Distal Urethroplasty and Glanuloplasty Procedure Can be Suitable for All Types of Glanular/Subcoronal Hypospadias

Shina Kawai, Taiju Hyuga, Shigeru Nakamura, and Hideo Nakai

OBJECTIVE To correct all types of glanular/subcoronal hypospadias, we performed surgery named the distal urethroplasty and glanuloplasty procedure (DUG procedure). We analyzed cases that we have experienced.

METHODS A vertical incision with the meatal margin was made in the 12 o'clock direction, with the margin of the external urethral meatus as the center. By this meatoplasty according to Heineke-Mikulicz principle, we changed all type of glanular/subcoronal hypospadias to the hypospadias with wide meatus and wide glans. And then Thiersh-Duplay procedure was performed.

RESULTS Consecutive 24 underwent modified DUG procedure. The mean age at the time of surgery was 19.0 ± 11.9 months and the mean preoperative glans width was 13 ± 1.5 mm. The external urethral meatus was located glanular in 13 and subcoronal in 11. Hypoplastic urethra (HU) was observed in 7. Skin chordee in 10, penile torsion in 6 and meatal stenosis in 10 were observed. The mean surgical duration was 106 ± 25.4 minutes and the mean postoperative observation period was 40.5 ± 26.2 months. All patients with preoperative skin chordee, penile torsion, and meatal stenosis were improved postoperatively, and in all cases, apart from the patient with meatal regression with longest HU from glanular to distal penile, the slit-like shape of the external urethral meatus was achieved.

CONCLUSION DUG procedure can be used for any type of glanular/subcoronal hypospadias but care should be taken not to indicate too aggressively for glanular/subcoronal hypospadias accompanying long HU to distal penile shaft. UROLOGY 124: 248–253, 2019. © 2018 Elsevier Inc.

For cases of glanular/subcoronal hypospadias, there are various surgical techniques and it is the most important factor to succeed in each operation to consider which surgical technique to perform in which case, including the option not to perform surgery.

Therefore, it is mandatory to establish the single procedure for all types of glanular/subcoronal hypospadias with high success rate.

In the second part of the nineteenth century, Thiersh-Duplay method originally described the creation of a neourethra by tubularizing the penile skin to the meatus.[1-3]

The glans approximation procedure (GAP), first reported by Zaontz[4] in 1989 as simplified version of the Thiersch-Duplay method, was used in cases of glanular hypospadias with wide glans, deep groove, and fish mouth meatus.

In 1997, Stock et al reported the distal urethroplasty and glanuloplasty (DUG) procedure[5] as a modification of the Thiersch-Duplay method and they described they have been able to extend the limited indications of the GAP repair and perform the procedure when the meatus is stenotic or proximal to the coronal sulcus by combining a Heineke-Mikulicz meatoplasty with the Thiersch-Duplay method for glanular/ subcoronal hypospadias.

We also have performed DUG procedure for glanular/ subcoronal hypospadias and, not only for the cases with meatal stenosis like Stock et al, we always have performed meatoplasty according to the Heineke–Mikulicz principle to change all type of glanular/subcoronal hypospadias to "ideal configuration of external urethral meatus and glans" suitable for GAP.

The aim of this study was to review our experience with this type of repair and to evaluate the factors that influenced good outcomes.

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SUBJECTS AND METHODS

This clinical research was approved by our Institutional Review Board (IRB: 17-079).

Our institution is a tertiary referral medical center. Of 157 patients who underwent initial hypospadias repair at our institution between September 2007 and March 2017, 24 patients (15.2%) underwent DUG procedure for glanular/subcoronal hypospadias, 63 patients underwent dorsal inlay graft urethroplasty for distal penile/midshaft/proximal penile hypospadias and 70 patients underwent parameatal foreskin flap urethroplasty (modified yoke procedure) for penoscrotal/scrotal/perinieal hypospadias.

The inclusion criterion for DUG procedure was the all cases of glanular or subcoronal hypospadias associated with following findings such as meatal stenosis, skin chordee or penile torsion and parent's preference.

We defined the case of hypospadias as subcoronal hypospadias if the upper margin of the meatus reaches coronary line.

A sound was inserted, and both the diameter of the external urethral meatus and the length of the hypoplastic urethra (HU) were measured. Meatal stenosis was diagnosed when an 8-Fr sound would not transverse the meatus. HU was diagnosed when the skin covering the urethra appeared transparent.

