

# Methods for closure of appendix stump during laparoscopic appendectomy procedure

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## ABSTRACT

The most frequent abdominal pathology requiring emergent surgery is acute appendicitis. Laparoscopic appendectomy has been performed for the treatment of acute appendicitis since 1983. Closure of the appendix stump is vital to prevent severe postoperative complications. Different methods are described for closure such as stapler, endoloop, titanium clips, non-absorbable polymer clips (hem-o-lok clip), handmade loops, transection by Ligasure or with bipolar cautery. The ideal method should be safe, applicable and cheap. The most appropriate method remains to be controversial. All methods are reported as safe, but some have higher costs, and some prolong the operation. In this article, we reviewed clinical and experimental studies on different methods of stump closure, and we tried to compare the benefit of these methods over others.

**Keywords:** Laparoscopic appendectomy, acute appendicitis, endostapler, endoloop, hand-made loop

## INTRODUCTION

The most common acute abdominal pathology requiring emergency surgery is appendicitis. Open appendectomy is the standard approach for treatment. Semm first defined laparoscopic appendectomy (LA) in 1983 as an alternative approach to open surgery (1). This method has been popularized and recommended as first choice treatment in especially women, the elderly and obese patients (2). Along with reported advantages such as less pain, earlier return to work, better cosmetic results, and shorter hospitalization of LA as compared to open appendectomy, there are negative issues such as high cost, long operation time and the high rate of intra-abdominal abscess (3-5).

One of the most important steps of the appendectomy procedure is closure of the appendix stump. Closure of the appendix stump is important to avoid serious complications such as postoperative fistula, peritonitis, and sepsis (6). This process is done by burying the appendix stump into the cecum or by suture ligating the appendix base without inversion in open surgery. On the other hand in LA, suture tying can be technically challenging or the surgeon may not be sure of its reliability. This situation has led surgeons to seek different alternatives for LA. The ideal method for appendix stump closure should be safe, accessible, technically simple to use and cost effective. This is why various different methods have been defined to close the appendix stump. However, in the literature, it is not clear which method is superior to the others. Studies report that all applied methods are safe. In this article, clinical and experimental studies on different methods to close the appendix stump were investigated and their superiority over each other was evaluated.

Methods that are used to close the stump in LA include staplers, endo-loop, titanium clips, nonabsorbable polymer clips (Hem-o-lock clips), hand-made loops, extracorporeal sliding knot, intracorporeal ligation, Ligasure use or division with bipolar cautery. Studies have reported that all of these methods are safe and feasible.

## Stapler Use

The first publications on the use of stapler in laparoscopic appendectomy were reported in 1990, and this practice became popular thereafter. Staplers allow simultaneous sealing and division of both the mesoappendix and the appendix base. Studies have shown that it is both easy to apply and safe (7, 8). One of the major advantages is its being safe even when the appendix base is inflamed and its diameter is too large (9). However, its advantage over other methods in terms of reliability has not been proven. The most important disadvantage is that it is more expensive than other methods (9, 10).

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### Endoloop

The Endoloop is a commercial product that is commonly used in LA. It can be made of silk or polyglactin, and can be of various thicknesses. Endoloop use has been proposed by several authors due to its safety in closing the appendix stump and its lower cost as compared to staplers (11, 12). While applying the Endoloop, the loop snare that is placed to the appendix base is tightened. Two Endoloops can be placed separately one over another. It provides stump closure in a similar manner to ligation in open appendectomy. Although the operation is prolonged as compared to use of stapler or clips, it is similar to other methods in terms of reliability (13). Endoloop is cheaper than stapler use, but still is costly than some other methods. In order to reduce the cost, a loop similar to the commercially sold Endoloop can be manually prepared. Handmade loops are prepared during surgery and are applied analogous to Endoloop. The cost of this method, which is easy to construct and apply, is significantly lower and can be safely applied (2, 14).

### Clips

Many studies have shown that different kinds of clips can be used safely with low cost. The studies in the literature are mainly on titanium or absorbable polymer (Hem-o-lock) clips. The most important feature of clip application is its ease of use. Thus, it enables reduction in operation time. It has been shown to be as safe as other methods (15-18). Delibegović et al (19) evaluated the effects of Endoloop, stapler and polymer clip applications on foreign body reaction and inflammation in an experimental study on rats, and reported that polymer clips were superior to other methods. The downside of clip use is its not being safe in case of intense inflammation where the diameter of appendix base is wide. Although it is reported that clips may be used up to a 16 mm diameter, the reliability is decreased in cases where the appendix base diameter is over 1 cm (6, 20, 21).

### Suture Knot

Suture closure of the appendix base in LA can be done in a similar manner to open surgery. To do this, a knot can be prepared within the abdomen or prepared extracorporeally and pushed into the abdomen. Intracorporeal tie knot requires more experience than other methods. Studies have shown these methods to be as safe as other methods (17, 22, 23). Ligating the appendix base with sutures is a very cheap method with a disadvantage of prolonging the operation time (17, 23).

### Cauterization or Vessel Sealing Devices

There is less data on the use of vessel sealing devices and cauterization than on staplers, Endoloop, sutures and clips. In a study of 60 patients, Khanna et al (24) reported that the appendix could safely be divided after bipolar coagulation for approximately 90 seconds. Aslan et al. (25) stated that bipolar cautery resulted in better epithelial healing than ligation in an experimental study on rats, and they concluded that it was a reliable method based on tests on burst pressure. However, these results on the use of bipolar cautery are not supported by other studies. Yang et al. (26) reported that the appendix base could be coagulated with Ligasure in LA without using clips or sutures in a similar manner with bipolar cautery. Two

subsequent experimental studies also supported this conclusion. In their experimental study on rats, Elemen et al. (27) showed that dividing the appendix stump with Ligasure alone provided better recovery, less inflammation, less operation time and similar bursting pressure properties as compared to polymer clips. The authors stated that Ligasure use was superior to clips in their experimental model. In an experimental study on rabbits, Sauza et al. (28) also reported that coagulation and division with Ligasure alone resulted in 100% fibrosis of the appendix stump, and that the appendix base can be safely divided after coagulation with Ligasure alone. However, similar to bipolar cautery, other clinical studies on Ligasure were not performed.

### CONCLUSION

Despite many studies, there is no universal agreement on any method. There is no particular method that is recommended in the literature. There are prospective randomized studies with large sample sizes that compared different methods. Stapler use can be considered when the appendix base is extremely inflamed or necrotic. It should be noted that stapler and Endoloop use are more expensive methods as compared to others. Using cheaper alternatives such as ligation with sutures and handmade loops will be more appropriate, due to the particular conditions of our country. In our own practice, we use handmade loops because it is safe, cheap and practical. Although Ligasure and bipolar cauterization are suggested as cheap and easy to use methods, clinical studies on these subjects are very limited. The safety of these methods that is observed in experimental studies must be supported by clinical studies.

In conclusion, evaluation of the literature data showed that all methods have a similar reliability. Therefore, methods that are cheap and easy to apply should be considered as first choice. Nevertheless, the final decision on the method to be used will rely on the surgeon's training and experience, the availability of equipments within that facility, costs and the extent of appendix inflammation.

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