the surgeon determine whether the urethral plate is suitable for tubularization or not [11]. A major part of the assessment of the severity of hypospadias is the ventral curvature or chordee. May be caused by skin tethering, fibrotic tissue, disproportion of the corpora or short urethral plate. Large amounts of ventral curvature may affect future sexual function and may need to be corrected during surgery [12].

Objective

To assess the importance of glans size, urethral plate width, and ventral curvature in predicting the success of the primary hypospadias repair.

Methodology

This prospective observational study was conducted at Jinnah teaching hospital Peshawar from June 2023 to June 2025. The total number of patients with hypospadias in the study was 95 (duly obtained with the inclusion of non-probability consecutive sampling technique). Patients with distal hypospadias, mid penile hypospadias, and proximal hypospadias who underwent primary repair were included. Children were also included in the study, where their parents/guardians gave informed consent for surgery and for the child to participate in the study. Patients who had previously undergone hypospadias repair, patients with recurrent hypospadias, patients with ambiguous genitalia or disorders of sexual development, patients with severe associated congenital anomalies, patients with an active local infection, patients with a bleeding disorder, and patients with incomplete postoperative follow-up were excluded from the study.

Data Collection

Patients who met the inclusion/exclusion criteria were recruited for the study following institutional ethical review committee approval. A structured proforma was used to capture demographic data, such as age, weight, where they lived and their clinical history. A complete examination of the genitalia was done to document the type of hypospadias, the position of the urethral meatus, the size of the glans, the width of the urethral plate, the presence and degree of urethral curvature, penile torsion, and associated anomalies. All the measurements were made preoperatively with a sterile caliper. The size of the glans was taken to be the largest diameter across the glans. The width of the urethral plate was measured at the narrowest section of the urethral plate. Clinical assessment of ventral curvature was supplemented by an artificial erection test, if necessary, during the operation. The curvature was classified as mild, moderate or severe. Surgical technique was chosen based on the type of hypospadias, quality of urethral plate, size of glans and degree of ventral curvature. The various techniques used were tubularized incised plate urethroplasty, Mathieu repair, onlay flap repair or staged repair as appropriate. Operative technique and placement of catheter or stent, duration of surgery, intra-operative findings, and correction of curvature were recorded. Patients were followed up postoperatively at intervals, ideally at 1 week, 1 month, 3 months and 6 months after surgery. A successful surgery was deemed successful if the meatus was reached to terminal or close to terminal, if the penis straightened, urinary stream was satisfactory, cosmetic appearance was acceptable and if there were no major surgical complications. Postoperative complications were recorded as: urethrocutaneous fistulas, glans dehiscence, meatal stenosis, urethral stricture, wound infection, residual curvature, and reoperation. The glans size, urethral plate width and degree of ventral curvature were the main predictor variables. The primary endpoint was success or failure of the hypospadias repair surgery. Other factors were age, type of hypospadias, location of urethral meatus, surgical technique, duration of the catheterisation, operating time and postoperative complications.

Statistical Analysis

Data was entered and analyzed with SPSS 29. Data presented as mean $\pm$ SD were quantitative variables like age, glans size, urethral plate width, and operative time. Qualitative variables like type of hypospadias, degree of ventral curvature, surgical technique, surgical complications and surgical outcome were described in frequencies and percentages. The chi-square test or Fisher's exact test was used to assess associations between categorical variables. A p-value of ≤ 0.05 was considered

statistically significant.

Results

A total of 95 patients were included in the study, mean age of the patients was 5.2 ± 2.8 years, and the mean weight was 17.4 ± 6.1 kg. Distal hypospadias was the most common type, observed in 54 (56.8%) patients, followed by mid-penile hypospadias in 26 (27.4%) and proximal hypospadias in 15 (15.8%). Penile torsion was present in 11 (11.6%) patients, associated undescended testis in 6 (6.3%), and previous circumcision was reported in 9 (9.5%) patients.

Table 1. Baseline Clinical Characteristics of Patients

Variable	Frequency / Mean $\pm$ SD
Total patients	95
Age, years	5.2 ± 2.8
Weight, kg	17.4 ± 6.1
Distal hypospadias	54 (56.8%)
Mid-penile hypospadias	26 (27.4%)
Proximal hypospadias	15 (15.8%)
Penile torsion present	11 (11.6%)
Associated undescended testis	6 (6.3%)
Previous circumcision	9 (9.5%)

Preoperative anatomical assessment showed that the mean glans width was 14.2 ± 2.8 mm. A glans width of less than 14 mm was present in 38 (40.0%) patients, while 57 (60.0%) had a glans width of 14 mm or more. The mean urethral plate width was 7.1 ± 1.8 mm. Urethral plate width was less than 8 mm in 51 (53.7%) patients and 8 mm or more in 44 (46.3%). No or mild ventral curvature was seen in 56 (58.9%) patients, while moderate curvature was present in 27 (28.4%) and severe curvature in 12 (12.6%) patients.

