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Examination of fecal electrolyte on pediatric patient with intestinal stoma

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Abstract: Intestinal stomas are increasingly performed in pediatric patients to manage various gastrointestinal conditions, such as congenital malformation of intestinal, necrotizing enterocolitis and intestinal obstruction, which are frequently occured in developing countries with Low-Middle Income Country (LMIC). However, the presence of a stoma has possibility of morbidity such as can significantly affect the body's fluid and electrolyte balance, particularly in infant and under five years old children. This risk is increased due to the immature renal system in pediatric patients, increased loss of fluids and electrolytes through stoma output, especially small intestinal stoma. In addition to being a challenge in the management of infants and children with stomas and intestinal resections, electrolyte imbalances are one of the factors contributing to morbidity and mortality in these group. Early detection of abnormalities can guide timely interventions such as fluid replacement therapy and dietary modifications, prevent complications like dehydration, metabolic acidosis or electrolyte disturbances. Measuring fecal electrolyte provide valuable insights into the patient's hydration status and potential electrolyte imbalances. Since the fecal sample measuring is the simplest, harmless and noninvasive than the other electrolyte tests, so it can be considered for pediatric patients.

Keywords: *Fecal electrolyte, High output stoma, Intestinal stoma, Pediatric, Resection.*

1. Introduction

Intestinal stoma is defined as a temporary or permanent opening of the intestinal tract. Most of the purposes of making this channel are for the diversion of fecal flow, decompression and can even be used as an alternative route for feeding. Most cases in children and infants are related to congenital malformation of the intestine, making a stoma is often only part of the management stages of acquired congenital abnormalities[1–3]. Creation of stoma, anastomosis and resection of the intestine will lead to a reduction in the absorptive area and disruption of the normal flora of intestinal[4].

Patients with intestinal stoma face significant risks of dehydration and electrolyte abnormalities due to altered intestinal physiology, loss of absorptive surface and increased stoma output related to changes in intestinal motility[5,6]. This altered physiology and potential for complications underscores the importance of careful monitoring and management in patients with intestinal stomas, particularly in pediatric populations where growth and development are crucial concerns. While electrolyte loss via the skin, kidneys, and gastrointestinal system has been extensively researched, there is a paucity of studies regarding electrolyte excretion by artificial means, such as gastrointestinal stomas. There for this review will focus on fecal electrolyte measured from intestinal stoma.

2. Changes in Intestinal Function following Intestinal Stoma Formation

Changes in intestinal function following intestinal stoma formation are significant and multifaceted. The formation of a stoma, particularly in the small intestine, can lead to substantial alterations in fluid and electrolyte balance. In the typical digestive process, the majority of nutrient absorption occurs in

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the initial portion of the small intestine, with approximately 9-10 L of endogenous fluid entering the digestive tract daily in adults[5].

When a stoma is formed, especially in the jejunum or ileum, it can disrupt the normal absorption processes. This disruption can result in increased fluid loss and electrolyte imbalances. The ileostomy effluent, for instance, is nearly isotonic with normal saline and contains a high concentration of sodium (approximately 120 mmol/L). Daily sodium loss through an ileostomy can be significantly higher (around 60 mEq) compared to normal fecal sodium loss (2-10 mEq) in individuals without a stoma[5,7].

The colon, which normally plays a crucial role in water absorption and fecal consistency regulation, is bypassed in cases of ileostomy. This bypass can lead to increased water loss and potentially dehydration if not properly managed. Additionally, the colon's function in absorbing certain vitamins (such as vitamin K and B12) and its role in hosting beneficial bacteria are compromised when it is bypassed. Furthermore, the alteration in gastrointestinal transit time can affect nutrient absorption and overall digestive function. The colon typically has the slowest transit time in the gastrointestinal tract, ranging from 24 to 150 hours depending on dietary factors. When this part of the digestive system is bypassed, it can lead to shorten transit times and potentially reduced nutrient absorption[5].

These changes in intestinal function following stoma formation necessitate careful management and monitoring of fluid and electrolyte balance, nutritional status, and overall health in patients with intestinal stomas

2.1. Changes of Microbiota and Normal Intestinal Flora

Gut microbiota is in transition in early life and easily disrupted and can result in long-term alteration by diet, antibiotic exposure and Short Bowel Syndrome (SBS) caused by massive intestinal resection[8].

In infants undergoing stoma creation and intestinal resection frequently exposed to prolonged antibiotic therapy, restricted enteral intake, exposed parenteral nutrition and alteration to their intestinal anatomy resulting in some degree of intestinal dilation over time which can predispose to microbial dysbiosis and infection[8,9].

Microbiota diversity at the distal of colorectum is high and certain bacteria are present in higher abundance that on patient with stoma will reduce the fecal transit to that location. Furthermore, most fecal stoma had soft stools caused by changes of microbiota and taxonomic diversity attributed to decreased of fecal consistency and shorter fecal transition period in the side colonic region. The heavy and solid consistency of fecal, based on bristol scale, were highly correlated with fecal bacteria richness, *Akkermansia* and *Methanobrevibacter*[10]. Studies conducted by Sakai, 2016 found that obligate anaerobes were low in patients with stomas. The same studies found an increase in aerobic bacteria such as *Enterococcus*, *Pseudomonas*, and *Acinetobacter* in patients with a stoma. These bacteria are responsible for the gene functions related to xenobiotics and can cause wound and suppurative infections[11].

