

# Re-do Hypospadias Repair: Comparative Analysis of Surgical Techniques and the Role of Hyperbaric Oxygen Therapy

## Yeniden Hipospadias Onarımı: Cerrahi Tekniklerin Karşılaştırmalı Analizi ve Hiperbarik Oksijen Tedavisinin Rolü

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### ÖZET

**Amaç:** Hipospadias onarımında amaç, fonksiyonel ve kozmetik olarak normal bir penis elde etmektir. Başarısız vakalar için yapılan yeniden onarım, rekonstrüktif ürolojide en zorlu işlemlerden biridir. Komplikasyon ve başarısızlık riskleri primer vakalara göre daha yüksektir. Hiperbarik oksijen terapisi (HBOT), uygun endikasyonlarla seçilmiş hastalara uygulanarak doku iyileşmesine katkıda bulunabilir. Bu çalışmada yeniden hipospadias onarımı yapılan hastaların cerrahi tipi ve HBOT uygulanıp uygulanmamasına göre karşılaştırmalı sonuçlarını sunmayı amaçladık.

**Hastalar ve Yöntem:** Bu retrospektif klinik çalışma, Ocak 2021 ile 2024 tarihleri arasında başarısız hipospadias cerrahisi sonrası tarafımıza başvurup yeniden onarım geçiren 0-17 yaş arası hastaları içermektedir. Preoperatif, peroperatif ve postoperatif veriler, operasyon türüne ve HBOT alınmasına göre analiz edilmiş ve karşılaştırılmıştır. **Bulgular:** Yeniden operasyon geçiren 34 hastanın içinde, 4'ü TIPU onarımı, 20'si tek aşamalı G-TIPU ve 10'u iki aşamalı onarım geçirmiştir. TIPU ve G-TIPU grubundaki hastaların ortalama yaşları 6,5±3,8 yıl, aşamalı onarım grubundaki hastaların ortalama yaşları ise 9,7±5,6 yıl idi (p=0,070). Kordi düzeltilmesi en sık TIPU ve G-TIPU grubunda Baskin plikasyonu ile yapılmıştır (n=9), iki aşamalı grupta ise Essed-Schroder plikasyonu (n=3) ve ventral korporatomi (n=3) teknikleri daha sık kullanılmıştır (p=0,004). Postoperatif HOSE skorları önemli ölçüde artış göstermiştir (preop HOSE: 8.5±2.9, postop HOSE: 13.6±1.6, p=<0.001). Gruplar arasında başarı oranlarında anlamlı bir farklılık bulunmamış olup, genel başarı oranı %76.5'tir. Greftli onarım yapılan hastaların 11'i (%36.7) postoperatif dönemde HBOT almıştır. HBOT grubunda başarı oranları daha yüksek olmakla birlikte aradaki fark istatistiksel olarak anlamlı değildir (n=9 (%81.8) vs. n=13 (%68.4), p=0.137).

**Sonuç:** Yeniden onarım yapılan vakalarda, greftli onarımın tek aşamalı veya iki aşamalı yaklaşımla kullanılması, klinik ve cerrahi değerlendirmelere dayanmalıdır. İstatistiksel olarak anlamlı olmasa da, seçilmiş vakalarda greft kullanımının başarıyı potansiyel olarak artırabileceği ve HBOT eklenmesiyle komplikasyonları azaltabileceği düşünülmektedir.

**Anahtar Kelimeler:** Hipospadias, yeniden onarım, bukkal greft, prepusül greft, hiperbarik oksijen tedavisi (HBOT), çocuk ürolojisi

### ABSTRACT

**Aim:** Re-do hypospadias surgery is among the most challenging in reconstructive urology, with higher risks of complications and failure compared to primary cases. Hyperbaric oxygen therapy (HBOT) can be applied on a patient-specific basis with appropriate indications to contribute to postoperative tissue healing. We aimed to present our surgical outcomes and comparative results based on receiving and non-receiving HBOT patients who underwent re-do hypospadias repair.

