International Journal of Multiphysics
Volume 18, No. 3, 2024
ISSN: 1750-9548

An Overview on Enterostomy Closure

Abdulrahman Mahmoud Ali, Ahmed Ezzat Rozeik, Doaa Omar Refaat, Ameen Mohamed Saleh, Amr Usama Elsafy

Department of Pediatric Surgery, Faculty of Medicine, Zagazig University, Egypt

***Corresponding author:** Abdulrahman Mahmoud Ali,

Abstract:

Enterostomy is a common procedure in pediatric and general surgery, often performed as a lifesaving intervention in neonates and children with intestinal obstruction, necrotizing enterocolitis, or congenital anomalies. Closure of the enterostomy is associated with significant morbidity, including wound infection, anastomotic leak, and postoperative obstruction. Optimizing timing, surgical technique, and perioperative care are critical to reduce complications and improve outcomes.

Keywords: Enterostomy; Stoma closure; Pediatric surgery; Anastomosis; Surgical outcomes.

Introduction:

Enterostomy, whether temporary or permanent, is frequently indicated in neonatal and pediatric surgery as part of the management of intestinal obstruction, perforation, necrotizing enterocolitis, or congenital anomalies of the bowel. While often lifesaving, enterostomy is not without complications, including fluid and electrolyte imbalance, poor weight gain, and stoma-related skin problems **(1).**

The closure of an enterostomy represents a technically demanding procedure, particularly in children with fragile bowel and compromised nutritional status. Surgical challenges include the presence of adhesions, the risk of anastomotic leak, and postoperative ileus. Careful preoperative assessment, optimization of nutrition, and timing of closure are crucial factors influencing patient outcomes **(2).**

Recent studies emphasize that advances in surgical techniques, anesthesia, and perioperative care have significantly reduced the morbidity and mortality associated with enterostomy closure. Nonetheless, the procedure still carries risks, and the decision regarding timing early versus delayed closure remains controversial and must be individualized according to patient condition and underlying pathology **(3).**

Preoperative preparation of Enterostomy closure

In the case of elective formation or closure of an Enterotomy or colostomy, many surgeons still prefer to perform preoperative mechanical bowel preparation for children outside of the neonatal period. At minimum, an oral clear liquids diet is given for 24 h prior to surgery. Traditional bowel preparation was preferred particularly for colon surgery, in children older than 1 year, who are usually admitted the day before surgery. A slender nasogastric feeding tube (6 Fr) is placed, and polyethylene glycol (PEG) solution is administered at a rate of 25 mL/kg/h until the output is clear **(4).**

Adolescents can undergo bowel preparation at home with a standard regimen (sodium phosphates oral solution for adults) or (PEG for young infants and children) used for adult surgery. Sodium phosphate oral solution is sometimes better tolerated by adolescents because a lower volume is needed than for PEG solution. Neonates and infants undergoing Enterotomy and colostomy formation or closure require only preoperative clear liquids with or without retrograde distal intestinal irrigation on the floor or in the operating room prior to incision **(5).**

Mechanical bowel preparation is usually not possible when there is obstruction or perforation. Three doses of oral antibiotics (erythromycin 15 mg/kg/dose and neomycin 30 mg/kg/dose or metronidazole 7 mg/kg/dose, up to adult

dose) are still given by some surgeons, particularly for older children and adolescents, as is distal tap water or 1 % neomycin enemas. Appropriate perioperative intravenous antibiotics are always used in every age group, prior to incision and for up to 24 h postoperatively. Preoperative contrast studies of the distal bowel (distal loopogram) are generally indicated prior to elective closure of enterostomies, especially in the setting of previous NEC, ischemia, volvulus, and atresia due to the risk of distal stricture **(6).**

