

## Effective Appendix Stump Closure Using the Double-shanked Titanium Ligation Clip (DS Clip): A Case Report

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### ABSTRACT

**Background:** During laparoscopic appendectomy, several methods and devices can be used to close the appendicular stump, such as endoloops, linear staplers, clips, and open purse-string sutures. The Double-shanked Titanium Ligation Clip® (DS clip; B. Braun Aesculap, Tuttlinger, Germany), a new device that can be used to close the appendicular stump, was approved for use in Japan in March 2015. We report a case of effective appendix stump closure using DS clips.

**Case presentation:** An 81-year-old man was admitted to our hospital with complaints of severe pain in the right lower quadrant of the abdomen. Abdominal contrast-enhanced computed tomography showed a thickened appendix (1.7 cm in diameter) with fecal stones, while acute inflammatory signs were visible around the appendix. He was diagnosed with acute appendicitis for which laparoscopic appendectomy was performed with a curative intent. It was difficult to mobilize the cecum because of inflammation, so we attempted to use DS clips instead of linear staplers. A histological examination revealed gangrenous appendicitis. The patient's postoperative course was uneventful and he was discharged 10 days postoperatively. We also used DS clips to close the appendicular stump in 12 other cases. We observed no intra- or postoperative complications and no cases of mortality.

**Conclusion:** The management of an appendicular stump using DS clips during laparoscopic appendectomy was simple, safe, and cost-effective. DS clips may be an alternative method to linear staplers.

**Key words:** Double-shanked Titanium Ligation Clip, laparoscopic appendectomy, acute appendicitis

Appendicitis is the most common cause of surgical abdominal pain in all age groups. Therefore, appendectomy is the most frequent emergency operation<sup>1,21)</sup>. There is some evidence that laparoscopic appendectomy is more efficient and superior than open appendectomy in that it results in a shorter hospital stay, less postoperative pain, and a decreased incidence of surgical site infections<sup>3,8,16)</sup>. However, some studies have indicated that it results in higher surgical costs<sup>5,8,9,14)</sup>. In laparoscopic appendectomy, several methods and devices can be used to close the appendicular stump, such as endoloops, linear staplers, clips, and open purse-string sutures. However, which of these methods is the most effective remains under debate<sup>11,15,20)</sup>. We recommend the use of an open purse-string suture to close the appendicular stump due to its cost-effectiveness and intraperitoneal removal of foreign bodies<sup>13)</sup>. In obese patients or cases of intra-abdominal adhesions, it is difficult to mobilize the cecum, so we often use a linear stapler despite its higher cost.

A new device that can close the appendicular stump,

the Double-shanked Titanium Ligation Clip® (DS clip; B. Braun Aesculap, Tuttlinger, Germany) was approved in March 2015 for use in Japan. This new device is made of pure titanium, a biocompatible implant material that leads to high tissue adaptation as well as a constant and high closing force. The design of the DS clip is characterized by two parallel and interconnected shanks that can prevent clip scissoring. Additionally, a latch at its tip can prevent tissue slippage (Figure 1).

Here we report a case in which we effectively performed appendix stump closure using DS clips.

### CASE PRESENTATION

An 81-year-old man was admitted to our hospital with complaints of severe pain in the right lower quadrant of the abdomen that persisted for >24 hours in October 2015. His medical history included hypertension, alcoholic hepatopathy, and post-distal gastrectomy. Upon admission, tenderness, Blumberg's sign, and involuntary guarding were evident over the right lower quadrant.

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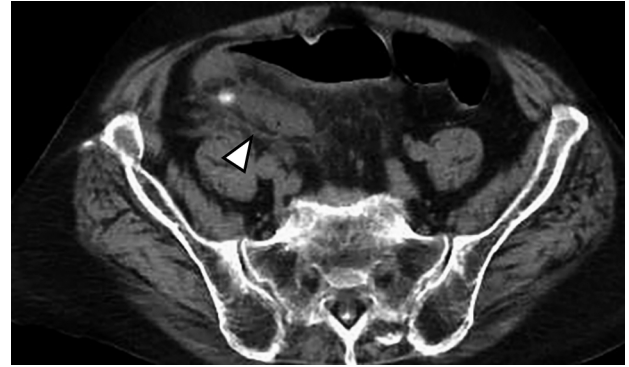


**Figure 1** Double-shanked Titanium Ligation Clip. Picture reprinted with permission from Aesulap AG (Tuttlingen, Germany).