The DUG procedure in this study almost conformed to the method reported by Stock et al.[5] Regarding the meatoplasty by Heineke-Mikulicz principle, they described to perform if the meatus was stenotic and they made a longitudinal midline incision from inside the dorsal edge of the meatus to the flat portion of the urethral plate. Meanwhile we made a vertical incision with the meatal margin as the center from inside the dorsal edge of the meatus to the distal end of the glanular groove and flattened the glans by a Heineke-Mikulicz closure for all cases (Fig. 1).

The surgery was performed at this hospital by 4 pediatric urologists.

We conducted a retrospective analysis of the following factors for the 24 cases that underwent DUG procedure according to the procedure described above: age at the time of surgery, preoperative glans width, position of the external urethral meatus, position and length of HU, the surgical duration, the duration of urethral catheter placement, and complications.

RESULTS

Characteristics of 24 patients undergoing DUG procedure are outlined in Table 1. The mean age at the time of surgery was 19.0 ± 11.9 months (7-51 months) and the mean preoperative glans width was 13 ± 1.5 mm (9-15 mm). Preoperative intramuscular testosterone injection was administered thrice for one case No.1 in Table 1.

Outcomes following DUG procedure are outlined in Table 2.

Foreskin reconstruction was performed in 23 cases, excluding one in which the penis was covered with a

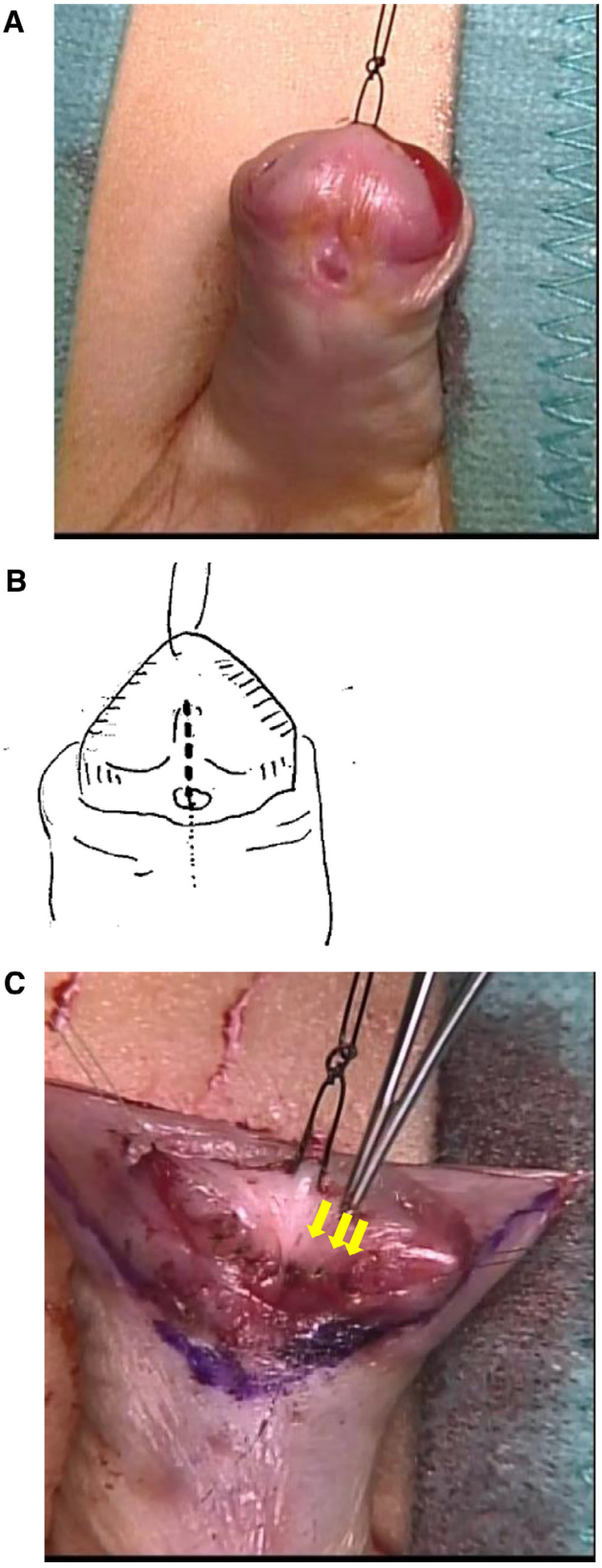

Figure 1. (A) Preoperative appearance of case No.16 was subcoronal hypospadia with the narrow and shallow urethral groove. (B) We made a vertical incision. (C) Meatoplasty by Heineke-Mikulicz principle flattened glans. Yellow arrows indicate transverse suture line. (Color version available online.)