Operative Technique

The surgical technique for stoma closure involves a series of precise steps to ensure the effective management of the bowel and surrounding tissues. The procedure begins with a transverse elliptic skin incision around the stoma, carefully made using a scalpel. The incision is placed all around the mucocutaneous junction, maintaining a 1–2 mm distance and extending 1 cm on either side. Electrocautery is employed to control bleeding from the skin. Following this, lateral skin tongues are elevated using Kocher or Allis clamps, and the enterostomy nipple may also be gently lifted with a Babcock clamp **(7).**

As the incision deepens, fine scissors are introduced upon reaching the seromuscular layer of the bowel. The bowel wall is meticulously separated from the subcutaneous fat using sharp dissection, ensuring no damage occurs to the bowel wall. The dissection proceeds down to the anterior rectus fascia, where the bowel meets **(8).**

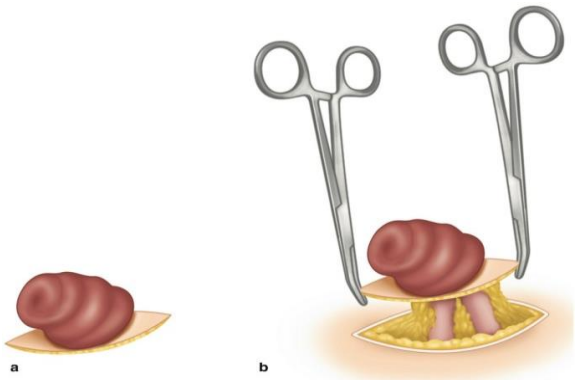

Fig (1): a) Transverse elliptic skin incision around the stoma. (b) Sharp dissection to separate the bowel from subcutaneous fat and fascial dissection down to the peritoneal cavity **(9).**

The fascial dissection requires careful and patient handling due to potential anatomical distortions. In some cases, a hernia sac may obscure the fascia. The dissection follows the bowel wall circumferentially, detaching it from the fascial ring and muscle layer until the peritoneal cavity is accessed. If the bowel is sutured to the fascia, the fascia may be incised to release the bowel. Once the peritoneal cavity is identified, an index finger is used to explore for adhesions, avoiding blunt finger dissection to prevent inadvertent bowel injury **(10).**

Peritoneal dissection continues with the finger to gently separate adhesions from the peritoneum. If difficulty arises, lateral extension of the incision may be necessary for improved exposure **(11).**

The stapled resection and anastomosis of the enterostomy are widely practiced, particularly when the bowel loop can be easily exteriorized. This technique effectively removes any segment with questionable bowel quality. The resection involves dividing the mesentery between the identified proximal and distal sides using clamping/ligating methods or advanced energy devices. Typically, the resection and reanastomosis are achieved with two loads of a linear stapler. A small enterotomy is created on either side in the anti-mesenteric position (Fig. 2a), and the stapler jaws are aligned to ensure the bowel loops are correctly positioned (Fig. 2 b, c). Care is taken to avoid trapping the mesentery in the stapler (Fig. 3). The stapler is fired, and a reload is obtained to grasp the ends of the enterotomy, closing off the end while simultaneously resecting the bowel (Fig. 4a, b) **(12).**

In some cases, surgeons may prefer a stapled isoperistaltic side-to-side anastomosis, manually closing the enterotomy site with absorbable sutures in two layers. This approach offers an alternative method for managing the resection and anastomosis, providing flexibility based on the specific intraoperative findings **(13).**

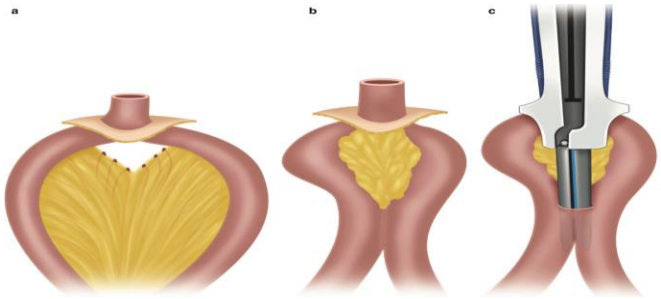

Fig (2): (a) Creation of small enterotomy in anti-mesenteric position. (b, c) Alignment of bowel loops with stapler jaws **(9).**