2.2. Changes the Intestinal Peristaltic

Contractions of the digestive tract are mediated by muscle fibers that are electrically connected to each other through gap junctions and cause ion movement from one muscle cell to another. In addition, it is also equipped with an enteric nervous system that functions to regulate gastrointestinal movement and secretion located throughout the walls of the digestive tract[12].

There is a change in intestinal motility after stoma formation and intestinal resection becomes hyperperistaltic as compensation for the reduced length of the intestine and is an adaptive response of the intestine to increase the absorption of nutrients remaining in the digestive tract. Massive intestinal resection causes SBS, which shortens transit time and causes diarrhea and malabsorption[5].

3. Factors that Affect Electrolyte Abnormalities

Electrolyte abnormalities can be influenced by various factors before, during and after surgery.

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3.1. Before Surgery

Malnourished children are particularly susceptible to electrolyte imbalances, making nutritional status assessment crucial. Extended fasting periods during preoperative and early postoperative phases, especially in gastrointestinal surgeries, can also contribute to electrolyte disturbances[13,14]

3.2. On Surgery

The location of the stoma and the length of the intestinal resection performed can predict the potential complications that occur. Short bowel syndrome (SBS) resulting from massive intestinal resection causes loss of absorption surface area so that the digestion and absorption of nutrients process are inadequate and the patient is at risk of experiencing malnutrition [5,15,16].

3.3. Post-Surgery

Infections can exacerbate electrolyte loss. For instance, studies have shown that patients with cholera infection exhibit higher sodium levels compared to those with other infections such as *rotavirus*, *klebsiella*, *salmonella*, EPEC, and *shigella*. Additionally, sodium fecal loss in well-nourished children or those with milder forms of Protein Energy Malnutrition (PEM) can be considerable in both cholera and non-cholera cases, further affecting electrolyte balance.[17].

4. Fecal Electrolyte Affects Electrolyte Abnormalities

Numerous organs are involved in electrolyte excretion, but the kidneys are the primary organ responsible for maintaining the body's electrolyte balance and eliminating it through urine[12]. Electrolytes are eliminated through the gastrointestinal tract, particularly in cases of malabsorption or diarrhea if absorption is imperfect. Electrolyte excretion through intestinal stoma, especially located above the colon, is electrolyte that are not absorbed by gastrointestinal tract. So, this examination should be confirmed with clinical condition or examination of blood electrolyte.

5. Indications for Fecal Electrolyte Examination

Fecal electrolyte examination is infrequently perfomed; nonetheless, quantifying electrolytes and osmolality in liquid stool samples can distinguish between osmotic and secretory aetiologies of chronic diarrhoea[17]. This examination useful and valuable as diagnostic tools in evaluating condition related to chronic chronic diarrhea, malabsorption condition, SBS and gastrointestinal disorders where there is a loss of fluids and electrolytes. Patients with high output stoma (HOS) often have significant losses of electrolytes like sodium, potassium, and bicarbonate. A fecal electrolyte examination can help quantify these losses and guide fluid and electrolyte replacement therapy[18].

6. Diagnostic Methods and Techniques

Electrolyte examination can be performed on all physiological body fluids where the cations and anions commonly examined are sodium, potassium, chloride, calcium and magnesium. The examination method used is flame photometry or ion selective electrodes[19]. The flame emission photometer, which quantifies light released by excited atoms, was extensively employed to ascertain the concentrations of sodium, potassium and Lithium. Due to the advancement of ion-selective electrodes (ISE) for these analytes, flame photometers are no longer commonly utilized in clinical chemistry laboratories[20]. An ion-selective electrode (ISE) functions as an electrochemical transducer that is designed to respond to a particular ion with precision. An ion-selective electrode exhibits a high degree of sensitivity and selectivity for the specific ion it is designed to measure. A membrane or another type of barrier is utilized to separate a reference solution and a reference electrode from the solution that is subject to analysis[21].

This examination is simple, requiring only the collection of a stool sample in a tube without any special treatment or addition of other substances. Preparation of fecal electrolyte examination samples is quite challenging. The laboratory analyst must ensure that there is no fecal debris by centrifuging, because it can cause blockage in the examination tool[18]. This examination is rarely performed due to the device's vulnerability to obstructions.

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Investigations into fecal electrolyte levels in pediatric patients with intestinal stomas remain infrequent. Establishing normal values is challenging due to the numerous complications in pediatric patients with stomas.

7. Conclusion

The formation of intestinal stoma is often part of the management stage of abdominal congenital abnormalities that often occur in infants and children. The stoma procedure is often accompanied by resection of necrotic tissue which will result in the loss of the absorptive area in the digestive tract.

Electrolyte imbalances frequently occur in pediatric patients with intestinal stomas and can lead to life-threatening conditions. Invasive and repeated blood electrolyte tests can cause pain, trauma, and even infection on pediatric patients. There is another alternative with minimal complications is examination of fecal electrolyte. Fecal electrolyte examination can determine complications that occur in patients with intestinal stoma. This non-invasive examination aims to identifying electrolyte loss, monitoring therapy results can also diagnose the cause of excessive fecal output and detect malabsorption of nutrient absorption disorders that occur.

Studies on fecal electrolyte examination in patients with intestinal stoma is rarely conducted and need for further studies to optimize management strategies and improve patient outcome especially in pediatric patients developing countries with LMIC.

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Abbreviations

EPEC	: Enteropathogen Eschericia coli
HOS	: High Output Stoma
h	: hour
ISE	: Ion Selective Electrodes
L	: liter
LMIC	: Low-Middle Income Country
mEq	: milliequivalent
mmol/L	: millimole per liter
PEM	: Protein Energy Malabsorption
SBS	: Short Bowel Syndrome

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