**Patients and Methods:** This retrospective clinical study included the patients aged 0-17 who had undergone unsuccessful hypospadias surgery and were subsequently re-operated between January 2021 and 2024. Preoperative, peroperative and postoperative data were analysed and compared according to operation type and HBOT receiving.

**Results:** Among the 34 patients who underwent reoperation, 4 underwent TIPU repair, 20 underwent single-stage G-TIPU, and 10 underwent two staged repair. The mean ages of patients were 6.5±3.8 years in the TIPU and G-TIPU group, and 9.7±5.6 years in the staged repair group (p=0.070). Chordee repair was most commonly performed using Baskin plication in the TIPU and G-TIPU groups (n=9), while in the staged group, Essed-Schroder plication (n=3) and ventral corporatotomy (n=3) techniques were more frequent (p=0.004). Postoperative HOSE scores showed a significant increase (preop HOSE: 8.5±2.9, postop HOSE: 13.6±1.6, p=<0.001). There was no significant difference in success rates between groups, with an overall success rate of 76.5%. Eleven (36.7%) of the patients who underwent graft repair received HBOT in the postoperative period. While success rates were higher in the HBOT group, the difference was not statistically significant (n=9 (81.8%) vs. n=13 (68.4%), p=0.137).

**Conclusions:** For re-do cases, the decision on using graft-based repair in a single-stage or two-stage approach should be based on clinical and surgical evaluation. Although not statistically significant, the use of grafts in selected cases is believed to potentially enhance success and reduce complications with the addition of HBOT.

**Keywords:** Hypospadias re-do hypospadias surgery, buccal graft, preputial graft, hyperbaric oxygen therapy (HBOT), pediatric urology

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## INTRODUCTION

Hypospadias is the most common congenital malformation of the penis, occurring in approximately one out of every 250 male children (1,2). Characterized by a ventrally located meatus, various degrees of penile curvature, and malformations of the prepuce. The most commonly used classification system is the Duckett classification, which categorizes cases based on meatal localization into anterior (glandular, coronal, distal penile), penile (midshaft, proximal penile), and posterior hypospadias (penoscrotal, midscrotal, perineal). About 70% of cases are classified as glandular or distal as mild forms, while the remainder are categorized as severe and complex (3).

In hypospadias surgery, there are three strategic objectives; achieving normal micturition, sexual intercourse, and closest to normal external appearance for psychological satisfaction (4). Various techniques have been described for repair. The choice of surgical repair depends on the severity of the condition, the surgeon's experience, and the expectations of the patient and parents. The outcomes of primary hypospadias surgeries include significantly higher complications compared to many other surgeries performed on children (5). Reoperations following unsuccessful initial attempts pose even greater challenges for surgeons. Different terms have been used to describe this group of patients and procedures, such as complex hypospadias surgery, secondary hypospadias surgery, re-do hypospadias surgery, failed hypospadias surgery or cripple hypospadias. Issues such as fibrotic tissue, relative hypovascularity, residual or recurrent chordee, fistula, diverticulum, urethral stricture and loss or inadequate penile skin often require simultaneous operation.

In clinical practice, techniques commonly used for primary repair are also applied to re-do cases (6). The decision on the type of surgical repair is based on the severity of the disease, the quality of tissue available for repair, and the surgeon's experience and preference. Although there is limited data and anecdotal use to enhance surgical healing, hyperbaric oxygen therapy (HBOT) can be applied on a patient-specific basis with appropriate indications to contribute to postoperative tissue healing (7).

For re-do hypospadias repair, the 2024 European Association of Urology pediatric urology guidelines do not propose a standardized surgical technique (8). Contributing to the literature with our results of re-do hypospadias repair, aiming to provide an approach tailored to the patient and the use of HBOT, remains our goal in this challenging field of pediatric urology where clear consensus has not yet to be established.

## PATIENTS AND METHODS

The study included the patients aged 0-17 who had undergone unsuccessful hypospadias surgery and were subsequently re-operated between January 2021 and 2024. Retrospective file reviews were conducted after ethical approval and written and verbal consent obtained from parents.

