Seminars in Pediatric Surgery 28 (2019) 131–134

Contents lists available at ScienceDirect

Seminars in Pediatric Surgery

journal homepage: www.elsevier.com/locate/sempedsurg

Error traps and culture of safety in anorectal malformations

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ARTICLE INFO

Keywords:
Anorectal malformation
Imperforate anus
Safety culture

ABSTRACT

Introduction: Attempting to decrease iatrogenic injuries and preventable harm, safety initiatives have become a priority in surgery. For adult hepatobiliary surgery, it has become common to study and consider "error traps" or common pitfalls that exist for laparoscopic cholecystectomy.[1–4] Extending this work to children, we have attempted to apply some of these initiatives by identifying error traps common to the care of patients born with anorectal malformations (ARM).

Methods: Five error traps were identified based on a retrospective analysis of operative records and radiographic studies from 398 re operative ARM cases performed by the authors. Once identified, the authors constructed a specific safety plan for each trap to promote a culture that will hopefully prevent ARM iatrogenic injuries.

Results: The identified error traps are: 1) creation of a colostomy too distal in the sigmoid colon, 2) inaccurate distal colostogram and definition of the patient's preoperative anatomy 3) absence of a Foley catheter during the repair of an ARM in males and the hazards of separating the anterior rectal wall from the genito-urinary (GU) tract 4) mismanagement of a post-operative anal stricture following an ARM reconstructive procedure 5) limited or unstructured follow up of these patients. For each of the five traps the authors present suggestions for their avoidance.

Conclusion: The repair on an anorectal malformation is an elective procedure and while not completely avoidable, there should be little tolerance for iatrogenic injury and preventable harm. A culture of safety should be followed, beginning with a recognition of the common error traps associated with ARM procedures.

Introduction

The spectral complexity and relative infrequency of anorectal malformations (ARM) makes the surgical management of these patients extremely challenging. Despite tremendous advances in understanding and surgical technique, many ARM patients still receive suboptimal operations or needlessly suffer surgical complications that have life-long consequences for continence and sexual function. While re-operations may restore the anatomic relationships jeopardized by suboptimal technique or complications, they usually cannot restore the original functional prognosis that the patient possessed at birth.

Understanding that "to err is human", medicine has embraced a culture stressing quality and safety of patient care. This new culture has stimulated considerable study of process and process improvement. A significant contribution of this work has been the recognition that for virtually every surgical procedure there are common mistakes and frequent errors that could be avoidable "traps" for the operating surgeon. In safety nomenclature, these error traps can be defined as "single or multiple circumstances that can result in an undesirable consequence such as an accident". The goal of this work was to help surgeons identify and understand the error traps common to ARM surgical procedures enabling them to avoid the consequences of these mistakes.

To this end, five error traps were identified based on retrospective analysis of operative records and radiographic studies from 398 re operative ARM cases performed by the authors. Once identified, the authors constructed a specific safety plan for each trap to promote a culture that will hopefully prevent ARM iatrogenic injuries.

(1) Creation of a colostomy too distal in the sigmoid colon (Fig. 1).
The first error trap to discuss is erroneous colostomy creation in patients who require a staged, multi-operative approach to their reconstruction. It is not uncommon to