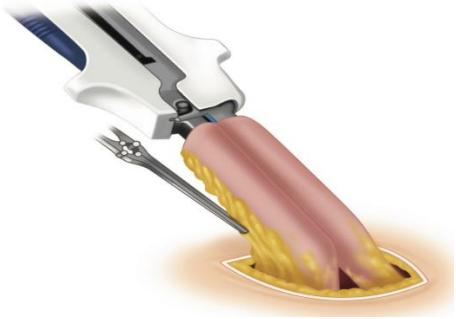

Fig (3): Careful positioning of the stapler to avoid trapping the mesentery **(9).**

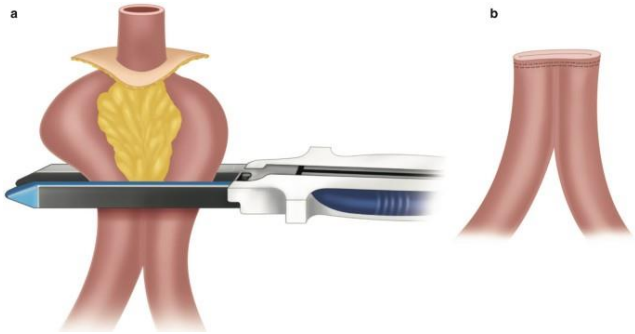

Fig (4): (a) Firing the second stapler cartridge. (b) Simultaneous resection of the bowel and closure of the end **(9).**

Particularly if the bowel mobility is limited, surgeon may be better served by doing a hand-sewn anastomosis. surgeon can either do this by means of a limited resection of the bowel and an end-to-end handsewn anastomosis in two layers, using a running absorbable suture such as a 3-0 PDS and interrupted Vicryl sutures. If difficult circumstances do not even permit such a limited resection, surgeon may elect to undo the nipple by carefully freeing the adhesions between the everted part and the inside layer **(14).**

Place two holding stitches on either end. Close the defect transversely in two layers. In contrast to a wide-lumen enterostomy takedown, there is not usually sufficient space to close that transverse enterotomy opening with staplers **(15).**

Closure of Abdominal Wall

Reduce the bowel into the abdominal cavity. Irrigate out the wound copiously with saline. Remove residual hernia sac and dissect the subcutaneous fat off the anterior wall of the fascia. Reapproximate the muscle layer with a few interrupted Vicryl stitches. Close the fascia with a running absorbable monofilament suture (e.g., PDS #1). Once the fascia is closed, irrigate out the wound with additional saline solution and skin is closed with subcutaneous drain **(16).**

Postoperative management

Most commonly, the enterotomy wound can be closed without enlarging the skin incision. Closing of the wound is associated with a 20–25% incidence of wound infection. Many surgeons therefore leave the skin open for healing by secondary intention. Since 75–80% do not get infected, surgeon might consider closing it and only open it if signs of infection develop. Additional methods include placing a dermal purse string suture with 3-0 monocryl throughout the circumference of the wound. Clinch the purse string down to contract the skin edges and loosely pack gauze within the opening of the wound. In any open wound scenario, surgeon would manage the wound by placing loosely packed moist gauze into the subcutaneous space to keep the tissue separated **(17).**

Placement of nasogastric tube is not routine, but may be necessary in patient who develop a profound ileus with nausea and vomiting. Daily wound care to wound bed. Educate the patient on proper wound care and packing techniques **(18).**

Complications of enterostomy closure

The complication rates post-closure vary widely, with some studies reporting frequencies between 10% and 32.6%. The timing of closure whether early or late—has been debated, with no clear consensus on the optimal approach to minimize complications **(19).**

The closure of an enterostomy can also be fraught with complications, including **(20):**

- **Anastomotic Leakage**: AL is defined as leaking of intestinal content into the peritoneal cavity through an anastomotic defect. Consequently, colonic bacteria such as Escherichia coli and Enterococcus faecalis spread throughout the peritoneal cavity causing peritonitis leading to sepsis and mortality **(21)**. Anastomotic leak is the most feared early complication of intestinal anastomosis. Any systemic or local factor that causes delay in the transition from the inflammatory phase to the fibroplasia phase can result in poor healing and AL **(22)**

Systemic conditions that increase the risk of AL are anemia, malnutrition with hypoalbuminemia, vitamin deficiencies, and steroid therapy. Local factors such as inadequate blood flow are associated with poor healing and AL .