Decision for surgery was made jointly by two pediatric

urology specialists and the family. Patients with disorders of sexual development, additional anomaly except undescended testes, and those who declined re-repair and underwent only meatoplasty or fistulectomy were excluded from the study. Patient demographics including age, presenting complaint, meatal localization, number of previous surgeries, HOSE score (Hypospadias Objective Scoring Evaluation) (9), presence of prepuce, and chordee status were recorded preoperatively. Surgical details such as repair type, presence of chordee, repair technique, type of urethral graft if used, type of covering flap tissue if used, and administration of HBOT in the postoperative period were documented. Patients were evaluated at postoperative 1 and 6 months for complications (fistula, meatal/urethral stricture, tissue dehiscence, diverticulum, residual chordee), postoperative HOSE score, and surgical success which was defined as no need for further surgery due to complications.

### **Surgical procedure**

All surgeries were performed jointly by two experienced pediatric urology specialists (AS and BT). When deciding on the approach to be applied, factors such as the family's expectations, meatal localization, presence and quality of ventral skin, presence of prepuce, quality and width of urethral plate, and degree of chordee were evaluated.

### **The surgical approach involved the following methods:**

#### **TIPU Technique:**

- Standard procedure started with degloving, followed by artificial erection testing (AET) to assess chordee.
- For chordee <30°, dorsal midline Baskin plication (10) was performed.
- After preparing glans wings, the urethral plate was incised vertically at the midline.
- Urethroplasty was done using 7/0 PDS sutures over an age-appropriate urethral catheter.
- Spongioplasty was performed, followed by ventral or dorsal dartos tissue as a covering flap if suitable.
- The surgery was continued with glanuloplasty, frenuloplasty, and skin reconstruction
- The catheter was replaced with a smaller one after removing the existing catheter.
- The catheter was removed after 5-7 days

#### **G-TIPU Technique:**

- Degloving was followed by chordee evaluation using AET
- For mild chordee midline dorsal Baskin plication was performed; for severe cases, Essed-Schröder plication was performed after neurovascular bundle release (11)
- After preparing glans wings, the urethral plate was incised
- A preputial or buccal graft was harvested
- The inlay graft was placed with multiple base fixation sutures
- Similar to TIPU, urethroplasty, spongioplasty, flap covering, glanuloplasty, frenuloplasty, and catheter insertion were performed respectively
- The catheter was removed after 10 days.

#### **Staged Repair:**

##### **First Stage:**

- After degloving and chordee evaluation, ventral fibrotic tissue was excised, and corporotomy incisions were made for severe chordee (>30°)
- A preputial or buccal graft was prepared and sutured to form a new urethral plate using 7/0 PDS sutures, followed by tie-over dressings

**Second Stage:**

- At least 6 months later, if the graft appeared healthy, the second stage involved degloving, excising unhealthy graft edges, and performing urethroplasty and flap covering.
- In cases where sufficient dartos tissue was not available, the tunica vaginalis flap was used
- Penile and scrotal reconstruction concluded the procedure, with the catheter removed after 10 days

In all type of surgeries, a feeding tube of appropriate size for the patient's age was used as the urethral catheter

**Hyperbaric Oxygen Therapy Protocol**

All patients were started on HBOT within 24 hours postoperatively. HBOT was administered once a day in a multiplace chamber. Patients inhaled pure oxygen at a pressure of 2.4 ATA (absolute atmospheric pressure) in 3 periods of 25 minutes. Some patients inhaled oxygen with a full face mask and child/infant patients recieved oxygen with a hood (Figure-1)

**Statistical Analysis**

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS). Quantitative data are presented as mean ± standard deviation. Categorical data are reported as frequency (n) and percentages (%). Differences between groups in categorical parameters were assessed using chi-