Additionally, the patient was febrile with a temperature of 39°C. Laboratory tests showed the following: C-reactive protein, 21.66 mg/dl (normal range, 0–0.30 mg/dl); and white blood cell count, 14,550/mm<sup>3</sup> (range, 3,300–8,600/mm<sup>3</sup>). Abdominal contrast-enhanced computed tomography (CT) showed a thickened appendix (1.7 cm in diameter) with faecal stones. Acute inflammatory signs were visible around the appendix (Figure 2). Following the diagnosis of acute appendicitis, laparoscopic appendectomy was performed with curative intent. The operation followed a standardized course. A three-trocar approach was used, with a 12.5-mm camera trocar in the umbilicus, a 5-mm trocar in the upper right abdomen, and a 10-mm trocar in the lower left abdomen. Intestinal expansion obstructed a good view of the appendix, the body of which was perforated. It was difficult to mobilize the cecum due to inflammation. We attempted to use a DS clip since the appendix was not fragile. After the mesentery of the appendix was cut with a laparoscopic coagulation shear, a DS clip was placed on the base of the appendix. Another clip was placed on the distal portion (Figure 3). After the area between the clips was severed, the specimen was excised from the abdomen. Macroscopically, the base of the appendicular stump was 16 mm. A histological examination revealed gangrenous appendicitis. The patient's postoperative course was uneventful and he was discharged 10 days postoperatively.

## DISCUSSION

Appendicitis is the most common cause of acute abdominal pain. Between January 2014 and September 2016, 113 patients underwent laparoscopic appendectomy for acute appendicitis at the Chugoku Rousai Hos-



**Figure 2** Abdominal contrast-enhanced computed tomograph showing a thickened appendix (1.7 cm in diameter) with fecal stones and acute inflammatory signs around the appendix (arrowhead).



**Figure 3** Intraoperative view of Double-shanked Titanium Ligation Clips used during laparoscopic appendectomy.

pital, Hiroshima. We often first attempt to use an open purse-string suture to close the appendicular stump. In obese patients or cases of intra-abdominal adhesions, we use a linear stapler instead. Since receiving approval in March 2015 in Japan, DS clips have been selected as an alternative to linear staplers.

It is important to choose the proper device to close the appendicular stump during laparoscopic appendectomy to prevent the occurrence of serious postoperative complications. During laparoscopic appendectomy, several methods and devices are available to close the appendicular stump, such as the endoloop, liner stapler, metal or polymer clips, and open purse-string suture. The best among them, however, remains controversial<sup>11,15,20</sup>.

A laparoscopic linear stapler is frequently used to close the appendicular stump. One study reported that this method is the safest but also most expensive option<sup>15</sup>. Meanwhile, an endoloop is less expensive than a stapler but more technically demanding and requires laparoscopic sewing experience<sup>6</sup>. Chikamori et al. suggested that ligation of the appendicular root should be only moderately tight to prevent an ischemic change in the stump as indicated by discoloration or oedema<sup>4</sup>.

In recent years, clips have been suggested as an alternative method to closing the appendicular stump during laparoscopy. Some reports have presented the results of

**Table 1** Cases treated using a Double-shanked Titanium Ligation Clip (DS clip)

Case	Age/sex	Body mass index	Surgical time (min)	Length of hospital stay (days)	Histological examination	Indication for DS clip use	Postoperative complication
1	42/M	23.2	52	7	phlegmonous	inflammatory adhesions	none
2	22/M	17.4	53	6	phlegmonous	intestinal expansion	none
3	74/M	24.4	86	10	perforated	inflammatory adhesions	none
4	81/M	28	60	11	perforated	inflammatory adhesions	none
5	52/M	18.9	75	11	catarrhal	inflammatory adhesions	none
6	33/M	21.5	64	8	phlegmonous	intestinal expansion	none
7	65/F	25.4	86	8	catarrhal	obesity	none
8	69/M	24.7	89	10	perforated	inflammatory adhesions	none
9	19/F	23	76	6	phlegmonous	intestinal expansion	none
10	70/M	26.5	197	14	perforated	inflammatory adhesions	none
11	67/M	23.4	131	12	phlegmonous	inflammatory adhesions	none
12	84/M	24.6	95	13	phlegmonous	obesity	none

non-absorbable polymeric clips, called Hem-o-loks, showing that polymeric clips reduced costs and produced comparable complication rates. However, the use of this polymeric clip is limited and depends on inflammatory severity and appendicular base diameter<sup>2,7,10,18,22</sup>. Recent non-randomized studies concluded that the polymeric clips could be used in cases with an appendix base of up to 10 mm and that an endoloop could be used in cases of an appendicular base of up to 15 mm<sup>12,17</sup>. The inflamed appendix is often thicker, so use of this application is limited.