Table 1. Characteristics of 24 patients undergoing modified DUG procedure

No.	Age (Month)	The Position of Meatus	Glans Width (mm)	Depth of Groove	Meatal Stenosis	Skin Chordee	Penile Torsion	Hypoplastic Urethra
1	15	G	9	S	–	+	···	–
2	16	G	12	D	+	+	+	–
3	14	G	···	D	–	+	···	–
4	18	G	···	D	+	···	···	–
5	47	G	···	S	+	+	+	–
6	12	G	15	D	–	···	···	–
7	9	G	15	S	–	+	+	–
8	51	G	···	D	–	+	+	–
9	21	G	···	···	–	···	···	glanular – distal penile
10	18	G	···	S	–	···	···	glanular – subcoronal
11	11	G	13	S	+	+	+	glanular – subcoronal
12	26	G	11	S	+	+	···	glanular – subcoronal
13	40	G	13	S	+	···	+	glanular – midshaft
14	12	G	13	···	–	···	···	glanular – subcoronal
15	10	S	13	D	+	–	···	–
16	9	S	14	S	–	–	···	–
17	12	S	13	S	+	–	···	–
18	7	S	12	S	–	+	–	–
19	13	S	···	S	–	···	···	–
20	15	S	14	S	+	···	···	–
21	16	S	13	S	–	–	–	–
22	10	S	14	D	–	+	···	–
23	26	S	14	···	–	···	···	–
24	29	S	13	D	+	–	···	subcoronal – distal penile

D, deep; G, glanular; S, shallow; SC, subcoronal.

Byar's flap due to an extremely small amount of ventral foreskin and there was no complication of foreskin reconstruction.

All patients with preoperative skin chordee, penile torsion (Supp. Fig. 1), and meatal stenosis (Supp. Fig. 2) were improved postoperatively.

In all cases, apart from the case of meatal regression (No.13 in Table 1), the slit-like shape of the external urethral meatus were achieved. The case occurred postoperative meatal regression to the subcolonal level was the case of a 3-year-old with the longest HU from the glanular to the midshaft level. This was the only case involving a complication. He is 7-year-old now and an additional operation has not been performed because of his parent's preference and his preoperative meatal stenosis was improved by the operation (Supp. Fig. 3).

Table 2. Outcomes following modified DUG procedure

Variable	Value
Total number (cases)	24
Foreskin reconstruction (cases)	23
Mean surgical duration (minutes²)	106 ± 25.4 (55-157)
The mean duration of urethral catheter placement (days²)	5.8 ± 2.1 (3-11)
The mean postoperative observation period (months)	40.5 ± 26.2 (6-104)
The postoperative shape of external urethral meatus	
Slit like (cases)	23
Fish mouse (cases)	1
Complications	
Meatal regression (cases)	1

DISCUSSION

The functional indications for surgery in hypospadias include a proximally located meatus, a ventrally deflected or spraying urinary stream, meatal stenosis, and a curved penis. The cosmetic indications include an abnormally located meatus, a cleft glans, a rotated penis with abnormal cutaneous raphe, a preputial hood, penoscrotal transposition, and a split scrotum.

For cases of glanular/subcoronal hypospadias, the need for surgery and the surgical technique to be used remain controversial.

According to a survey conducted by the European Associatio`n of Urology of 377 pediatric urologists, pediatric surgeons, urologists, and plastic surgeons in 68 countries,[6] 143 (39%) opted for tubularized incised plate urethroplasty (TIP) in cases of glanular hypospadias, 125 (34.1%) for meatal advancement and glanuloplasty, 55 (15%) for other techniques, and 44 (12.0%) for no treatment.

