

A Cheap and Effective Handmade Balloon Trocar for Laparoscopic Total Extraperitoneal Hernia Repair

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Abstract

Introduction: In the laparoscopic totally extraperitoneal (TEP) technique for the treatment of inguinal hernia, balloon dissector equipment is widely used all over the world to open the preperitoneal area and create sufficient working area. Since this equipment is expensive, it requires a less costly device. This study aims to evaluate the efficiency and reliability of the low-cost handmade balloon trocar (HMBT) device.

Methods: Fifty-two patients (47 male and 5 female) who underwent TEP with HMBT between May 2018 and September 2019 were analyzed retrospectively for patient demographics, duration of operation, open techniques or transabdominal preperitoneal necessity, drain use, complications, and hospital stay periods.

Results: The mean age was 32.45 ± 12.63 years; the mean body mass index was 26.01 ± 3.01 kg/m². ASA scores were 1, 2, and 3. The mean operation time was 41.21 ± 7.51 min. There were no intraoperative complications in any patients. Six patients required a drain; Five patients were discharged after drain removal. One patient needed re-hospitalization due to scrotal hematoma. Fifty-one patients were discharged on the 1st post-operative day. The mean hospital stay period was 26.13 ± 6.56 h.

Discussion and Conclusion: HMBT may be a safe, cheap, and feasible alternative method of achieving the preperitoneal space in TEP.

Keywords: Handmade balloon trocar; inguinal hernia; preperitoneal space; totally extraperitoneal repair.

Inguinal hernia repair is one of the most frequently performed operations all over the world^[1]. The presence of various repair techniques points out that there is not a "best technique"^[1]. Laparoendoscopic techniques provide less pain and faster recovery, compared to that of open techniques. Total extraperitoneal (TEP) repair is a preferred method among the present laparoscopic ones. As contrary to the other techniques, in this technique, intraperitoneal

cavity access is not necessary which decreases such complications as intra-abdominal organ injury and post-operative ileus^[2]. The biggest disadvantage of the laparoscopic techniques is its cost due to expensive disposable endoscopic tools used^[1]. Hernia group 2018 guideline suggested that the use of a minimal number of disposable equipment to decrease the cost^[1].

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Submitted Date (Başvuru Tarihi): 20.05.2020 **Accepted Date (Kabul Tarihi):** 15.07.2020

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The studies in which the minimal number of disposable tools was used and preperitoneal balloon and mesh fixator were not used showed that the cost was comparable to the that of open repairs^[3,4]. Balloon dissector is used to open preperitoneal space in TEP technique^[5-7]. However, following the space opening with balloon dissector, a Hasson trocar would have been placed to continue the surgical procedure. In recent years, studies are reporting the use of combined systems of balloon dissector and trocar together to open the space^[8-10]. Spacemaker™ Plus dissector (Medtronic Inc, Minneapolis, USA) is the most widely used one among these balloon dissector systems used today (Fig. 1a). International Endohernia Society guidelines suggest the use of balloon dissector especially during the early learning curve^[11]. Despite being easy to use and very effective, balloon dissector is still an expensive hand tool.

We developed a more usable and cheaper trocar balloon system and aimed to analyze its effectiveness and advantages in laparoscopic hernia repair.

Materials and Methods

This retrospective study was performed at a training and research hospital, between May 2018 and September 2019. Fifty-two patients (47 male and 5 female), operated by a single surgeon who was experienced in laparoscopic surgery and underwent TEP with handmade balloon trocar (HMBT) were analyzed. As it was a retrospective study, ethical committee approval was not taken. Patients were diagnosed with inguinal hernia by abdominal ultrasonography or physical examination. Informed consent forms were obtained from all patients before the surgery. Age, gender, height, weight, body mass index (BMI), and comorbid diseases of the patients were recorded. Duration of operation, complications, hospital stay period, and follow-up period were recorded. Post-operative complications, such as wound infections, seroma, and scrotal edema, were also recorded.

