

The Choice of Bowel Segment in Enterourethroplasty for The Salvage of Bulbo-Membranous Stricture: Anatomical Study of Fresh Corpses

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1. Abstract

1.1. Introduction & Objectives

After the description of the technique for the first time by AR Mandy in 2009, entero-urethroplasty represents a valid technique in the management of salvage bulbo-membranous stricture. It was treated by interpositioning a tailored intestinal flap from the ileum, the appendix, the right colon, or the sigmoid colon. The aim of this study is to compare the feasibility of each intestinal flap through an anatomical study of fresh corpses.

1.2. Materials & Methods

We performed anatomical dissection on 27 fresh corpses for three years (2019-2021). The dissection protocol consists of: Abdomino-perineal approach, inferior pubectomy with a 25mm diameter, and four flaps from the sigmoid, right colon, terminal ileum, and the appendix. The calculated parameters are: The length of the removed segment (RS), the length of the flap (F), the exit length of the flap (EL), and the length of the sacrificed segment (SS). The best flap is the one that comes out far from the pubis with less bowel segment sacrificed.

1.3. Results

Most corpses were dissected 24 to 36 hours after death. The cause of death must not affect the digestive tract or the pelvis. The average length of the flap was 8.2 cm for the sigmoid colon, 9.5 cm for the right colon, 7.3 cm for the terminal ilium and 5.6 cm for the stomach.

The sigmoid flap gives the greatest length of exit from the pelvis, estimated at 6.2cm with a sacrificed segment of 9.2cm. The

terminal ileum easily accesses the perineum with an exit length of 5.3 cm, but the sacrificed segment is larger (21.3 cm). Table: Calculated parameters.

1.4. Conclusions

Entero-urethroplasty remains a very feasible technique. The sigmoid flap pedicled on the superior sigmoid is the most appropriate segment for this technique. The terminal ileum remains an adequate segment, better than the right colon.

2. Introduction

The primary reconstruction for urethral strictures can be performed with penile or preputial skin and buccal or bladder mucosa [1,2]. However, in patients with complex, long-segment urethral strictures and significant scar tissue formation after the failure of a previous anterior urethroplasty still an operative challenge. In these complex cases, the key is to obtain a suitable substitute for urethral reconstruction [3].

From the viewpoint of postoperative quality of life, the intestinal epithelium perfectly replaces the urothelial tissue. Enterocystoplasty has proven its quality in urinary diversions. Consequently, the long urethral stricture can be replaced by an intestinal flap [4,5].

After the first description of the technique by AR Mandy in 2009, entero-urethroplasty represents a valid technique in the management of salvage bulbo-membranous stricture. Several case reports have been reported in the literature to describe the technique using different intestinal segments [6,7].

Unfortunately, in children, the results of urethral substitution are not encouraging, and recurrent stricture, anastomotic stenosis, diverticula, and stone formation have been reported [8]. Well vascularised conduit and tension-free anastomosis are the main factors that account for functional results, while the bed of the conduit is often fibrotic and avascular in recurrent complicated strictures [9].

The ileum, stomach, the right colon, and the sigmoid colon have all been used as pedicled flaps in the reconstruction of the posterior urethra [10,11]. In this study, we compare the feasibility of harvesting each intestinal flap through an anatomical study of fresh corpses, in order to describe the most suitable segment that will replace the long urethral stricture in a tension free technique to avoid anastomotic stenosis.

3. Materials & Methods

3.1. Patient Selection

We performed anatomical dissection on 27 fresh corpses for three years (2019-2021) in the department of legal medicine at university of Oran in Algeria. Cadavers less than 48 hours post-mortem were included. The dissection was performed during autopsy if it was indicated by the legist doctor upon the body's arrival. We have excluded cadavers resulting from pulmonary

accidents, abdominal trauma or pelvic fracture, drownings, cadavers in advanced decomposition, deaths involving ingestion of corticosteroids, and deaths following a prolonged stay in intensive care unit. A surgical protocol has been established for all cadavers, including a standard data collection form.

3.2. Surgical Technique

The dissection protocol was through an abdomino-perineal approach, with inferior pubectomy with a 25mm diameter, and four flaps from the sigmoid, right colon, terminal ileum, and the appendix (Figure 1).

The calculated parameters are: The length of the removed segment (RS), the length of the flap (F), the exit length of the flap (EL), and the length of the sacrificed segment (SS). By comparing these parameters between the different intestinal segments, the best flap is the one that comes out far from the pubis with less bowel segment sacrificed (Figure 2).

3.3. Statistical Analysis

Descriptive statistics were reported as median or mean, standard deviation for continuous data, and as number (%) for categorical data. Statistical analyses were performed with SPSS software (25.0).