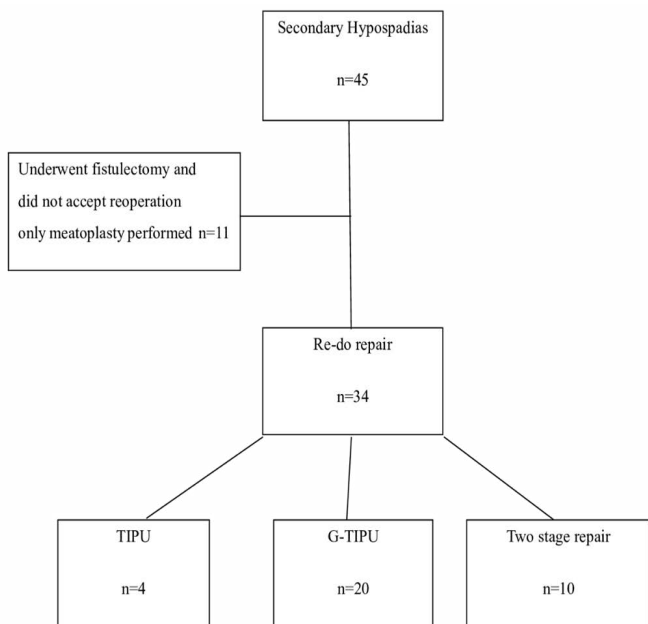
square tests or Fisher's exact tests. Continuous variables were analyzed using t-tests for comparisons between groups. The normality of data distribution was evaluated with the Shapiro-Wilk test. For data that did not meet the normality assumption, non-parametric tests, such as the Mann-Whitney U test, were used. A mixed ANOVA was used to analyze the correlated data between groups across preoperative and postoperative assessments. Statistical significance was defined as  $p < 0.05$ .

**RESULTS**

The data of a total of 45 patients with an average follow-up duration of  $13.5 \pm 6.3$  months were evaluated. Eleven patients who did not accept reoperation and underwent only meatoplasty or fistulectomy were excluded from the study. Among the 34 patients who underwent reoperation, 4 underwent TIPU repair, 20 underwent single-stage G-TIPU, and 10 underwent two staged repair. It was notable that families who did not accept reoperation had significantly higher numbers of previous failed surgeries compared to those who underwent reoperation (Non-acceptors:  $2.9 \pm 1.9$  vs. Acceptors:  $1.7 \pm 0.7$ ,  $p=0.010$ ). The study flowchart is shown in Figure-2.

The mean ages of patients were  $6.5 \pm 3.8$  years in the TIPU and G-TIPU group, and  $9.7 \pm 5.6$  years in the staged repair group ( $p=0.070$ ). Sixty-five percent of patients primarily presented due to urinary complaints, while penile curvature and cosmetic issues were less frequently seen presenting symptoms. Regarding meatus localization, patients in the TIPU and G-TIPU group were predominantly distally located, whereas those undergoing staged repair had penile and proximal localizations ( $p=0.001$ ).

The number of previous surgeries was higher in the staged repair group, although the difference was not statistically significant (TIPU and G-TIPU:  $1.5 \pm 0.8$ , Staged:  $1.9 \pm 0.5$ ,  $p=0.280$ ). Chordee repair was most commonly performed using Baskin