We developed a new and cheaper spacemaker balloon dissector to decrease the cost of balloon spacemaker to a minimum. This device can be made in the operation room and used immediately. It can be made in every operation room using a latex balloon for children and a trocar.

Preparation of the Handmade Balloon

One 10 inches transparent latex balloon, one 12 mm serrated trocar, lubricant fluid, and 2/0 silk ligature (Ethicon) were needed to make this balloon-trocar (Fig. 1b). The balloon was sterilized with hydrogen peroxide. The lip of the

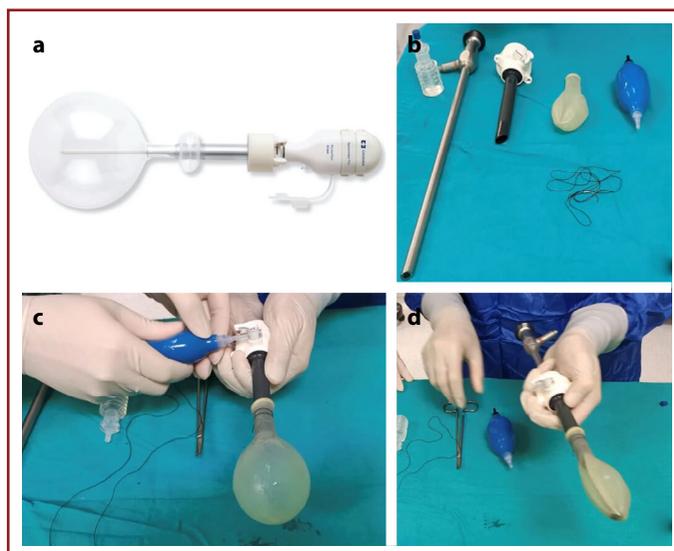


Figure 1. (a) Spacemaker™ Plus dissector system, (b) materials used for making balloon trocar, (c) handmade balloon trocar construction and pump inflated control, and (d) inserting the optical camera into the balloon trocar.

balloon was passed over the tip of the serrated trocar by 2 cm and fixed by ligating the 2/0 silk around it (Fig. 1c). The lubricant was applied into the trocar and optical camera was inserted through the trocar until the distal tip of the balloon (Fig. 1d). The external surface of the balloon was also lubricated. A 1.5 cm infra umbilical midline skin incision was made and subcutaneous tissue was dissected till the anterior rectus abdominis sheath. The anterior rectus sheath was incised and rectus abdominis muscle was lateralized using small S-shaped retractors. The preperitoneal space behind the rectus abdominis muscle was dissected by finger dissection and balloon trocar was placed through this area and advanced to the pubis. Thirty-degree optical camera was inserted through the trocar until the symphysis pubis and air pump was attached to the airport of the trocar and pumped 30 times and the balloon was insufflated under direct vision. When the landmarks of TEP were seen (i.e., symphysis pubis and epigastric vessels), the optical camera was taken out and the balloon was deflated and the balloon trocar was removed (Fig. 2a). The balloon was separated from the trocar and the trocar was inserted again. The trocar port was air-sealed with suturing the skin around it and the trocar was fixed to the skin with these sutures. The preperitoneal area structures were visualized (Fig. 2b) and a 5 mm trocar was placed at the point 3 cm superior to the symphysis pubis on the midline. Another 5 mm trocar was inserted at the midpoint between the optic and suprapubic trocar. Using laparoscopic hand tools, hernia sac was dissected off the spermatic cord or hernia