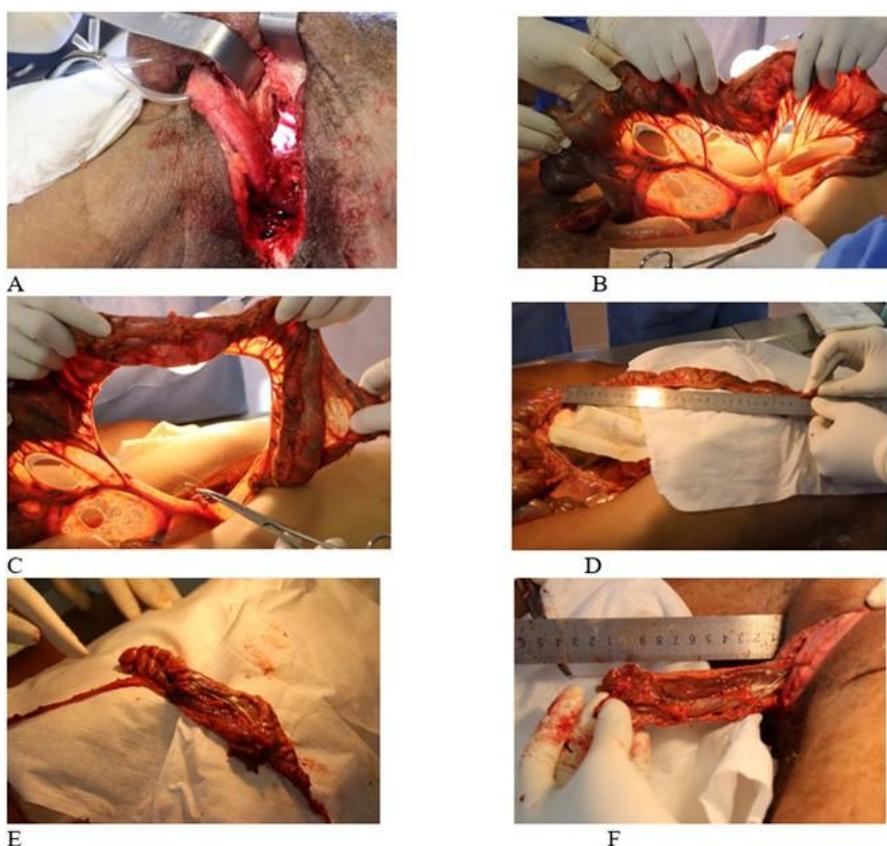


Figure 1: Surgical protocol

A: Abdomino-perineal approach, inferior pubectomy with 25mm diameter

B: Terminal ileum vascularization

C: The removal of the terminal ileum

D: The length of the removed segment (RS),

E: The length of the flap (F)

F: The exit length of the flap (EL)

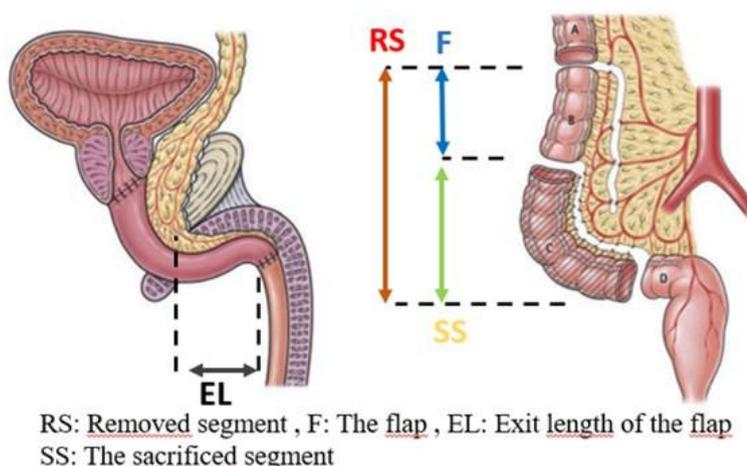


Figure 2: The calculated parameters.

3.4. Ethical Statement

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Informed consent was taken from all the deceased’s parents or their legal guardians or the competent authorities of our country. The study was approved by the ethics committee of the University of Oran, Faculty of Medicine in Oran (Algeria).

4. Results

27 corpses were included in the study. The mean age of the corpses was 67 ± 4.3 years, all males. These cadavers were intended for autopsy. The cadavers underwent dissection less than 48 hours after death. The mean BMI was 26 ± 5.1 . Causes of death were mainly heart failure, respiratory failure, or ischemic heart

failure. Non-infectious medical causes and trauma accounted for 9 (33.4%) and 5 (18.51%) of deaths, respectively (Table1).