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https://doi.org/10.1053/j.sempedsurg.2019.04.016
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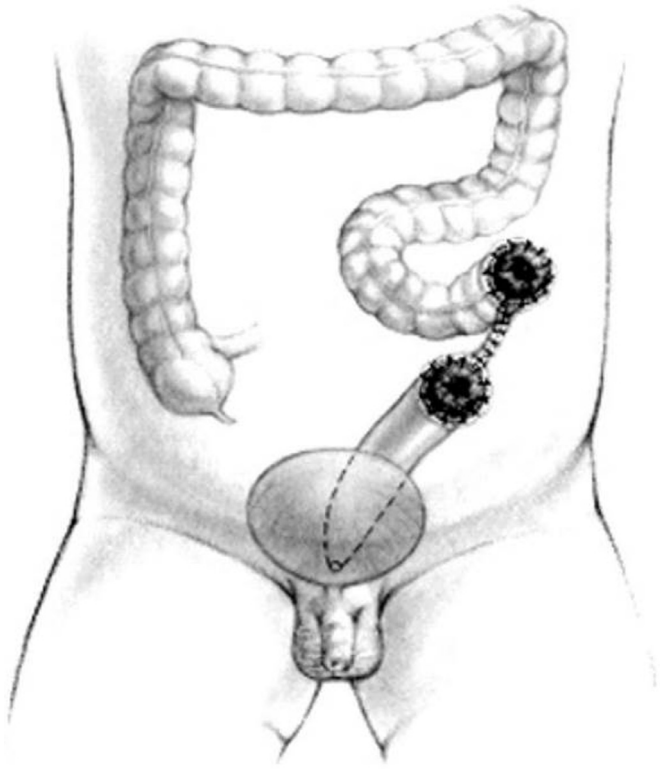

Fig. 1. Colostomy created too distal in the sigmoid colon, leaving a short segment of bowel, distal from mucous fistula, available for the pullthrough.

postpone the definitive operative reconstruction of ARM patients until several months after their birth. This postponement can be safely done in most cases by diverting their fecal stream via a colostomy in the first few days of life. While creating a colostomy is a technically straightforward procedure, positioning the colostomy's stomal opening too distal in the sigmoid colon can have dire consequences and greatly hamper future reconstructive procedures. Distal positioning of the colostomy stoma creates a very short segment of defunctionalized colon, the mucus fistula or the segment of colon that lies between the stoma and the perineum, that is anchored to the anterior abdominal wall.[5] This can be problematic because it can make advancement of that defunctionalized colon to the perineal skin impossible due to its short length as well as limited blood supply. When surgeon's encounter this problem during the definitive repair it is not uncommon that they mistakenly believe that this very short segment of most distal colon is useless. This leads them to resect the distal defunctionalized segment and pull the proximal colostomy stoma for advancement to the perineum. With this single maneuver, the patient loses any potential for future bowel control as the most distal portion of the colon is critical and indispensable for this functional continence.

The safety plan to avoid the error trap of erroneous positioning of the colostomy stoma begins with the understanding that fecal diversion is rarely, if ever, an emergent procedure in ARM cases. It is a procedure that should be performed electively after the patient has been stabilized and other potential anomalies have been assessed and managed (Fig. 2). To ensure that adequate colon length is available to pull that segment through to the perineum during definitive reconstruction, the colostomy should be constructed at the level of the distal DESCENDING colon rather than in the sigmoid colon (Fig. 3).

(2) Inaccurate distal colostogram and definition of the patient's preoperative anatomy.

The second trap we have identified is inaccurate preoperative definition of the patient's native colorectal and urogenital anatomy. This error occurred most commonly when preoperative imaging, primarily the distal colostogram, was suboptimal. The value and importance of the distal colostogram, where contrast is forcibly injected into the distal, defunctionalized colon through the diverting colostomy, is well recognized in the literature. Suboptimal technique in performing the colostogram, primarily by failing to provide adequate pressure for the contrast to reach the most distal aspect of the mucus fistula, can lead the surgeon into a host of traps involving strategic errors in the reconstructive process.[6,7] This is particularly important in referral cases, where the colostomy was opened in another institution. To achieve the necessary pressures to ensure that contrast reaches the full extent of the colon located distal to the colostomy, a Foley catheter must be introduced through the mucous fistula and pressure maintained by using its balloon to occlude the proximal portion of the fistula. The radiologist must understand that forcibly pushing the contrast into the colon and generating pressure in the mucus fistula is a crucial aspect of the study and merely allowing contrast to flow by gravity is inadequate.[8,9]

