The Glanular-Frenular Collar (GFC) Technique

8

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Abstract

A clear understanding of the normal anatomy of the penis is essential for anatomical reconstruction of hypospadias. It is necessary to know that the male urethra is NOT a uniform tubular structure and the glanular urethra differs from the penile urethra in that it forms a fossa (navicularis) with a specific shape, with different boundaries, attachments, and elasticity. The fibrous ligamentous framework of the penis is the main component of this difference. Details of penile anatomy that have been completely overlooked in the history of hypospadias surgery include the "septum glandis", the tunica albuginea, the distal ligament, the navicular fossa, and the flow-dynamics of urine in the male urethra (Özbey and Kumbasar, Turk J Urol. 43:525–9, 2017; Henle, Anatomischer Hand-Atlas zum Gebrauch im Secirsaal (Band 6), 1877; Özbey, J Anat. 234:728–9, 2019; Özbey H, Arlı, Med Hypotheses. 140:109642, 2020). I believe that the surgical process for hypospadias should guide two distinct concepts of surgical repair reserved for the glanular and penile urethra. The Glanular-Frenular Collar (GFC) technique simulates the embryological development of

This chapter specifically addresses a new concept for reconstruction of the glanular urethra. Issues related to the etiology and elimination of the ventral curve are not discussed.

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the urethra and aims to provide the structural and functional anatomical features of the glanular and penile urethra in hypospadias (Özbey and Etker, J Pediatr Urol. 13:34e1–6, 2017; Özbey H, J Pediatr Urol 20:539–40, 2024).

Keywords

Penis · Anatomy · Hypospadias · Septum glandis · Tunica albuginea · Fossa navicularis · Distal ligament · Urine flow dynamics

8.1 Introduction

The "septum glandis" is a fine fibrous tissue surrounding and holding the glanular urethra (fossa navicularis) in the midline with its upper and lower median septum. Although this information was first published in 1877 by Dr Jacob Henle, we had to uncover the same information after 140 years, using magnetic resonance imaging (MRI) [1–6]. According to our findings in both clinical and MRI studies: (1) the corpus spongiosum gradually ends where it meets the fossa navicularis, and after this level extensions of its tunica albuginea (septum glandis) cover the fossa navicularis, (2) the glans penis is NOT the expanded end of the corpus spongiosum, (3) the ventral surface of the glans is also NOT the extension of the "urethral plate" as in the penile urethra, which is surrounded by the corpus spongiosum, (4) the glans doesn't circumferentially cover the glanular urethra and the wings of the glans are separated by this fine fibrous-connective tissue (septum glandis), (5) the septum glandis together with its epithelial extension, the frenulum, forms the ventral wall of the glanular and subcoronal urethra, and (6) the extensions of the tunica albuginea of the corpora cavernosa form the distal (corpora-glans) ligament [1, 2, 7]. The distal ligament provides a strong connection to the corpora cavernosa, which contributes to the flexibility and rigidity of the glans penis and to bear the buckling pressure created during sexual intercourse [8]. The lower median septum is also the ventral connection of the glans to the corpus spongiosum (ventral shaft of the penis) and contributes to the glans stability.

By analyzing the dynamics of urine flow in the male urethra, we showed that the wider caliber of the navicular fossa than the penile urethra should provide an increase in pressure and a decrease in the velocity of the urine flow. The wave-like shape of the urine is the result of the navicular form of the glanular urethra with its vertical, elliptical opening covered by the fibroelastic septum glandis. We considered the FN and SG as "flow control chamber" to control the flow of the urine exiting the urethra [4]. This information, which forms the basis of the GFC technique, was also first introduced to hypospadias surgery by the author of this chapter.

8.2 Indications

The GFC technique can be used in all forms of hypospadias, either to create a glanular urethra alone or to create the penile and glanular urethra together. It can also be used in failed hypospadias repairs when there is a limited amount of foreskin

available as the GFC technique involves two distinct approaches to urethral reconstruction. The GFC technique doesn't involve glans dissection and aims to keep glans tissue intact. The subepithelial glans approximation in the original GFC technique has been replaced with an internal approximation suture. As in normal anatomy, the formation of a loose connective tissue (septum and frenulum) between the wings of the glans provides space for the re-formation of the fossa navicularis and the elasticity required for its functional anatomy [5].