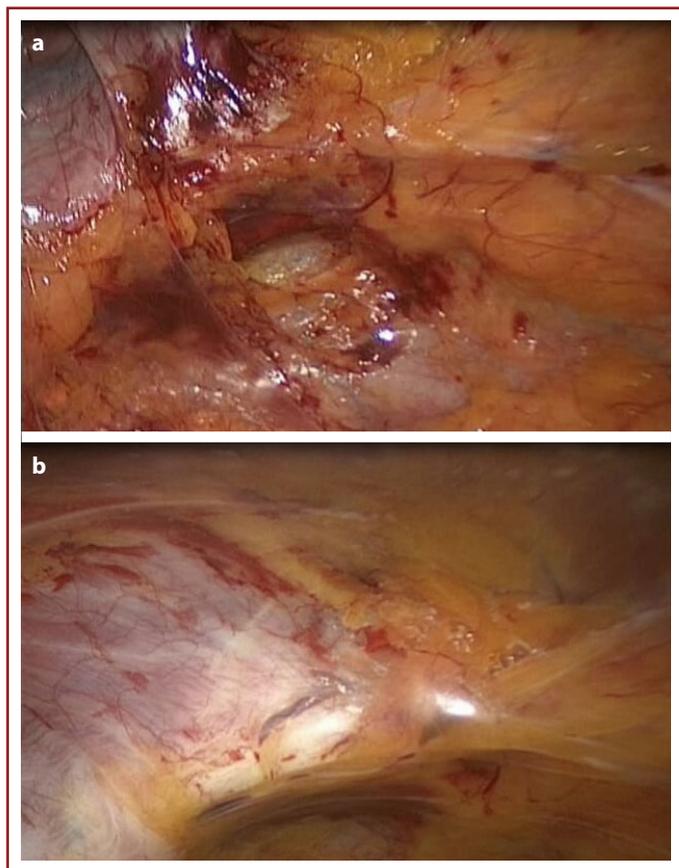


Figure 2. (a) Intraoperative view: View of preperitoneal space opening through the balloon trocar, and **(b)** intraoperative view: View of the anatomical structures of the preperitoneal area after balloon trocar removal.

region depending on the type of the hernia, indirect, direct, and femoral, respectively. 15×10 polypropylene mesh was put inside through the optical trocar, placed to cover the defective area, and fixed at two points to the abdominal wall, cooper's ligament and anterolateral wall, 2 cm medial to the superior iliac crest, using absorbable fixator device. The preperitoneal area was deflated and the anterior sheath of the rectus abdominis muscle was closed using 2/0 polyglactin suture. The skin was closed using 4/0 polyglactin.

Results

This technique was used in 54 patients. Fifty-two patients, 47 male and 5 female, were involved in the study. The procedure was converted to transabdominal preperitoneal repair (TAPP) in two patients due to tearing of the distal hernia sac and collapse of the preperitoneal area during dissection. The mean age was 32.45 ± 12.63 years. The mean BMI was 26.01 ± 3.01 kg/m². The mean duration of operation was 41.21 ± 7.51 min and the mean hospital stay pe-

riod was 26.13 ± 6.56 h, respectively. The post-operative complications were scrotal edema in 4, seroma in 3, and trocar site infection in 2 patients, respectively. Hemovac drain was placed in six patients due to blood oozing and 5 of them removed on the first post-operative day. However, hematoma fulfilling scrotum was developed in one patient; no intervention was performed and it spontaneously resolved at the end of 3rd post-operative month on the follow-up. This patient was using anticoagulants because of cardiac bypass surgery 2 years ago. The mean follow-up period was 16 weeks and there was no recurrence.

Discussion

In spite of having the advantages of less early post-operative pain and fewer analgesics need, better cosmetic results, and earlier work return, depending on the equipment used, laparoscopic inguinal hernia repair has a higher cost compared to that of open repair^[1]. There is no difference between TAPP and TEP in terms of cost^[1]. There are studies on minimal use of disposable tools, avoiding mesh fixator and balloon dissector use in TEP to decrease the cost^[1]. Farinas et al.^[12] compared disposable and non-disposable tool use in their clinical study on 92 patients and reported that non-disposable tools decreased the cost significantly. Lau et al.^[13] reported that reusable tools decreased the cost, too. We used reusable tools in our study.

Avoiding of mesh fixation is another method of decreasing the cost. However, it is very controversial without any consensus on it. Some authors reported that non-use of fixation device might result in migration of the mesh into the surrounding tissues^[14,15]. However, Clause et al.^[16] in their randomized clinical study showed radiologically that there is not any significant difference in terms of mesh migration between the mesh fixation used and non-used groups. In recent years, new 3-dimensional mesh types have been developed, but they are also expensive^[1,17].