The TIP was introduced by Snodgrass[7] in 1994 and he described there was no contraindication to the TIP as the method in distal hypospadias[8] but some authors described there was increased difficulty in performing good quality urethroplasty or glanuloplasty when the glans is hypoplastic and/or the urethral groove is narrow and insufficiently deep (Fig. 1) and case selection was a crucial factor influencing the complication rate.[9-11]

The meatal advancement and glanuloplasty was first reported as a surgical treatment for glanular hypospadias especially broad and flat glans in 1981 by Duckett.[12]

However, problems such as meatal regression and a non-slit-like external urethral meatus were noted. The technique was not always completely satisfactory, which led the author to modify and refine it in 1991[13] to avoid meatal stenosis and regression. To prevent meatal regression, they described the glans wrap to support the advanced ventral urethral wall requires a solid approximation of glans tissue in 2 layers and meatal stenosis may be avoided by an adequately deep dorsal Heineke-Mikulicz tissue rearrangement, making the incision from within the urethral meatus distally into the glanular urethral groove. They also mentioned case selection was critical to surgical outcome therefore excessively thin or rigid ventral parameatal skin, or a meatus that is too proximal or too wide must be avoided.

The GAP, first reported by Zaontz[4] in 1989, was used in such cases of glanular hypospadias with a wide, deep granular groove and a wide-mouthed meatal opening and it has been reported that the most important factor for successful GAP is case selection.[14]

Stock et al reported the DUG procedure[5] in 1997 and they described they have been able to extend the limited indications of the GAP repair with a longitudinal midline incision in the glanular groove extending from the tip of the urethral plate down into the stenotic meatus and transverse suture in a Heineke-Mikulictz fashion if the meatus was stenotic and this was necessary in approximately 50% of patients. They reported 11 cases with complication (5 fistulae, 2 meatal stenosis, 4 distal breakdowns of the distal neourethra) in 512 patients and they described absent glanular groove are probably not candidates for the DUG repaire since 2 of their 4 paitents with distal breakdown of their repairs had such variants.

Therefore, we performed meatoplasty according to the Heineke-Mikulicz principle for all cases not only for creating a wide-mouthed meatal opening but also enlarging the width of the glans with a vertical incision in the 12 o'clock direction, with the meatal margin at the center and subsequent transverse suturing according to Heineke-Mikulicz principle (HMP) prior to performing GAP. As a result, despite the fact that the cases with shallow groove occupied more than half in our study, we experienced only one case with complication even though the number of our series was small and we might use more excellent devices in recent years.

Other merits of GAP include the fact that additional penile reconstructive procedures, such as chordee repair and revision of circumcision, can be simultaneously performed.[14] Since circumcision is not routinely performed in Japan, almost all patients underwent foreskin reconstruction when performing DUG procedure without any difficulty and complication.

We experienced the only case with a complication. It was meatal regression and this occurred in case No.13. The details were shown in Supplementary Figure 3. Though his meatus was within the glans, his HU was the longest in all cases and this is the only case of which HU reached to the midshaft level. We had classified hypospadias at the location of the meatus and decided whether or not to perform DUG in this study. However, this case suggested that the position of the meatus alone was not enough to decide the indication of DUG and the possibility that the length of the HU should also be considered.

Orkiszewski reported only 22 patients (14.7%) of 150 hypospadias lacked HU and recommended the classification of hypospadias based on the position of the division of corpus spongiosum in respect to the penile shaft and bony structures of the pelvis even though present systems for categorizing hypospadias variants are based on the location of the external meatus with respect to specific penile elements and/or surrounding structures such as the scrotum or perineum.[15] And he also described the repair of the urethra should extend proximally as far as the division of the urethra should extend proximally as far as the division of the corpus spongiosum and distally to the tip of the glans, when possible.

And it was reported that the cases with neourethra from midshaft of penis to tip of the glans had more complication than the cases with neourethra from glanular/subcoronal level in Thiersch-Duplay procedure.[16] The key to performing the Thiersch-Duplay procedure is ensureing that the urethral plate is of sufficient width to allow for formation of neourethra of adequate circumference. If the plate is too narrow to create a neourethra of adequate circumference but the length of the plate is short, Heineke-Mikulicz procedure can make the plate wider. But the plate is too narrow and long, an onlay flap needs to be applied or, alternatively, the plate needs to be hinged. And urethroplasties solely using ventral tissues like Thiersch-Duplay procedure may present an additional risk of late failure, as they may not grow satisfactorily with the rest of the genital tubercle. Because the tissues sitting distally to the division of the corpus spongiosum had different characteristics than those located proximal to the division of the corpus spongiosum and on the genital tubercle dorsum.[17]

Namely, it was not appropriate to decide to perform DUG to case No. 13 only by the position of the external urethral meatus. At the point we observed his HU reached to the midshaft level, we should have recognized that this case was not a candidate for DUG procedure and we should have chosen the other surgical technique, dorsal inlay graft urethroplasty we underwent for distal penile/midshaft/proximal penile hypospadias.