8.3 Steps of the Procedure (Fig. 8.1)

- The GFC technique starts with the separation of the outer and inner prepuce and degloving of the penis as previously described [9] (Fig. 8.1). The separation of the outer and inner prepuce enables the penis to be anatomically degloved according to its fibrous layers (dartos, Buck's fascia, and the tunica albuginea).
- The inner prepuce is modeled retaining its surfaces around the ventral glans for use in forming the septum and frenulum. In this way, the boundaries of the future glanular urethra, which will form the navicular fossa, are determined.
- A holding suture is placed to the inner preputial collar approximately 10–15 mm from the glans. This suture is pulled over the glans to expose the inner surface of the collar. The edges of the collar and its subepidermal layers are sutured midline (7/0 polydioxanone) to form a dense mesenchymal tissue (septum glandis) and frenulum (Glanular-Frenular Collar; GFC) (Fig. 8.2). The collar is pulled down and sutured to the penile foreskin, either with or without preserving the remainder of the foreskin

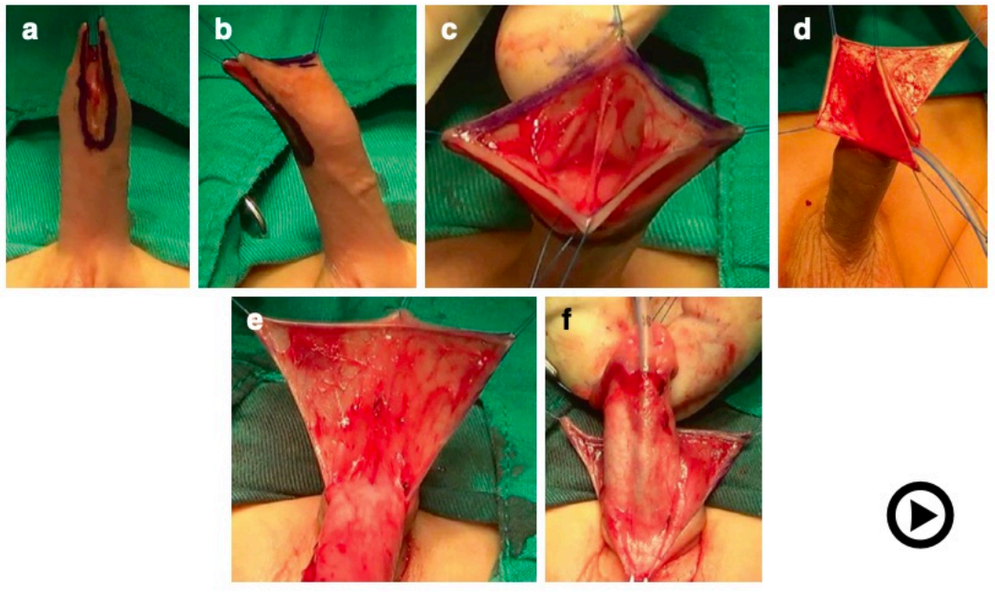

Fig. 8.1 Separation of the outer and inner foreskin and degloving of the penis for the GFC technique. GFC procedure. (https://doi.org/10.1007/000-cn3)

Fig. 8.2 The main maneuver of the GFC technique is to pull the collar (inner foreskin) over the glans to expose its inner surface and work from its inner side

- The glans wings are approximated with a (5/0 polyglactin) suture from the inside of the collar (internal approximation), without glans incision. The collar is pulled down and sutured to the penile foreskin, either with or without preserving the remainder of the foreskin

8.4 Tips and Tricks

- Proper placement of the holding sutures is critical to proper dissection for foreskin modeling (Fig. 8.1a, b).
- Following the natural border between the outer and inner foreskin allows entry into the relatively avascular space, preserving their major vascular supplies (Fig. 8.1c–f).
- If the relaxation incision to the urethral plate is necessary, it should NOT be extended to the anterior glans surface [11].
- The most important maneuver of the GFC technique is to pull the collar over the glans to expose its inner surface and to reconstruct the ventral wall (septum and frenulum) of the glanular urethra (Fig. 8.2).
- Internal approximation of the glans wings is another important maneuver of the GFC technique, eliminating glans dissection. The internal approximation suture should be placed exactly where the glans wings should have their maximum apposition.

Video – Hypospadias Repair with the Glanular-Frenular Collar (GFC) Technique

8.5 Results and Conclusion

The male urethra is NOT a uniform tubular structure. The ventral wall of the glanular urethra is formed by the median primordial fascial tissues that form a septum (glandis), and the frenulum. Glanular urethra is not covered by the corpus spongiosum and the glans is NOT an anterior expansion of the corpus spongiosum. A midline incision of the glans should be avoided as this type of incision can cause iatrogenic damage to the distal ligament and may be the cause of erectile dysfunction [10, 11]. It is clear that formation of a normal glanular urethra, with its fossa navicularis, "septum glandis" and frenulum are important indicators of an anatomically functional and aesthetically normal looking hypospadias reconstruction [12–14] (Fig. 8.3).

Fig. 8.3 Pre- and postoperative views of two patients operated with the GFC technique

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