Table 2. Anatomical Predictors Assessed Before Surgery

Variable	Frequency / Mean $\pm$ SD
Glans width, mm	14.2 ± 2.8
Glans width <14 mm	38 (40.0%)
Glans width $\geq$ 14 mm	57 (60.0%)
Urethral plate width, mm	7.1 ± 1.8
Urethral plate width <8 mm	51 (53.7%)
Urethral plate width $\geq$ 8 mm	44 (46.3%)
No/mild ventral curvature	56 (58.9%)
Moderate ventral curvature	27 (28.4%)
Severe ventral curvature	12 (12.6%)

Tubularized incised plate urethroplasty was the most frequently performed procedure, used in 62 (65.3%) patients, followed by onlay flap repair in 14 (14.7%), Mathieu repair in 11 (11.6%), and staged repair in 8 (8.4%) patients. The mean operative time was 78.6 ± 19.4 minutes, and the mean catheter duration was 8.3 ± 2.6 days. Overall surgical success was achieved in 78 (82.1%) patients, while 17 (17.9%) developed surgical failure or major complications.

Table 3. Surgical Technique and Postoperative Outcomes

Variable	Frequency / Mean $\pm$ SD
TIP urethroplasty	62 (65.3%)
Mathieu repair	11 (11.6%)
Onlay flap repair	14 (14.7%)
Staged repair	8 (8.4%)
Operative time, minutes	78.6 $\pm$ 19.4
Catheter duration, days	8.3 $\pm$ 2.6
Successful repair	78 (82.1%)
Surgical failure/major complication	17 (17.9%)
Urethrocutaneous fistula	8 (8.4%)
Glans dehiscence	5 (5.3%)
Meatal stenosis	4 (4.2%)
Urethral stricture	3 (3.2%)
Wound infection	6 (6.3%)
Residual ventral curvature	4 (4.2%)
Reoperation required	7 (7.4%)

Patients with successful repair had a larger mean glans width compared with those who developed failure or complications, 14.8 ± 2.5 mm versus 11.6 ± 2.4 mm, with a statistically significant difference ($t = 4.88$, $p < 0.001$). Glans width less than 14 mm was more frequent in the failure group, 14 (82.4%), compared with the successful repair group, 24 (30.8%) ($\chi^2 = 15.52$, $p < 0.001$). Mean urethral plate width was also significantly greater in the successful repair group, 7.6 ± 1.6 mm, compared with 4.9 ± 1.2 mm in the failure group ($t = 6.43$, $p < 0.001$). Urethral plate width less than 8 mm was present in 15 (88.2%) patients with failure compared with 36 (46.2%) patients with successful repair ($\chi^2 = 9.82$, $p = 0.002$).

Table 4. Association of Anatomical Factors With Surgical Success

Variable	Successful repair n=78	Failure/complication n=17	Test statistic	p-value
Glans width, mm	14.8 ± 2.5	11.6 ± 2.4	$t = 4.88$	< 0.001
Glans width < 14 mm	24 (30.8%)	14 (82.4%)	$\chi^2 = 15.52$	< 0.001
Urethral plate width, mm	7.6 ± 1.6	4.9 ± 1.2	$t = 6.43$	< 0.001
Urethral plate width < 8 mm	36 (46.2%)	15 (88.2%)	$\chi^2 = 9.82$	0.002
Moderate/severe ventral curvature	25 (32.1%)	14 (82.4%)	$\chi^2 = 14.59$	< 0.001
Proximal hypospadias	8 (10.3%)	7 (41.2%)	$\chi^2 = 9.94$	0.002
Operative time, minutes	75.3 ± 17.8	93.8 ± 20.6	$t = 3.80$	< 0.001

Logistic regression analysis showed that glans width less than 14 mm, urethral plate width less than 8 mm, and moderate or severe ventral curvature were independent predictors of surgical failure. Patients with glans width less than 14 mm had 4.86 times higher odds of surgical failure (AOR=4.86, 95% CI: 1.42–16.63, $p = 0.012$). Urethral plate width less than 8 mm increased the odds of failure by 5.74 times (AOR=5.74, 95% CI: 1.36–24.25, $p = 0.017$).

Table 5. Logistic Regression Analysis for Predictors of Surgical Failure

Predictor	Adjusted odds ratio	95% CI	Test statistic	p-value
Glans width <14 mm	4.86	1.42–16.63	Wald $\chi^2 = 6.31$	0.012
Urethral plate width <8 mm	5.74	1.36–24.25	Wald $\chi^2 = 5.65$	0.017
Moderate/severe ventral curvature	4.21	1.24–14.26	Wald $\chi^2 = 5.29$	0.021
Proximal hypospadias	3.68	0.98–13.81	Wald $\chi^2 = 3.71$	0.054
Age >5 years	1.42	0.42–4.76	Wald $\chi^2 = 0.31$	0.571

Discussion

It is one of the most challenging surgeries in pediatrics urology because the final result of the repair relies on the technique used and on penile local anatomy. The present study included 95 patients who underwent primary repair for hypospadias to assess how the size of the glans, width of the urethral plate and ventral curvature relate to successful surgery. A total of 78 patients (82.1%) were successfully operated and 17 patients (17.9%) had surgical failure or major complications in the post period. This means that while the majority of patients had good results, there were a significant proportion who developed complications where attention had to be paid to the risk factors encountered prior to the surgery. This study found that distal hypospadias (56.8%) was the most frequent type, followed by mid-penile (27.4%) and proximal (15.8%) types of hypospadias. The distribution is in keeping with the clinical distribution of hypospadias as distal variants are more common than proximal variants. Surgical failure patients were more likely to have proximal hypospadias (7 patients, 41.2% of surgical failure patients versus 8 patients, 10.3% of surgical success patients). This discovery indicates that there are more complications and an increased level of operative difficulty in the more proximal location, but this did not prove to be statistically significant on multivariable analysis [13].