The limitations of this study include the fact that there was a small number of subjects and that we did not perform postoperative assessment using subjective evaluation methods such as HOSE,[18] HOPE,[19] or PPS.[20] However, some research indicates that the results obtained with subjective evaluation methods correspond with those obtained with objective evaluation methods.[21]

CONCLUSION

1. DUG procedure is applicable to nearly all cases of glanular/subcoromal hypospadias irrespective of the

morphology of the external urethral meatus and the depth of the groove.

2. DUG procedure achieves most functional and cosmetic goals. However, this procedure should not be applied for the cases of which the hypoplastic urethra extends to the distal penile shaft even if the external urethral meatus is in the glanular / subcoronal position.
3. At our hospital, the success rate of this procedure when applied to all cases of glanular/subcoronal hypospadias with meatal stenosis, skin chordee and skin chordee was 95% in average of 40 months postoperatively. Therefore, we will continue to recommend this surgical procedure.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.urology.2018.06.062.

References

1. Thiersh C. On the origin and operative treatment of epispadias. *Arch Heilk*. 1869;10:20.
2. Duplay S. De l'hypospadias perineo-scrotal et de son traitement chirurgical. *Arch Gen Med*. 1874;513:657.
3. Duplay S. Sur le traitement chirurgical de l'hypospadias et de l'epispadias. *Arch Gen Med*. 1880;145:257.
4. Zaontz MR. The GAP (glans approximation procedure) for glanular/coronal hypospadias. *J Urol*. 1989;141:359–361.
5. Stock JA, Hanna MK. Distal urethroplasty and glanuloplasty procedure: results of 512 repairs. *Urology*. 1997;49:449–451.
6. Springer A, Krois W, Horcher E. Trends in hypospadias surgery: results of a worldwide survey. *Eur Urol*. 2011;60:1184–1189.
7. Snodgrass W. Tubularized, incised plate urethroplasty for distal hypospadias. *J Urol*. 1994;151:464–465.
8. Snodgrass WT, Bush N, Cost N. Tubularized incised plate hypospadias repair for distal hypospadias. *J Pediatr Urol*. 2010;6:408–413.
9. Ferro F, Vallasciani S, Borsellino A, Atzori P, Martini L. Snodgrass urethroplasty: grafting the incised plate—10 years later. *J Urol*. 2009;182(4 Suppl):1730–1734.
10. Manzoni G, Bracka A, Palminteri E, Marrocco G. Hypospadias surgery: when, what and by whom? *BJU Int*. 2004;94:1188–1195.
11. Jayanthi VR. The modified Snodgrass hypospadias repair: reducing the risk of fistula and meatal stenosis. *J Urol*. 2003;170(4 Pt 2):1603–1605. discussion 1605.
12. Duckett JW. MAGPI (meatoplasty and glanuloplasty): a procedure for subcoronal hypospadias. *Urolog Clin North Am*. 1981;8(3):513–519.
13. Duckett JW, Snyder 3rd HM. Meatal advancement and glanuloplasty hypospadias repair after 1,000 cases: avoidance of meatal stenosis and regression. *J Urol*. 1992;147(3):665–669.
14. Gittes GK, Snyder CL, Murphy JP. Glans approximation procedure urethroplasty for the wide, deep meatus. *Urology*. 1998;52:499–500.
15. Orkiszewski M. A standardized classification of hypospadias. *J Pediatr Urol*. 2012;8:410–414.
16. Grosos C, Bensaid R, Gorduza DB, Mouriquand P. Is it safe to solely use ventral penile tissues in hypospadias repair? Long-term outcomes of 578 Duplay urethroplasties performed in a single institution over a period of 14 years. *J Pediatr Urol*. 2014;10:1232–1237.
17. Koff SA, Jayanthi VR. Preoperative treatment with human chorionic gonadotropin in infancy decreases the severity of proximal hypospadias and chordee. *J Urol*. 1999;162:1435–1439.
18. Holland AJ, Smith GH, Ross FI, Cass DT. HOSE: an objective scoring system for evaluating the results of hypospadias surgery. *BJU Int*. 2001;88:255–258.
19. van der Toorn F, de Jong TP, de Gier RP, et al. Introducing the HOPE (Hypospadias Objective Penile Evaluation)-score: a validation study of an objective scoring system for evaluating cosmetic appearance in hypospadias patients. *J Pediatr Urol*. 2013;9(6 Pt B):1006–1016.
20. Weber DM, Landolt MA, Gobet R, Kalisch M, Greeff NK. The Penile Perception Score: an instrument enabling evaluation by surgeons and patient self-assessment after hypospadias repair. *J Urol*. 2013;189:189–193.
21. Scarpa M, Castagnetti M, Musi L, Rigamonti W. Is objective assessment of cosmetic results after distal hypospadias repair superior to subjective assessment? *J Pediatr Urol*. 2009;5:110–113.