**Figure 1.** Flowchart of the study



**Figure 2.** Two hypospadias patients with their father in a multiplace hyperbaric chamber

**Table 1.** Preoperative, perioperative, and postoperative data according to the type of surgery

	<b>TIPU and G-TIPU n=24</b>	<b>Two-staged n=10</b>	<b>p</b>
Age (year)*	6.5±3.8	9.7±5.6	0.070
Symptoms, n(%)			
Urinary problems	16(66.7%)	6(60%)	
Penile chordee	5(20.8%)	3(30%)	
Cosmetic problems	3(12.5%)	1(10%)	
Meatal location , n(%)			0.001
Distal	15 (62.5%)	0	
Penile	9 (37.5%)	5 (50%)	
Proximal	0	5 (50%)	
Number of previous operations *	1.5±0.8	1.9±0.5	0.280
Chordee repair n(%)			0.004
Baskin	9(37.5%)	0	
Essed- Schröder	1(4.2%)	3(30%)	
Corporotomy	0	3(30%)	
Graft, n(%)			0.124
Preputial	7(29.2%)	1(10%)	
Buccal	13(54.2%)	9(90%)	
Flap, n(%)			0.001
Ventral	16(66.6%)	0	
Dorsal	2(8.3%)	5(50%)	
Tunica vaginalis	0	2(20%)	
HBOT, n(%)	8(33%)	3(30%)	0.680
HOSE score*			
Preoperative	9.9±2.5	5.8±2	<0.001
Postoperative	13.8±1.5	12.9±1.3	0.064
Success , n(%)	20(83.3%)	6(60%)	0.144
Complications, n(%)	6 (25%)	4 (40%)	0.644

\* mean ± standard deviation

**Table 2.** Comparison of data between patients receiving HBOT and not receiving HBOT in graft procedures

	<b>HBOT receiving n=11</b>	<b>HBOT non receiving n=19</b>	<b>p</b>
Age (year)*	6±4.5	8.3±3.6	0.141
Meatal location , n(%)			0.331
Distal	3(27%)	8(42%)	
Penile	5(46%)	9(47%)	
Proximal	3(27%)	2(11%)	
Number of previous operations *	1.7±0.7	1.8±0.7	0.475
Chordee repair n(%)			0.103
Baskin	3(27%)	5(26%)	
Essed- Schröder	1(10%)	3(15%)	
Corporotomy	0	3(15%)	
Graft, n(%)			0.924
Preputial	3(27%)	5(26%)	
Buccal	8(73%)	14(74%)	
Flap, n(%)			0.108
Ventral	4(36%)	10(52%)	
Dorsal	4(36%)	3(15%)	
Tunica vaginalis	1(10%)	1(5%)	
HOSE score*			
Preoperative	9.1±3	7.8±2.9	0.253
Postoperative	13.6±1.4	13.6±1.8	0.913
Success , n(%)	9(81.8%)	13(68.4%)	0.137
Complications, n(%)	2(18%)	7(36%)	0.142

\* mean ± standard deviation

plication in the TIPU and G-TIPU groups (n=9), while in the staged group, Essed-Schroder plication (n=3) and ventral corporotomy (n=3) techniques were more frequent (p=0.004). Eight patients received preputial grafts, while 22 received buccal mucosa grafts. Sixteen patients had flaps placed on the tubularization line, and there was a statistically significant difference between groups regarding flap use and preferred flap location (p=0.001).

Preoperative HOSE scores differed significantly between the groups (p < 0.001). Postoperative HOSE scores demonstrated a significant increase in both groups (p < 0.001), with the magnitude of the increase significantly differing between the groups (p<0.001). There was no significant difference in success rates between groups, with an overall success rate of 76.5% (p=0.144). Complications did not significantly differ between groups (p=0.644). No complications were observed after the first stage in patients who underwent staged surgery. Table-1 summarizes preoperative, perioperative, and postoperative data according to the type of surgery performed.

Eleven (36.7%) of the patients who underwent graft repair received HBOT in the postoperative period. There were no statistically significant differences between the HBOT and non-HBOT groups in terms of age, meatal location, number of previous operations, chordee repair type, graft and flap type (p=0.141, p=0.331, p=0.475, p=0.103, p=0.924, p=0.108 respectively). While success rates were higher and complication rate lower in the HBOT group, the differences were not statistically significant (n=9 (81.8%) vs. n=13 (68.4%), p=0.137 and n=2(18%) vs. n=7(36%) p=0.142 respectively). The comparative data on HBOT and non-HBOT are presented in Table-2.