Anastomotic leak presenting on POD 1 or 2 is invariably due to technical reasons. AL secondary to interference in the normal healing mechanism usually presents around the end of the first postoperative week. AL can present either as diffuse peritonitis when the leak is uncontrolled or as localized intra-abdominal collection/abscess if the leak is controlled. An uncontrolled leak with diffuse peritonitis is associated with high morbidity and mortality and requires re-exploration. During relaparotomy, a thorough lavage of the peritoneal cavity should be carried out. In most circumstances, it is better to bring the bowel loops as stoma. A controlled leak presenting with a localized intra-abdominal abscess can be managed conservatively with percutaneous drainage of the abscess under imaging guidance and antibiotics **(23).**

- **Bowel Obstruction**: Blockage at or near the site of the anastomosis by adhesions or leakage or not perfect anastomosis, requiring additional surgical intervention **(24).**

- **Wound Infection**: The most common postoperative complication. Rates of wound infection are higher with open surgeries being 10–15%. Perioperative administration of antibiotic agents reduces the rates of wound infection. It can lead to serious conditions such as wound dehiscence **(25**).

- **Incisional hernia**, including parastomal hernia, is a recognized complication following enterostomy closure. It occurs due to weakness of the abdominal wall at the site of the previous stoma or surgical incision. The reported incidence of incisional hernia after stoma closure varies between 7–25% in pediatric and adult series, depending on patient-related and technical factors **(26)**. Risk factors include poor nutritional status, wound infection, obesity, immunosuppression, and inadequate fascial closure **(27)**. In children, rapid growth and the presence of congenital abdominal wall weakness may further predispose to hernia formation **(28)**.

Clinically, patients present with a bulge at the stoma closure site, which may increase in size on straining. While many hernias remain asymptomatic, complications such as bowel obstruction, pain, and, rarely, strangulation may occur, necessitating surgical repair. Preventive measures include meticulous fascial closure with slowly absorbable or non-absorbable sutures (e.g., PDS), reinforcement with mesh in selected high-risk cases, and optimization of nutritional and infection status preoperatively **(29)**.

- **Bleeding**

This is common in patients with sepsis and deranged coagulopathy. It may manifest in the immediate postoperative period as either melena or bleeding from an intra-abdominal drain **(30)**

Patients with bleeding should be aggressively managed with correction of coagulopathy (if present) and blood transfusion.

If the bleeding results in hemodynamic instability with a significant decrease in hemoglobin, urgent re-exploration should be performed. Intraoperative anastomotic site bleeding is characterized by blood in the intestinal lumen distal to the anastomosis. In such circumstances, the anterior layer of the sutures is opened and both layers are examined for evidence of any bleeding. Once the bleeding site is identified, it can be controlled by hemostatic sutures. The decision to reanastomose or convert into stoma depends upon the general condition of the patient. Conversion to stoma is preferred in patients with hemodynamic instability **(30).**

- **Anastomotic Stricture**

It is a late complication of intestinal anastomosis. The risk is marginally increased after end-to-end anastomosis, especially when performed using a stapled technique **(31).**

Wound dehiscence

It is the partial or complete separation of the layers of a surgical incision after enterostomy closure. This condition can range from superficial separation of the skin to more severe full-thickness separation involving the underlying tissues.