EDITORIAL COMMENT

The distal urethroplasty and glanuloplasty procedure represents a combination of Heinke-Mikulicz and Thiersch-Duplay techniques, both are well established procedures that have stood the test of time. The dorsal vertical incision, which is closed transversely heals by primary intention, rather than being left open to heal by secondary intention as described in the tubularized incised plate urethroplasty procedure. Furthermore, the incision widens, advances and when made deep enough creates a deep glanular sulcus, which is surgically favorable, as opposed to a shallow or flat glans, which is surgically unfavorable.

Since our first reported series of 512 cases in 1997 (Ref. 2), I have maintained the same low morbidity rate (2.1%) in hundreds of cases of distal sub-coronal and coronal hypospadias repairs, with an additional 1% of small fistulas, which became apparent after toilet training in children, who had had their surgery in infancy.

I wish to congratulate the authors on their good outcome using the distal urethroplasty and glanuloplasty procedure.

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AUTHOR REPLY

We recognize that the step to transversely close the dorsal vertical incision of the urethral plate has brought two advantages to the distal urethroplasty and glanuloplasty (DUG) procedure over the tubularized incised plate urethroplasty procedure, which leaves the incision unsutured. One is that transversely closing the dorsal vertical incision enables incision of the urethral plate out to the neomeatus at the end of the glans, and, as a result, it becomes possible to widen the glans of the portion that becomes the neomeatus. The other advantage is not leaving the

neourethra with a denuded surface for re-epithelialization or possible scar formation.

Regarding complications, there were 15 cases that underwent surgery in infancy and completed toilet training during the postoperative observational period (average period: 52 ± 26 months) among our 24 cases. There was no additional case with complications (urethral stenosis, meatal stenosis, fistula, and meatal regression) that became apparent after toilet training. However, none of our patients have yet reached puberty.

It was pointed out that there is a risk of reconstructed urethral stenosis as a late complication following the Thiersch-Duplay procedure that uses solely ventral penile tissues in hypospadias repair.[1] It was explained that ventral tissues may not grow satisfactorily with the rest of the genital tubercle, because tissues sitting beyond the division of the corpus spongiosum are poor androgen responders compared to the tissues sitting proximal to the division of the corpus spongiosum.[2]

The DUG procedure is also a method that uses solely ventral penile tissues; therefore, we will follow-up our patients until adolescence.

In our country, it was reported that the proportion of glandular/subcoronal hypospadias was less than in other countries.[3-5] Therefore, we are in great need of a unified surgical technique for these cases, and we will continue to perform the DUG procedure.

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References

1. Grosos C, Bensaid R, Gorduza DB, Mouriquand P. Is it safe to solely use ventral penile tissues in hypospadias repair? Long-term outcomes of 578 Duplay urethroplasties performed in a single institution over a period of 14 years. *J Pediatr Urol*. 2014;10:1232–1237.
2. Koff SA, Jayanthi VR. Preoperative treatment with human chorionic gonadotropin in infancy decreases the severity of proximal hypospadias and chordee. *J Urol*. 1999;162:1435–1439.
3. Kurahashi N, Murakumo M, Kakizaki H, et al. The estimated prevalence of hypospadias in Hokkaido, Japan. *J Epidemiol*. 2004;14(3):73–77.
4. Schneuer FJ, Holland AJ, Pereira G, Bower C, Nassar N. Prevalence, repairs and complications of hypospadias: an Australian population-based study. *Arch Dis Child*. 2015;100:1038–1043.
5. Canon S, Mosley B, Chipollini J, Purifoy JA, Hobbs C. Epidemiological assessment of hypospadias by degree of severity. *J Urol*. 2012;188:2362–2366.

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