## DISCUSSION

In re-do hypospadias repair, the goal remains achieving a functional and cosmetically normal penis (12). This type of surgery is among the most challenging in reconstructive urology, with higher risks of complications and failure compared to primary cases. The reported complication rates following reoperations vary widely, ranging from 14% to 50% (13). Several factors contribute to these higher risks, including the lack of detailed surgical history, abnormal residual tissue for repair, and the need for more complex interventions. Typically, modifications of techniques used in primary repairs rather than entirely new surgical approaches are employed in reoperations. The choice of method depends on factors such as the quality and structure of available tissues, surgeon experience, expectations of the family and child, and psychological considerations.

The TIPU technique, which does not necessitate the use of grafts during urethroplasty, is advantageous in cases where the urethral plate is sufficient, scar-free, well-vascularized, and without significant chordee in redo cases (6). Eliçevik et al. reported the largest series in the literature with a study of 100 patients undergoing re-do TIPU. They reported a complication rate of 26%, with only 3 cases requiring residual chordee repair with Nesbit plication in their series. They also reported that

if previous unsuccessful surgery was performed in a flap-based fashion, the complication rate is lower in re-do TIPU repair. Third redo tubularized incised plate urethroplasty was performed for neourethral stenosis and dehiscence in 3%. Although the diameter of the neourethra was adequate after a deep third midline incision, the outcome was a failure in those patients (14). Similar to the authors' findings, in our series, TIPU was preferred in 4 of our patients, who had only one previous failed operation story including 3 patients underwent Mathieu repair and 1 patient underwent TIPU repair, due to good urethral plate quality and absence of residual chordee, and all patients who underwent re-do TIPU achieved satisfactory slit-like meatus.

According to the algorithm proposed by Snodgrass et al. for redo cases, tubularization with an inlay graft (G-TIPU) is recommended for cases where there is a narrow urethral plate but no significant scarring on it and the degree of chordee is not severe (<30°). For cases with scarred urethral plates which have no viable tissue or with severe chordee, staged substitution repair is preferred (6). Preputial grafts are often used if available; otherwise, buccal grafts may be considered. Rarely, retroauricular grafts have also been reported (15). Schwentner et al. reported using inguinal skin grafts (16); however, the use of bladder mucosa and skin has been largely abandoned nowadays (17). Snodgrass and Bush collected data on hypospadias repairs (TIPU, G-TIPU, and two-staged). In contrast to the 12% complication rate in primary TIPU repair, complications in reoperative urethroplasty occurred in 32% of TIPU cases, 35% in G-TIPU, and 40% in two-stage repairs (18). In our series, consistent with the literature, success rates were found to be 80% in the G-TIPU group and 60% in the two-stage repair group. In cases where there is insufficient penile skin, procedures such as the Cecil procedure (19) (burying the penis in the scrotum temporarily) or skin graft harvesting may be necessary. None of the cases in our series required such interventions.

Evaluation of surgical outcomes in hypospadias was historically based on the surgeon's assessment, but nowadays, validated scoring systems are available. However, there is no universally accepted objective assessment system (20). An ideal scoring system should be reproducible, free of inter-observer variability, and include significant functional and aesthetic criteria, as well as relevant surgical complications. We use the HOSE system, which includes evaluating meatal position and shape, urinary stream, straightness of erection, and presence and complexity of urethral fistula, to assess outcomes. The authors recommending this scoring system suggest that achieving 14 or more points out of 16 is acceptable (9). In our study, patients undergoing TIPU achieved 100% with 14 or more points, those with G-TIPU achieved 80%, and those with two-stage repairs achieved 60% according to the HOSE classification. The difference between these groups was not found to be statistically significant. However, it should be noted that the recommendation of 14 points or more may be more applicable to primary cases.