Pathophysiology

It occurs when the layers of a surgical wound fail to heal properly, leading to partial or complete separation. This condition poses a heightened risk for infection, as the open wound becomes vulnerable to bacterial infiltration. The risk of infection can be localized, affecting the wound site, or systemic, potentially leading to more severe complications such as sepsis. Factors contributing to wound dehiscence include inadequate wound closure techniques, increased intra-abdominal pressure, patient comorbidities, and poor nutritional status **(32).**

In the pediatric population, the incidence of wound dehiscence following enterostomy closure varies. Reported frequencies range from 0% to 12.5%, reflecting variability in patient populations, surgical techniques, and postoperative care practices. Complications associated with wound dehiscence can be diverse and include **(33):**

Causes (34):

- **Infection**: Bacterial infections can compromise the integrity of the wound, leading to dehiscence.
- **Inadequate Wound Healing**: Factors like poor nutritional status, diabetes, or corticosteroid use can impair wound healing.

- **Increased Intra-abdominal Pressure**: Conditions such as coughing, vomiting, or straining can put undue pressure on the surgical site.
- **Technical Issues**: Poor surgical technique or inadequate suturing may contribute to the risk of dehiscence.
- **Tension on Wound Edges**: Excessive tension on the wound edges during closure can lead to separation.

Clinical Presentation (35):

- **Superficial Dehiscence (partial)** : Separation of the skin and subcutaneous tissue, often associated with serous or purulent discharge.
- **Deep Dehiscence (complete)** : Involves deeper tissues including fascia and may result in exposure of underlying structures. It may present with significant drainage, pain, and potential protrusion of internal organs.

Diagnosis (36):

- **Clinical Examination**: Visual inspection of the wound and palpation to assess depth and extent of separation.
- **Imaging**: Ultrasound or CT scans may be used to evaluate the extent of dehiscence and rule out underlying abscesses or other complications.

Management and Prevention

Effective management of wound dehiscence is achieved through a combination of preventive measures and therapeutic interventions **(37).**

Preoperative Planning:

Patient optimization is prioritized to ensure that individuals are in the best possible condition before surgery. This involves addressing nutritional deficiencies and managing chronic health conditions. A standardized surgical technique is adhered to, which includes meticulous tissue handling, appropriate closure methods, and thorough hemostasis **(38).**

Postoperative Care:

Wound monitoring is conducted regularly to identify signs of dehiscence, infection, or other complications early. This enables timely intervention. Wound management strategies are implemented, including the use of antibiotics and dressings, to support healing and prevent further complications **(38).**

Follow-Up:

Reevaluation visits are performed to monitor wound healing and address any issues promptly. This may involve additional surgical interventions if necessary **(39).**

References:

1. Al-Salem AH. Complications of enterostomy in infants and children. Saudi Med J. 2007;28:157–60.
2. Banieghbal B. Early closure of ostomies in infants: a systematic review. Pediatr Surg Int. 2009;25:511–8.
3. Hall NJ, Drewett M, Wheeler RA, Curry JI. Stoma closure in infants: timing of closure and outcomes. Pediatr Surg Int. 2011;27:1001–4.
4. Soldes, O. S. J. F. o. P. S. S. E. (2017). Ileostomy and colostomy. 479-485.
5. Santos-Jasso, K. A., Lezama-Del Valle, P., Arredondo-Garcia, J. L., García-De la Puente, S., & Martinez-Garcia, M. C. J. J. o. P. S. (2020). Efficacy and safety of an abbreviated perioperative care bundle versus standard perioperative care in children undergoing elective bowel anastomoses: A randomized, noninferiority trial. 55(10), 2042-2047.