The average lengths of the flaps were 8.2, 9.5, 7.3, and 5.6 cm from the sigmoid, right colon, terminal ileum, and appendix, respectively. The sigmoid flap offered the greatest length of pelvic exit, estimated at 6.2 cm, with the shortest sacrificed segment at about 9.2 cm. The right colon gives a flap length of 9.5 cm, which is the longest flap, however the sacrificed segment is very large (14.2cm). The exit segment remains smaller than that of the sigmoid colon. The terminal ileum and the appendix offer the same parameters with a flap length of 7.3 and 7.6 cm, respectively, but the sacrificed segment was estimated to be 21.3 and 18.1 cm (Table2).

Table1: Corpses characteristics.

| Characteristics | Total: 27 corpses, (Mean ± SD) |
|--------------------------|--------------------------------|
| Age (yrs) | 67 ± 4.3 yrs |
| Body mass index (BMI) | 26 ±5.1 |
| Etiology of death | |
| Medical non-infectious | 9 (33.4%) |
| Infectious | 3 (11.12%) |
| Traumatic | 5 (18.51%) |
| Sudden | 2 (0.7%) |
| Criminal | 4(14.81%) |
| Other | 4(14.81%) |
| Age of death (mean ± SD) | 48± 12h |

Table 2: Study parameters.

| Average (cm) | The sigmoid | The right colon | Terminal ileum | Appendix | p |
|-----------------------|-------------|-----------------|----------------|----------|-------|
| Removed segment RS | 17.4 | 23.7 | 28.6 | 25.6 | NS |
| Flap F | 8.2 | 9.5 | 7.3 | 7.6 | 7.6 |
| Exit length | 6.2 | 5.5 | 5.3 | 4.6 | 0.04 |
| Sacrificed segment SS | 9.2 | 14.2 | 21.3 | 18.1 | 0.021 |

5. Discussion

The use of intestinal flaps for unsalvageable bulbomembranous strictures or traumatic defects was first described by two experimental studies. The first study was in 1969. Hennebert and Jain described an experimental study in dogs and four very short case reports of ileourethroplasty in patients in Kinshasa (Zaire). The second study was in 2005. Lee et al. described the use of a re-configured flap of sigmoid colon in one patient with a complicated pelvic fracture-related urethral injury with 15 months of follow-up [12,13].

Currently, entero-urethroplasty is a technique validated by several publications; however, the choice of the best intestinal segment is still being studied. The aim of this study is to determine the best intestinal segment to replace the urethra. After studying the parameters, the best flap is the one that extends far from the pubis with the least bowel segment sacrificed. The two most promising segments identified are the sigmoid colon and the terminal ileum, which align with several studies [6].

During harvesting, it's better if the origin of the vascular pedicle is as close to the pelvic floor and perineum as possible. The further away from the perineum, the main feeder vessels arise, resulting in a longer pedicle, therefore more functioning bowel will have to be sacrificed in its creation.

Hence, the sigmoid and the ileum are better because they are the closest to the perineum and most expendable [14,15].

The terminal ileum is a segment close to the perineum, but it requires a very long sacrificed segment. Ileum is favored for several reasons. First, the identification of a usable bowel segment proximal to the ileocecal valve is simple. Second, the luminal diameter is smaller compared to the jejunum, like the native urethra, and requires less manipulation for neourethral construction. Additional advantages include the fact that it is hairless, better providing a like-with-like reconstruction compared to forearm flaps, and can be used to reconstruct large segments.

Despite these advantages, several concerns exist. The need for a laparotomy and bowel manipulation for flap harvest is a significant consideration [16,17].

The appendix appears to be a promising conduit to replace the missed urethra, and may be used either pedicled or as a free flap with microvascular anastomosis. In our study, the appendix was used as a flap with mobilization of the ileocecal block. This is a segment that is often used in the pediatric population. Small or large bowel conduits need reductive tailoring, and complications such as diverticula formation and urethral stone or stricture are common, while the appendix seems a more compatible conduit for the urethra [18]. A completely different approach has been described to avoid mobilizing the ileocecal valve. The appendix can be removed and then vascularized by the inferior epigastric artery, which is freed up to the perineum and then anastomosed with the appendicular artery in a tension free suture. This is a very promising approach that requires mastery of microsurgery [19,20].

Aside from the complications described after entero-urethroplasty, such as anastomotic stenosis, urethral diverticula, stone formation, and urinary incontinence, urinary incontinence remains a constant complication, especially if the bladder neck is involved [21]. The urethral sphincter is often compromised in patients with proximal obliteration of the long segment of the urethra caused by a traumatic pelvic fracture or repeated surgery. The ability to achieve urinary continence after urethral reconstruction using an intestinal flap depends on the integrity of the bladder neck. Treatment of this complication requires the implantation of an artificial sphincter [22].

6. Conclusion

Enterourethroplasty remains a very feasible technique. The sigmoid flap pedicled on the superior sigmoid is the most appropriate segment for this technique. The terminal ileum and appendix remain a suitable segment, better than the right colon. This surgery should be performed in tertiary centres.

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