As the surgical space is restricted in TEP technique, preperitoneal landmarks must be well known and preperitoneal space must be created well for optimum operation. During preperitoneal space creation, tearing of the peritoneum, bleeding of soft tissues, and minor vessels and, even, bladder and intestinal injuries might occur^[18]. The balloon dissector device has been widely used for easier space creation^[3-8]. Different types of balloon dissectors have been used. Along with the techniques using both balloon trocar and Hasson trocar together, there is also the spacemaker balloon dissector device which combines both balloon dissector and trocar in one system, thus, making the proce-

dure easier^[5-7,10,12,13,18]. The studies suggesting plain dissection technique, in which preperitoneal space is created using the tip of laparoscope to decrease the cost, were reported^[18,19]. Both these studies emphasized that plain dissection technique does not statistically differs from balloon dissection technique in terms of seroma, wound infection, scrotal edema, and bleeding development but, the surgeon must have an experience to perform this technique. Misra et al.^[20] reported that balloon dissection technique decreases seroma, scrotal edema, and post-operative pain significantly. We have been using balloon dissection technique in our department as we have to train residents and the learning curve of TEP is a difficult one. Before developing this device, we had used spacemaker balloon dissector. Our device provides all advantages of balloon dissectors on creating preperitoneal space and its cost is cheaper compared to the other commercial balloon dissectors. Disposable balloon dissectors costs between 150 and 200 USD in our country. The production cost of our device includes 2 USD for 10 inches transparent balloon and its sterilization, 1 USD for 2/0 silk suture, 25 USD for 12 mm trocar, making a total amount of 28 USD.

Seroma is a commonly seen complication following inguinal hernia repairs. Its incidence following TEP repair is low in experienced centers and it was reported between 1.13% and 37.9%^[21-24]. Lau et al.^[25] reported the factors increasing the seroma development risk as age, giant scrotal hernia, remnant distal hernia sac, and scrotal hernia sac. They also emphasized that excessive dissection of the cord, bleeding, and extension of the operation duration increase the seroma development risk. We observed seroma in 3 of our patients (5.76%), which resolved spontaneously without any intervention.

Scrotal edema is another common complication. Similar to that of the seroma, age, giant hernia defect, presence of scrotal hernia sac, and remnant distal hernia sac are among the contributing factors^[25]. Misra et al.^[20] reported the scrotal edema incidence as 17.8% in their randomized study. Krishna et al.^[21] compared TAPP and TEP in their randomized prospective clinical study and reported the scrotal edema incidence as 9.4% for TEP. In our study, four patients (7.69%) developed scrotal edema.

The most severe and disturbing complication following inguinal hernia repairs is recurrence. Its incidence for TEP repair is between 1% and 2%^[26,27]. We did not observe any recurrence at the end of 16.6 months of follow-up period.

An important problem in TEP repair is conversion need to TAPP or open repair if a good preperitoneal space cannot

be created or space is collapsed because of peritoneal tearing. Misra et al. reported the conversion rate at 3.8%. There was conversion to TAPP in 2 of our patients (3.4%) due to tearing of peritoneum during the dissection of the hernia sac in our study.

Conclusion

Being easy-to-use and cheap, this new HMBT can be used easily in TEP repair. Everyone can make this handmade trocar shortly in the operation room and its accessibility is superior to commercial balloon dissectors. Thus, it decreases medical costs and provides an innovative and economical alternative.

Ethics Committee Approval: This retrospective study was performed at a training and research hospital, between May 2018 and September 2019.