There was a high correlation between glans size and surgical outcome. Patients who had a successful repair had a larger mean glans width of 14.8 ± 2.5 mm than the patients who failed or had complications of 11.6 ± 2.4 mm. Likewise, the width of the glans was less than 14 mm in 14 patients (82.4%) from the failure group as opposed to 24 patients (30.8%) from the successful group [14]. For logistic regression, glans width < 14 mm was an independent predictor of surgical failure, with an adjusted odds ratio of 4.86. This result will emphasize the importance of having a sufficiently large glans to achieve good glans closure, to avoid tension over the neourethra, and to obtain better cosmetic and functional outcomes. Increased risk for glans dehiscence, fistulation and wound breakdown with a small glans [15].

There was also a significant association of urethral plate width with surgical success. Mean urethral plate width was 7.6 ± 1.6 mm in the successful group and was 4.9 ± 1.2 mm in the failure group. Narrow urethral plate (<8 mm) was noted in 15 patients (88.2%) of failure, while it was noted in 36 patients (46.2%) of successful repair. The multivariable analysis indicated that urethral plate width < 8 mm was an independent risk factor for surgical failure, with a 5.74-fold higher risk [16]. This reinforces the principles of a wide, healthy, well-vascularized urethral plate for tubularization and healing and a narrow urethral plate for urethral stenosis, urethral fistula, and failure of urethral repair. Another significant anatomic factor that influenced outcome was ventral curvature [17]. The failure cohort had moderate or severe ventral curvature in 14 patients (82.4%), while the successful cohort had it in 25 patients (32.1%). It was also independently associated with surgical failure with an adjusted odds ratio of 4.21. The degree of curvature of the ventral wall is significant and may require further corrective manoeuvres, including degloving, dorsal plication, urethral plate transection or staged repair. The extra measures add to the complexity of surgery and can lead to a greater incidence of complications after surgery [18]. The most frequently seen complication in this study was urethrocutaneous fistula occurring in 8 patients (8.4%), followed by wound infection (6.3%), glans dehiscence (5.3%), meatal stenosis (4.2%), residual ventral curvature (4.2%), and urethral stricture (3.2%). Seven patients (7.4%) needed reoperation. These complications are frequently seen following hypospadias surgery and may be associated with poor tissue quality, tension of the suture line, vascularity, infection, and the extent of the abnormality. This study indicates that these negative outcomes are significantly influenced by a smaller glans size, a smaller urethral plate width, and a higher degree of curvature of the urethra in the ventral direction.

Patients whose surgery failed or developed complications also had a longer operative time (93.8 ± 20.6 minutes) than those that were successfully repaired (75.3 ± 17.8 minutes). This could be due to poor anatomical features, the meatal location being in the proximal end, a narrow urethral plate or significant urethral curvature [19]. An increased operative time can also lead to an increase in tissue handling and edema that can impact the healing process. But the operative time is probably more indicative of complexity than it is of failure. Previous studies confirm that anatomical factors have an impact on surgical results following hypospadias repair, and the results of this study corroborate this. A few previous studies noted that a narrower glans width is related to an increased risk of glans dehiscence and fistula formation. Earlier literature also has

indicated that narrow urethral plate width is associated with increased risk of urethral complications, particularly after tubularized incised plate urethroplasty. An important factor which is associated with more severe hypospadias is significant ventral curvature, which has been described to be correlated with a greater incidence of staged repair, chordee and complications following surgery [20].

There are some limitations of the study. Performed on a relatively small number of patients, $n = 95$, and follow-up was only carried out during the period of postoperative follow-up that was stipulated in the study. No definitive conclusions could be drawn regarding the long-term results, such as urinary stream pattern, cosmetic satisfaction, pubertal penile growth and sexual function. Furthermore, surgeon experience, tissue handling, suture material, postoperative management and surgery type may also be confounding factors that affect surgical outcome. Although the study has its limitations, the authors have given valuable evidence that a preoperative anatomical assessment can be useful in predicting surgical success after hypospadias repair.

Conclusion

The anatomical factors that were significant predictors of surgical success following hypospadias repair were glans size, urethral plate width and ventral curvature. Surgical outcome was good for a larger glans width, a wider urethral plate, and no or mild ventral curvature, whereas small glans, narrow urethral plate, and moderate to severe ventral curvature were related to higher risk of surgical failure and postoperative complications. Patients with poor anatomical features had a higher prevalence of urethrocutaneous fistula, glans dehiscence, meatal stenosis, wound infection, residual curvature and reoperation..

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