The DS clip can solve these problems. The use of DS clips instead of linear staplers reduces costs. The price of a set of four DS clips is approximately 7,800 ¥, whereas a stapler costs 28,000 ¥ and two endoloops cost 8,666 ¥. Furthermore, DS clips could be used in cases of an appendicular base of up to 20 mm<sup>19</sup>.

In our hospital, we previously attempted to use the DS clip in obese patients or in cases involving intra-abdominal adhesions or intestinal expansion due to inflammation since it is difficult to mobilize the cecum. We used a DS clip to close the appendicular stump perioperatively in 12 cases after the DS clip received approval (Table 1). In these cases, the cecum could not be mobilized due to intra-abdominal inflammatory adhesions (six cases), intestinal expansion (four cases), and obesity (two cases). There were no postoperative complications in these cases. The median hospital stay was 10 days. Rickert et al. recommended the use of DS clips for appendicular stump closure due to the safety and effectiveness of the titanium used in its design<sup>19</sup>. Of the 390 patients who were treated using a DS clip, 37 adverse events were reported. Superficial wound infections were found in nine (2.31%) patients, intra-abdominal abscesses in five (1.28%) patients, appendicular stump leakage in one (0.26%) patient, and other adverse events in 22 (5.64%) patients. Strzałka et al. also compared the results of minimally invasive appendectomies performed using a linear stapler, DS clip, and invaginating sutures<sup>23</sup>. In doing so, they found that the shortest hospital stay and lowest complication rate occurred in patients whose treatment included the use of a DS clip.

Meanwhile, the DS clip should be used carefully in cases in which inflammation spreads to the cecum. As a foreign body, the DS clip may cause significant allergic reactions or mechanical small bowel obstruction<sup>13,24</sup>. The long-term postoperative course has not been fully described in the reported cases, so further investigations of patients treated with a DS clip are necessary.

In conclusion, here we reported a case of effective appendicular stump closure using DS clips. Thus, DS clips can be an alternative method to staplers in certain circumstances.

## CONCLUSIONS

We used DS clips to close the appendicular stump during operation in 12 cases. We observed no cases of intraoperative complications or mortality. No postoperative complications were observed in 12 cases. The management of an appendicular stump using DS clips during laparoscopic appendectomy was simple, safe, and cost-effective. DS clips can be an alternative method to linear staplers.

**Consent:** Written informed consent was obtained from the patient for the publication of this case report and accompanying images.

**Competing interests:** The authors declare no competing interests.

**Author contributions:** KI and SF made substantial contributions to the study conception and design as well as to the data acquisition and interpretation. SF, KO, HS, MS, YH, SF, MT, and HS were involved in drafting or critically revising the manuscript for important intellectual content. SF provided final approval of the version to be published. All authors read and approved the final manuscript.

