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Different types of anastomotic methods: a review of literature

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ABSTRACT

Constructing successful anastomosis is an important concept in gastrointestinal tract surgeries, which can be affected by various factors such as preoperative bowel condition, intra- and postoperative complications, bleeding and the device characteristics. Suturing, stapling and compression anastomosis are different techniques. Despite the invention of compression anastomosis, which goes back almost two centuries, this method has not obtained the popularity of the suturing and stapling anastomosis and further studies are required. Designing methods and devices with no drawbacks might reduce the complications associated with anastomosis as the alternative to suturing and stapling anastomoses. Several materials can be used as reinforcement materials, which can improve the consequences of the stapled anastomosis. In addition to reinforcement materials, other forms of supports have been proposed, which might be capable of reducing the postoperative complications of anastomosis. In this study, we briefly review various types of anastomotic techniques and associated complications in different types of gastrointestinal surgeries.

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Introduction

Construction of successful anastomosis is a major part of some types of surgeries such as colorectal surgeries. Various complications can be associated with anastomosis after the surgeries including bleeding, leakage and stricture, which can increase the postoperative morbidity and mortality rate (1). In this regard, different techniques of anastomosis have been proposed to improve the surgical outcomes and to decrease the following adverse effects.

These anastomotic methods and devices are invented with the purpose of being used in various surgical procedures on digestive tract such as upper and lower gastrointestinal tracts, side to end, end to end anastomoses, etc. Despite several methods of anastomosis, the consistently safe strategy is required. To date, three methods commonly used for anastomosis are proposed including hand sewn, stapling and compression.

In this study, we briefly discuss the importance of successful anastomosis and introduce various devices invented for improving this process.

Literature review

Anastomosis

Comprehensive understanding of the mechanism of healing anastomosis (connecting two luminal structures) and different associated complications is beneficial for improving the applied methods to achieve more successful gastrointes-

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tinal anastomosis and to reduce the incidence of complications and dehiscence.

Variety of factors affect the successful anastomosis specifically at the first postoperative days, such as surgical approach, nutritional condition, medical application, infection, suture or staple holding ability, etc. Due to the specific properties of the hidden anastomosis area (existence of aerobic and anaerobic bacteria and the shear stress of the wound environment) various difficulties might occur during wound healing process of the anastomotic area (2,3).

The process of the healing anastomosis consists of a coordinated cellular and molecular communications, which can be divided into three different phases including lag phase (acute inflammatory phase), proliferation phase and eventually remodeling phase.

Collagen is known as the major component involved in anastomosis healing through increasing and preserving the intestinal wall stability and strength by its synthesis and crosslinking with fibers. Based on the previous articles, collagens type I, type III and type V are the major components of submucosa layer, which provide a great tensile strength of gastrointestinal system (4,5).

Despite the effect of metalloproteinase (MMP) enzymes on degenerating collagens in the initial postoperative hours or days, collagen synthesis will continue until five or six days after the operation. According to experimental studies on rats, MMP are proposed as risk factors of anastomosis dehiscence especially on the first postoperative days until the synthesis of collagen increases (6).

Bursting pressure was evaluated as a mechanical marker in vitro on rat models, which revealed increased anastomosis stability to intraluminal pressure. It is suggested that this pressure will increase immediately after the surgery and continues until postoperative day 7. In this regard, bursting pressure will reach to 100% on postoperative day 7 (7).

Anastomotic techniques

Various materials have been proposed for suturing and stapling and have been used for creating the anastomosis such as catgut, stainless still, absorbable sutures and stapling devices.

Late in 19th century, Billroth and colleague conducted the first successful manual anastomosis in intestinal surgery. The idea of using stapling devices increased since 1908 that Humer Hültl introduced the first stapling device (8). Hand sewning and stapling are two mostly used techniques for anastomosis with similar safety and effectiveness regarding the mortality rate, anastomosis dehiscence and the consequent infection. Despite the comparable function and the efficacy of these two methods and no superiority of stapling over suturing, stapling is not routinely applied in intraperitoneal colorectal surgeries because of higher incidence of stricture of colorectal anastomosis location (9,10).

Due to the lack of sufficient multicenter, comprehensive randomized controlled clinical trials and reliable evidence regarding the effectiveness of stapling devices and their superiority over suturing method, application of this method is still under consideration in several types of surgeries (9,11). In one systematic review on the advantageous of stapling over the suturing, it was suggested that the surgeon could choose one technique based on his/her own preference (12).

Since 19th century, the concept of creating a successful anastomosis has been under research. Investigators were interested to design a method that excluded the possibility of leakage following anastomosis. The idea of compression anastomosis has been proposed by Felix-Nicholas Denans, in 1928 (13). Compression anastomosis was based on two opposing rings that trap the ends of transect bowel. Denans has suggested the compression anastomosis concept by applying silver or zinc rings in canine models for constructing end to end anastomosis. Bonnier, in 1885, and Murphy, in 1892, designed the first devices for performing anastomosis, which consisted of 2 metallic rings, which was not effective enough regarding its clinical usage (14,15).