6. Bianchini, S., Rigotti, E., Monaco, S., Nicoletti, L., Auriti, C., Castagnola, E., . . . La Grutta, S. J. A. (2022). Surgical antimicrobial prophylaxis in abdominal surgery for neonates and paediatrics: A RAND/UCLA Appropriateness Method Consensus Study. 11(2), 279.
7. Peltrini, R., Imperatore, N., Altieri, G., Castiglioni, S., Di Nuzzo, M. M., Grimaldi, L., . . . Corcione, F. J. H. (2021). Prevention of incisional hernia at the site of stoma closure with different reinforcing mesh types: a systematic review and meta-analysis. 25, 639-648.
8. Pine, J., Stevenson, L., & On, J. J. S. (2023). Intestinal stomas. 41(1), 55-61.
9. Duldulao, M. P., & Kaiser, A. M. (2022). Closure of Loop Ileostomy. In Chassin's Operative Strategy in General Surgery: An Expositive Atlas (pp. 381-385): Springer.
10. MARTIN-DEL-CAMPO, L. A. J. A. o. R. G. S. E.-B. (2021). Clinical Anatomy and Physiology of the Abdominal Wall. 23.
11. Podder, A. R., Seshadri, J. G., Podder, A. R., & Seshadri, J. G. J. A. o. D. G. S. (2020). Anatomy: How to Locate Vital Structures in Pelvis. 11-67.
12. Zenger, S., Gurbuz, B., Can, U., Balik, E., Yalti, T., & Bugra, D. J. L. s. A. o. S. (2021). Comparative study between ghost ileostomy and defunctioning ileostomy in terms of morbidity and cost-effectiveness in low anterior resection for rectal cancer. 406, 339-347.
13. Steger, J., Jell, A., Ficht, S., Ostler, D., Eblenkamp, M., Mela, P., . . . Management, C. R. (2022). Systematic review and meta-analysis on colorectal anastomotic techniques. 523-539.
14. Taher, M., Elshafiey, M., Refaat, A., Nasr, E., & Ahmed, G. (2025). Isoperistaltic hand-sewn side-to-side bowel primary anastomosis: a safe approach after bowel resection in children with neutropenic enterocolitis. Surgery Today, 1-7.
15. Man, J., Hrabe, J. J. C. i. c., & surgery, r. (2021). Anastomotic Technique—How to Optimize Success and Minimize Leak Rates. 34(06), 371-378.
16. FERRETS, P. C. I. J. F., Rabbits, Rodents-E-Book: Ferrets, R., & Rodents-E-Book. (2020). Soft Tissue Surgery: Ferrets. 432.
17. Carrano, F. M., Maroli, A., Carvello, M., Foppa, C., Sacchi, M., Crippa, J., . . . Ben David, N. J. B. o. (2021). Negative-pressure wound therapy after stoma reversal in colorectal surgery: a randomized controlled trial. 5(6), zrab116.
18. Alemdar, A., & Yeşiltaş, M. J. T. E. R. J. (2023). Routine postoperative nasogastric or nasojejunal tube placement may be unnecessary after gastric resection. 1-6.
19. Collaborative, D. C. R., Chambers, A., Stearns, A., Walsh, A., Rankin, A., Khan, A., . . . Shaw, A. J. C. D. (2021). Factors impacting time to ileostomy closure after anterior resection: the UK closure of ileostomy timing cohort study (CLOSE-IT). 23(5), 1109-1119.
20. Cauley, C. E., Kalady, M. F. J. C. i. C., & Surgery, R. (2021). Special considerations of anastomotic leak in patients with rectal Cancer. 34(06), 426-430.
21. **Komen N, Morsink MC, Beiboer S, Miggelbrink A, Willemsen P, van der Harst E, Lange JF, van Leeuwen WB.** Detection of colon flora in peritoneal drain fluid after colorectal surgery: can RT-PCR play a role in diagnosing anastomotic leakage?. Journal of microbiological methods. 2009 Oct 1;79(1):67-70.
22. **Ashkanani F, Krukowski ZH.** Intestinal anastomosis. Surgery (Oxford). 2002 May 1;20(5):104-7.
23. **Phitayakorn R, Delaney CP, Reynolds HL, et al.** Standardized algorithms for management of anastomotic leaks and related abdominal and pelvic abscesses after colorectal surgery. World J Surg. 2008;32(6):1147–1156
24. Burke, J. R. (2024). The Evaluation of Colorectal Anastomotic Leak and Novel Prevention Strategies (Doctoral dissertation, University of Leeds).
25. Tsalikidis C, Mitsala A, Mentonis VI, Romanidis K, Pappas-Gogos G, Tsaroucha AK, Pitiakoudis M. Predictive factors for anastomotic leakage following colorectal cancer surgery: where are we and where are we going?. Current Oncology. 2023 Mar 7;30(3):3111-37.