Without adequate pressure the contrast will always stop at the pubococcygeal level, suggesting a "high" anorectal malformation with no fistula, which is a very rare anomaly. In our series of almost 3000 cases, 95% of male patients have some type of urinary fistula and in those rare cases without a fistula, the blind ending colon is usually found at the level of the bulbar urethra.[10] The significance of this finding is that virtually all male ARM patients have their distal rectum passing through the funnel-like striated sphincter mechanism that has muscular tone constricting the distal colon or colonic fistula. To overcome the constrictive forces of the sphincter and opacify the most distal portion of the colon, it is necessary to apply significant hydrostatic pressure by injecting the contrast through a syringe.

For female patients with ARM, specifically recto-perineal and recto-vestibular fistulas, the evaluation of the pre-operative anatomy should include the inspection of the vagina to confirm that the patient has one. If an absent vagina is found, during the repair of the anorectal malformation, the genital reconstruction should also be addressed.[11]

Our safety plan to ensure excellent and reproducible preoperative colostograms of our patients, has been to strictly standardize our protocols for performance of the study. That protocol includes 6 major points that should be visualized during the study. They are summarized in Fig. 4. For females with recto-perineal and recto-vestibular fistulas, inspection of the genitalia is a mandatory pre-operative maneuver.

(3) Absence of a Foley catheter during the repair of an ARM in males and the hazards of separating the anterior rectal wall from the genito-urinary (GU) tract.

The third error trap in ARM procedures involves the challenges of separating the anterior rectal wall from the genito-urinary (GU) tract. Most ARM reconstructive procedures require complete mobilization of the rectum in order for it to be positioned within the sphincteric complex and reach the perineal skin for construction of the patient's neo-anus. This amount of mobilization requires that the rectum be fully