AKA-2 is a not-absorbable device, which was designed for colorectal anastomosis by Kanschin in 1984, and would be expelled from the body after 6 days (16). Valtrac biofragmentable anastomotic ring (BAR) is another device developed by Hardy in 1985 (17), almost one century after Bonnier. Based on various investigations, BAR could be applied in surgeries on different parts of gastrointestinal tracts and could be used as a reliable alternative to suture and staple methods, due to its different properties such as efficacy, safety, lower mortality rate, rapidity, lack of foreign material presence in body and no stenosis (18-21).

Another device, nickel-titanium with shape memory alloy (SMA), was invented later for compression anastomosis, which is used in clip or ring forms and was expelled from the body almost after seven days (22). Based on several studies, applying this method is associated with lower risk of infection, close to the “no touch” surgery idea. Moreover, it leads to the lower expenses compared with staples (23,24). According to FDA, compression anastomosis clip (CAC) is safe in experimental and clinical surveys of intestinal anastomosis.

Endoluminal compression anastomotic ring (En-

doCAR) is another type of nickel-titanium device, which acts through simultaneous necrosis-healing process and it will be expelled from the body in one week by finishing the healing process (25).

Magnomosis is another method, which constructs a magnetically mediated intestinally anastomosis through an impermanent device with compression necrosis effect.

Despite various types of anastomosis devices designed since almost previous century, these devices did not obtain the importance and reputation of other approaches such as stapling, which has a great efficacy in providing intestinal anastomosis (26).

Several articles have compared the efficacy of various anastomosis methods to reveal the most effective one, which should be easily performed, powerful and operator independent.

Majority of articles clinically evaluated the efficacy of devices for compression anastomosis creation, studied BAR. In these studies, BAR was used for various types of anastomosis in surgeries on different sites of gastrointestinal tract. According to one study, no statistically significant difference was obtained by comparing BAR with stapled anastomosis regarding the surgery time interval, blood loss during the operation and postoperative difficulties (27-29). In another study, no statistically significant difference was reported between BAR and sutured anastomosis regarding the postoperative complication incidence aw well (28). It has been proposed that BAR can be applied safely in emergency conditions and high risk colorectal surgeries compared with sutured and stapled ones.

In the study of Wullstein et al., the efficacy of AKA-2 was evaluated regarding the reduction of mortality and morbidity occurrence rate due to the leakage side effect. Based on their results, anastomosis AKA-2 could be applied in distal colon and rectal resection (30). There are only limited studies that clinically investigated the efficacy of SMA nickel-titanium anastomosis and the majority of studies have been performed on animals. According to these studies, compression anastomosis clips are safe, beneficial and easy to be used in colon surgeries (31). Kopelman et al. investigated the efficacy of nickel-titanium compression anastomosis rings to provide end to end colorectal anastomosis in animals. They revealed promising results, which should be studied in further investigations (32).

In 2009, Jamshidi et al. invented a magnamosis device consisted of 2 neodymium-iron-boron magnets affixed to polytetrafluoroethylene moldings and evaluated its efficacy in an experimental study. According to their findings, no sign of leakage was observed and magnetic anastomosis resulted in more strength, earlier patency and no stenosis compared with stapled anastomosis (26).

Bowel preparation

According to some studies, prescribing various regimens for patients, who are the candidates for elective surgeries, will lead to bowel preparation that might be effective in reducing the associated anastomosis complications such as leakage (28,33).

Reinforcement materials

Various reinforcement materials are used for reducing the associated complication of staple devices such as bleeding, leakage, morbidity and mortality. Different types of materials can be used as buttressing materials including non-absorbable materials, semi-absorbable and absorbable ones. According to the conducted studies, reinforcement material has eliminated the bleeding, increased the burst pressure and had a positive influence on tumor recurrence. Despite the promising outcomes of using reinforcement materials, further studies are needed to increase the evidence. We mention several examples of different types of these materials. The ePTFE is one of the non-absorbable reinforcement materials. Bovine pericardium and porcine small intestinal submucosa are two types of semi-absorbable materials. Polyglycolic acid (trimethylene carbonate), cellulose, and knitted calcium alginate are different examples of fully absorbable materials (34-37).

Conclusion

Despite different alternative anastomotic methods to conventional approaches (suturing and stapling), further studies are needed to investigate the efficacy and safety of applying these methods in human. Compression anastomosis has been proposed decades ago but they could not obtain the sufficient popularity. Controlled magnetic anastomosis is a novel technique that should be more accurately considered in the future studies to obtain the reliable evidence in clinical applications. Future studies will provide more information regarding the constructing safe anastomosis, raising bursting pressure and reducing the leakage incidence.

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Conflict of Interest

The authors declare no conflict of interest.

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