As previously mentioned, the likelihood of complications

increases with repeated surgeries in hypospadias repair, leading to decreased success rates. According to a study, urethroplasty complications are twice as likely in patients undergoing a secondary repair compared to those undergoing primary repair, and this risk exceeds 40% in patients undergoing three or more procedures (18). Each unsuccessful surgery can cause significant psychological distress for both patients and parents. Additionally, certain complications such as glans dehiscence may be perceived differently by families and surgeons. In patients who undergone multiple unsuccessful surgeries, functional outcomes may be prioritized over cosmetic results (21). It is also theorized that meatal retrusion to the sulcus after glans dehiscence might have some beneficial effects. The glans is the most rigid part of the urethra, so glans dehiscence might improve urinary function, especially in cases where a long neourethra is created, such as in proximal hypospadias repairs (22). The clinical relevance of glans dehiscence should be considered in relation to the severity of hypospadias. Successful glans reconstruction may be more critical in distal repairs, where surgery typically has a lower complication rate and achieving good cosmetic outcomes is the primary goal (23). In our own series, as the number of surgeries increases, families' cosmetic expectations tend to decrease while functional expectations become more prominent. It has been noted that families who do not accept further repairs for their children have significantly higher numbers of previous unsuccessful operations compared to those who consent to further repairs ( $p=0.010$ ). For these families, children underwent only meatoplasty due to glans dehiscence causing micturition problems. Although quality of life scores were not measured, families expressed satisfaction in the post-operative period. Families should be evaluated from this perspective as well, and psychological support should be provided when necessary.

Hyperbaric oxygen therapy is currently utilized as a salvage therapy for compromised grafts and ischemic non-healing wounds (24). Its beneficial effects are attributed to several mechanisms, including hyperoxygenation, stimulation of fibroblast proliferation, deposition of collagen, angiogenesis, and vasculogenesis. HBOT alters local ischemic conditions, thereby facilitating various wound healing processes. Additionally, it enhances endothelial progenitor cell mobilization and stimulates hypoxia-inducible factor, which aids in the formation of new blood vessels (angiogenesis) and can reverse tissue ischemia, a common cause of graft failure (24,25). A systematic review and meta-analysis by Anand et al., involving 4 studies and 176 patients, reported that HBOT reduces graft failure and complications while being safe to use (26). Neheman et al. applied HBOT in cases of cripple hypospadias and found it to be safe in pediatric patients, potentially reducing the high surgical failure rates due to graft contraction (7). Although in the literature HBOT is primarily recommended for staged repairs to stabilize grafts, in our study, we also used it in appropriate cases of single-stage inlay grafts (G-TIPU). While success rates in HBOT receiving patients were higher compared to unrepaired patients in our study, this difference did not reach statistical significance, possibly due to

the small number of cases. Consistent with the literature, in our series, HBOT protocol completion was unsuccessful in only one patient due to child non-compliance and in another due to ear pain.

The cost of HBOT is always a matter of debate. Failure of hypospadias surgeries causes problems for both the patient and the healthcare system (27). According to our observations, the involvement of patients in repeated surgical procedures also affects the mental state of the patient and their family. The burden of repeated surgical procedures on the health insurance system should be evaluated. In terms of cost-effectiveness, we think that HBO therapy provides an advantage in terms of saving patients from recurrent surgical procedures for a long time in selected patients.

We believe that our study can contribute to the literature on re-do hypospadias repair and the use of HBOT, which is newly introduced in this patient group lacking standardized treatment algorithms. However, our study has some limitations. Firstly, its retrospective nature, small sample size, and heterogeneous patient group make it challenging to draw robust comparisons. Secondly, the selection of the surgical technique was not based on objective and quantitative measurement criteria, and there was a lack of measurement of perioperative parameters that could affect surgical outcomes, such as urethral plaque width, glans diameter, and tube length. Lastly, in a condition significantly affecting the psychology of both patients and families, postoperative quality of life and psychological status were not measured. Considering these limitations, interpretation and generalization of the results should be done cautiously.

## CONCLUSION

Our findings support that TIPU in re-do hypospadias surgeries may be suitable for cases only with distal meatal location, no significant chordee and a healthy urethral plate adequate width. For more complex cases, the decision on using graft-based repair in a single-stage or two-stage approach should be based on the surgeon's evaluation. Although not statistically significant, the use of grafts in selected cases is believed to potentially enhance success and reduce complications with the addition of HBOT. High-volume randomized controlled trials in this regard would provide guiding evidence.

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