## ABBREVIATIONS

DS clip, Double-shanked Titanium Ligation Clip; CT, computed tomography

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## REFERENCES

1. Addiss, D.G., Shaffer, N., Fowler, B.S. and Tauxe, R. 1990. The epidemiology of appendicitis and appendectomy in the United States. *Am. J. Epidemiol.* 132: 910–925.
2. Ates, M., Dirican, A., Ince, V., Ara, C., Isik, B. and Yilmaz, S. 2012. Comparison of intracorporeal knot-tying suture (polyglactin) and titanium endoclips in laparoscopic appendiceal stump closure: a prospective randomized study. *Surg. Laparosc. Endosc. Percutan. Tech.* 22(3): 226–231.
3. Biondi, A., Grosso, G., Mistretta, A., Marventano, S., Toscano, C., Drago, F., Gangi, S. and Basile, F. 2013. Laparoscopic vs. open approach for colorectal cancer: evolution over time of minimal invasive surgery. *BMC Surg.* 13(Suppl 2): S12.
4. Chikamori, F., Kuniyoshi, N., Shibuya, S. and Takase, Y. 2002. Appendiceal Stump Abscess as an Early Complication of Laparoscopic Appendectomy: report of a case. *Surg. Today* 32: 919.
5. Chung, R.S., Rowland, D.Y., Li, P. and Diaz, J. 1999. A meta-analysis of randomized controlled trials of laparoscopic versus conventional appendectomy. *Am. J. Surg.* 177: 250.
6. Costa-Navarro, D., Jiménez-Fuertes, M. and Illán-Riquelme, A. 2013. Laparoscopic appendectomy: quality care and cost-effectiveness for today's economy. *World J. Emerg. Surg.* 8: 45.
7. Di Saverio, S., Mandrioli, M., Sibilio, A., Smerieri, N., Lombardi, R., Catena, F., et al. 2014. A cost-effective technique for laparoscopic appendectomy: outcomes and costs of a case-control prospective single-operator study of 112 unselected consecutive cases of complicated acute appendicitis. *J. Am. Coll. Surg.* 218(3): e51–e65.
8. Garbutt, J.M., Soper, N.J., Shannon, W., Botero, A. and Littenberg, B. 1999. Meta-analysis of randomized controlled trials comparing laparoscopic and open appendectomy. *Surg. Laparosc. Endosc.* 9: 17–26.
9. Golub, R., Siddiqui, F. and Pohl, D. 1998. Laparoscopic versus open appendectomy: a metaanalysis. *J. Am. Coll. Surg.* 186: 545–553.
10. Gomes, C.A., Junior, C.S., de Peixoto, R.O., Netto, J.M., Gomes, C.C. and Gomes, F.C. 2013. Appendiceal stump closure by metal endoclip in the management of complicated acute appendicitis. *World J. Emerg. Surg.* 8: 35.
11. Gorter, R.R., Heij, H.A., Eker, H.H. and Kazemier, G. 2014. Laparoscopic appendectomy: State of the art. Tailored approach to the application of laparoscopic appendectomy? *Best Pract. Res. Clin. Gastroenterol.* 28(1): 211–224.
12. Hue, C.S., Kim, J.S., Kim, K.H., Nam, S-H. and Kim, K.W. 2013. The usefulness and safety of Hem-o-lok clips for the closure of appendicular stump during laparoscopic appendectomy. *J. Korean. Surg. Soc.* 84(1): 27–32.
13. James, M., Nottingham. 2002. Mechanical Small Bowel Obstruction from a Looser Linear Cutter Stapler After Laparoscopic Appendectomy. *Surg. Laparosc. Endosc. Percutan. Tech.* 12: 289–290.
14. Katkhouda, N., Mason, R.J., Towfigh, S., Gevorgyan, A. and Essani, R. 2005. Laparoscopic versus open appendectomy: a prospective randomized double-blind study. *Ann. Surg.* 242: 439–450.
15. Kazemier, G., in't Hof, K.H., Saad, S., Bonjer, H.J. and Sauerland, S. 2006. Securing the appendiceal stump in laparoscopic appendectomy: evidence for routine stapling? *Surg. Endosc.* 20(9): 1473–1476.
16. Kurtz, R.J. and Heimann, T.M. 2001. Comparison of open and laparoscopic treatment of acute appendicitis. *Am. J. Surg.* 182: 211–214.
17. Partecke, L.I., Kessler, W., von Bernstorff, W., Diedrich, S., Heidecke, C-D. and Patrzyk, M. 2010. Laparoscopic appendectomy using a single polymeric clip to close the appendicular stump. *Langenbecks. Arch. Surg. Dtsch. Ges. Für. Chir.* 395(8): 1077–1082.
18. Rembiasz, K., Bobrzyński, A., Budzyński, A., Strzałka, M., Gwóźdź, A., Migaczewski, M., et al. 2010. Analysis of complications of laparoscopic management of abdominal diseases related to extended indications. *Wideochir. Inne. Tech. Malo. Inwazyjne.* 5(2): 53–59.
19. Rickert, A., Krüger, C.M., Runkel, N., Kuthe, A., Köninger, J., Jansen-Winkel, B., Gutt, C.N., Marcus, D.R., Hoey, B., Wentz, M.N. and Kienle, P. 2015. The TICAP-Study (titanium clips for appendicular stump closure): A prospective multicentre observational study on appendicular stump closure with an innovative titanium clip. *BMC Surg.* 17; 15: 85.
20. Sajid, M.S., Rimple, J., Cheek, E. and Baig, M.K. 2009. Use of endo-GIA versus endo-loop for securing the appendicular stump in laparoscopic appendectomy: a systematic review. *Surg. Laparosc. Endosc. Percutan. Tech.* 19(1): 11–15.
21. Seem, K. 1983. Endoscopic appendectomy. *Endoscopy* 15: 59–64.
22. Shaikh, F.M., Baiwa, R. and McDonnell, C.O. 2015. Management of appendiceal stump in laparoscopic appendectomy—clips or ligature: a systematic review and meta-analysis. *J. Laparoendosc. Adv. Surg. Tech.* 25(1): 21–27.
23. Strzałka, M., Matyja, M. and Rembiasz, K. 2016. Comparison of the results of laparoscopic appendectomies with application of different techniques for closure of the appendicular stump. *World J. Emerg. Surg.* 11: 4.
24. Tamai, K., Mitsumori, M., Fujishiro, S. 2001. A case of allergic reaction to surgical metal clips inserted for postoperative boost irradiation in a patient undergoing breast conserving therapy. *Breast Cancer* 8: 90–92.