26. Liu DS, Banham E, Yellapu S. Prophylactic mesh reinforcement reduces stomal site incisional hernia after ileostomy closure. *World J Surg* (2013) 37(9):2039–45.
27. Henriksen NA, Helgstrand F, Vogt KC, Jorgensen LN, Bisgaard T; Danish Hernia Database; Danish Vascular Registry. Risk factors for incisional hernia repair after aortic reconstructive surgery in a nationwide study. J Vasc Surg. 2013;57(6):1524-1530.e1-3.
28. Wang L, Qu L, Lin S, Yang Q, Zhang X, Jin L, Dong H, Sun D. Biological functions and applications of antimicrobial peptides. Current Protein and Peptide Science. 2022 Apr 1;23(4):226-47.
29. Deerenberg EB, Henriksen NA, Antoniou SA, et al. Updated guideline for closure of abdominal wall incisions from the European and American Hernia Societies. Br J Surg. 2022;109(12):1239-1250. doi:10.1093/bjs/znac302
30. Zafar SN, Kiran RP. Diagnosis and treatment of postoperative bleeding in patients undergoing abdominal surgery. J Gastrointest Oncol. 2023;14(1):57-68.
31. Bannura GC, Cumsille MA, Barrera AE, Contreras JP, Melo CL, Soto DC. Predictive factors of stenosis after stapled colorectal anastomosis: prospective analysis of 179 consecutive patients. World journal of surgery. 2004 Sep;28(9):921-5.
32. Parada, L., & Mangelsdorff, G. (2022). Care and Management of Surgical Wounds, Wounds Dehiscence, and Scars. In Foot and Ankle Disorders: A Comprehensive Approach in Pediatric and Adult Populations (pp. 89-111): Springer.
33. Kumata, Y., Ishii, D., Ishii, S., Motoki, K., Ueno, N., Hinooka, R., & Miyagi, H. J. S. C. R. (2024). A case series of prophylactic negative pressure wound therapy use with purse-string closure in stoma closure wounds in infants. 10(1), 20.
34. Grada, A., & Phillips, T. J. J. C. i. D. (2022). Nutrition and cutaneous wound healing. 40(2), 103-113.
35. Okeahialam, N. A., Thakar, R., & Sultan, A. H. (2024). Perineal and Anal Sphincter Wound Healing Complications. In Pelvic Floor, Perineal, and Anal Sphincter Trauma During Childbirth: Diagnosis, Management and Prevention (pp. 135-160): Springer.
36. Dover, A. R., Innes, J. A., & Fairhurst, K. (2023). Macleod's Clinical Examination-E-Book: Macleod's Clinical Examination-E-Book: Elsevier Health Sciences.
37. Sandy-Hodgetts, K., Assadian, O., Wainwright, T. W., Rochon, M., Van Der Merwe, Z., Jones, R. M., . . . Smith, G. J. J. o. w. c. (2023). Clinical prediction models and risk tools for early detection of patients at risk of surgical site infection and surgical wound dehiscence: a scoping review. 32(Sup8a), S4-S12.
38. Sandy-Hodgetts, K., Alves, P., Conway, B., Djohan, R., Idensohn, P., McIsaac, C., . . . Romanelli, M. (2022). Optimising prevention of surgical wound complications: Detection, diagnosis and prediction.
39. Eriksson, E., Liu, P. Y., Schultz, G. S., Martins-Green, M. M., Tanaka, R., Weir, D., . . . regeneration. (2022). Chronic wounds: Treatment consensus. 30(2), 156-171.