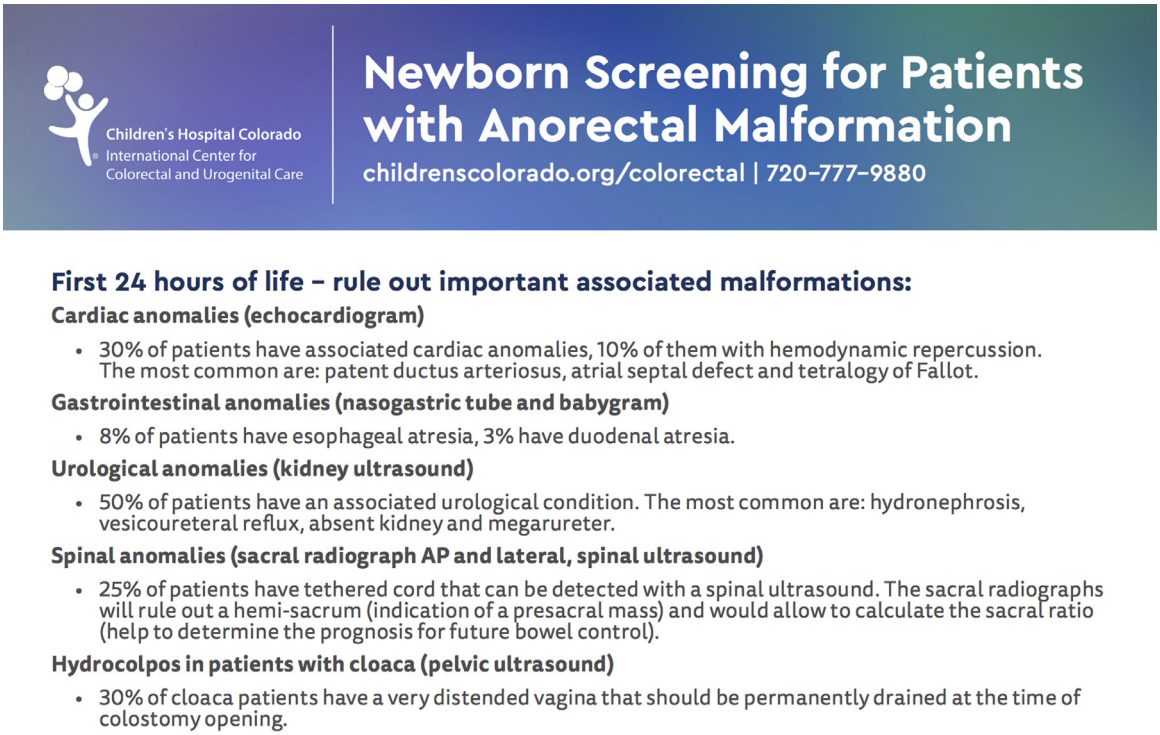

Fig. 2. Newborn screening card showing important associated anomalies that should be ruled out during the first 24 h of life of a patient with anorectal malformation.

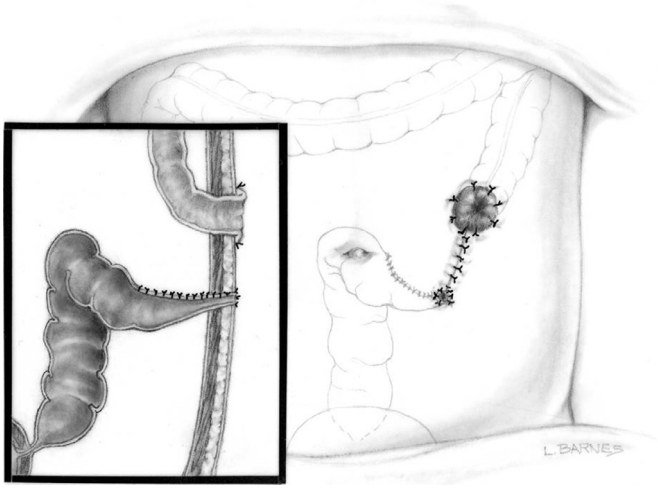

Fig. 3. Ideal colostomy for patients with anorectal malformation: divided stomas, at the descending colon, mucous fistula should be tapered to avoid prolapse.

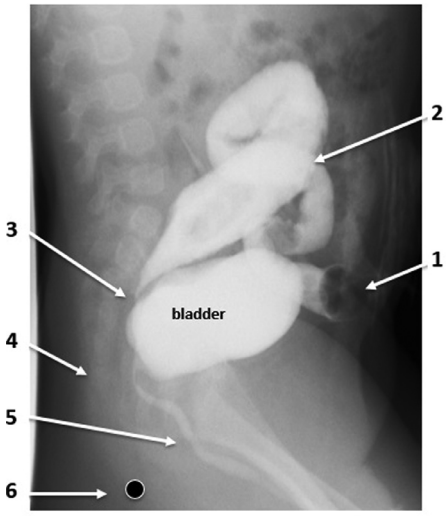

Fig. 4. Six points that should be seen in a technically correct high pressure distal colostogram: (1) mucous fistula site, (2) amount of bowel length available for the pullthrough, (3) rectal end and communication with the urinary tract when present, (4) the tip of the sacrum, (5) the urethra and bladder if possible, and 6) anal marker.

disconnected, in a 360-degree manner, from all attachments. The anterior rectal wall is always intimately attached to the GU tract making for a difficult and tedious dissection to separate the rectum from the urethra in males and the vagina in females. In male patients, this dissection is greatly facilitated by preoperative placement of a Foley catheter that is a tremendous aid in identifying the urethra while mobilizing the anterior rectal wall. In female patients, a lacrimal duct probe or small Hegar dilator in the vagina can serve the same purpose as a Foley catheter in the male, but more commonly the surgeon must rely on meticulous technique and understand that the plane that separates the vagina and rectum can be more of a theoretical or potential plane rather than an actual anatomic boundary. In these cases, the surgeon must literally create two separate and different anatomic walls out of essentially one structure (common wall).

One common misunderstanding in GU tract separation, is that the rectum will enter the GU tract in a "T" configuration. This is true in higher malformations like recto-bladderneck fistulas, but in lower malformations the common rectal-GU wall can be quite long and wide. Attempting to circumferentially dissect such a malformation

thinking that it can be divided by stapling or ligation can lead to catastrophic GU injury or unnecessarily shorten the length of colon available to reach the perineum.[6]

The safety plan for protecting the GU tract during the anterior rectal wall mobilization begins with insisting that a Foley catheter be placed in ALL MALE patients preoperatively. Frequently, placing the Foley catheter may require cystoscopic assistance to traverse a tortuous urethra or rectourethral fistula both of which are common in male ARM patients. In both genders, meticulous surgical technique for separating the GU tract from the rectum is imperative and should be standardized. We have standardized this process for the posterior sagittal approach that begins with accurate identification and mobilization of the POSTERIOR rectal wall before proceeding with mobilizing the lateral rectal walls. We will not proceed to the anterior rectal wall dissection until AFTER the posterior-lateral mobilization is completed. This portion of procedure can be challenging even for the most experienced surgeons and one should never hesitate to get help from another surgeon when encountering confusing or difficult circumstances. Another set of eyes or a valued opinion, even for a short amount of time, may represent the difference between a successful operation or a serious complication. Finally consider aborting the operation without completing the reconstruction when the rectum cannot be found via a posterior sagittal approach, which can occur when the colostogram was suboptimal, OR when the urethra or bladder have been inadvertently opened.

(4) Mismanagement of a post-operative anal stricture following an ARM reconstructive procedure.
The fourth error trap involves the recognition and management of a post-operative anal stricture following an ARM reconstructive procedure. Fortunately, this complication is rare but almost always due to compromised blood supply to the portion of colon pulled through to the perineum. While we recommend a post-operative anal dilation program to maintain the size of the neo anus during healing, we do not recommend it as a treatment for a matured rectal stricture. Attempts to forcibly dilate such a stricture invariability leads to recurrence, worsening of the stricture or complications related to rectal perforation. In cases of a mature stricture, the only recommended treatment is revision of the reconstruction by resecting the stricture and advancing more proximal, well perfused colon to the perineum.

Our safety plan for this error trap involves accurate recognition of a rectal stricture which is usually heralded by complaints of severe pain when parents pass a dilator. Avoidance of this complication is achieved by strict adherence to basic surgical principles of preserving colonic blood supply during any ARM reconstructive procedure and not compromising the operation by proceeding with final reconstruction in cases where the colon appears ischemic.

(5) Limited or unstructured follow up of these patients.
Finally, the fifth, and perhaps most common, ARM error trap is that of limited or unstructured follow up of these patients. The importance of the long-term follow-up of patients with anorectal malformations cannot be overemphasized and should be taken as a personal responsibility of the operating surgeon. This follow up frequently involves multidisciplinary coordination that includes management of fecal[12–14] and urinary incontinence or incapacity to empty the bladder adequately, management of constipation,[15] monitoring of renal function,[16–18] as well as assistance with reproductive or sexual issues. Being born with an ARM is a chronic medical condition with consequences that last for life and most patients will need specific coordination to transition their care to adult providers.[19]

The safety plan is simple to conceive but very challenging to orchestrate. It involves a protocol driven multi-disciplinary team providing careful parent and patient counseling in a frequently recurring outpatient environment throughout life.

Conclusion

We have previously published our experience discussing specific complications in ARM surgery such as male urological injuries[5] and the consequences of re-operations,[6] but we are not aware of another work that has attempted to summarize so many pitfalls for the surgeon treating patients with anorectal malformations. The repair on an anorectal malformation is an elective procedure and the harm from an iatrogenic injury can easily exceed the benefit of attempting formal reconstruction. An understanding of the common error traps to create a culture of safety should be incorporated into the practice of all surgeons who care for ARM patients.

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