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: H.Ö., T.D., Design: H.Ö., T.D.; Data collection of Processing: H.Ö., T.D., O.S.; Analysis or Interpretation: H.Ö., T.D.; Literature Search: H.Ö., T.D., O.S.; Writing: H.Ö., T.D., O.S.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. HerniaSurge Group. International guidelines for groin hernia management. *Hernia* 2018;22:1–165. [\[CrossRef\]](#)
2. Belyansky I, Tsirlina VB, Klima DA, Walters AL, Lincourt AE, Heniford TB. Prospective, comparative study of postoperative quality of life in TEP, TAPP, and modified Lichtenstein repairs. *Ann Surg* 2011;254:709–15. [\[CrossRef\]](#)
3. Khajanchee YS, Kenyon TA, Hansen PD, Swanström LL. Economic evaluation of laparoscopic and open inguinal herniorrhaphies: The effect of cost-containment measures and internal hospital policy decisions on costs and charges. *Hernia* 2004;8:196–202. [\[CrossRef\]](#)
4. McCormack K, Wake B, Perez J, Fraser C, Cook J, McIntosh E, et al. Laparoscopic surgery for inguinal hernia repair: Systematic review of effectiveness and economic evaluation. *Health Technol Assess* 2005;9:1–203. [\[CrossRef\]](#)
5. Cable RL, Gilling PJ, Jones WO. Laparoscopic extraperitoneal inguinal hernia repair using a balloon dissection technique. *Aust N Z J Surg* 1994;64:431–3. [\[CrossRef\]](#)
6. Kieturakis MJ, Nguyen DT, Vargas H, Fogarty TJ, Klein SR. Balloon dissection facilitated laparoscopic extraperitoneal hernioplasty. *Am J Surg* 1994;168:603–7. [\[CrossRef\]](#)
7. Schwaitzberg SD, Hermann GD. Transballoon trocar insertion during preperitoneal hernia repair. *Surg Endosc* 2001;15:1235–6. [\[CrossRef\]](#)

8. Al Mahroos M, Vassiliou M. Laparoscopic totally extraperitoneal (TEP) inguinal hernia repair. In: Hope WW, Cobb WS, Adrales GL, editors. *Textbook of hernia*. Cham: Springer International Publishing; 2017. p.99–107. [\[CrossRef\]](#)
9. Voeller G, Powell BS. Technique: laparoscopic TEP. In: Jacob BP, Ramshaw BP, editors. *The SAGES manual of hernia repair*. New York: Springer; 2013. p. 71–80. [\[CrossRef\]](#)
10. Tastaldi L, Bencsath K, Alaedeen D, Rosenblatt S, Alkhatib H, Tu C, et al. Telescopic dissection versus balloon dissection for laparoscopic totally extraperitoneal inguinal hernia repair (TEP): A registry-based randomized controlled trial. *Hernia* 2019;23:1105–13. [\[CrossRef\]](#)
11. Bittner R, Arregui ME, Bisgaard T, Dudai M, Ferzli GS, Fitzgibbons RJ, et al. Guidelines for laparoscopic (TAPP) and endoscopic (TEP) treatment of inguinal hernia [International Endohernia Society (IEHS)]. *Surg Endosc* 2011;25:2773–843. [\[CrossRef\]](#)
12. Farinas LP, Griffen FD. Cost containment and totally extraperitoneal laparoscopic herniorrhaphy. *Surg Endosc* 2000;14:37–40. [\[CrossRef\]](#)
13. Lau H. Endoscopic extraperitoneal inguinal hernioplasty: Disposable and reusable instruments. *Surg Technol Int* 2006;15:109–15.
14. Chowbey PK, Bagchi N, Goel A, Sharma A, Khullar R, Soni V, et al. Mesh migration into the bladder after TEP repair: A rare case report. *Surg Laparosc Endosc Percutan Tech* 2006;16:52–3. [\[CrossRef\]](#)
15. Choy C, Shapiro K, Patel S, Graham A, Ferzli G. Investigating a possible cause of mesh migration during totally extraperitoneal (TEP) repair. *Surg Endosc* 2004;18:523–5. [\[CrossRef\]](#)
16. Claus CM, Rocha GM, Campos AC, Bonin EA, Dimbarre D, Loureiro MP, et al. Prospective, randomized and controlled study of mesh displacement after laparoscopic inguinal repair: Fixation versus no fixation of mesh. *Surg Endosc* 2016;30:1134–40. [\[CrossRef\]](#)
17. Bell RC, Price JG. Laparoscopic inguinal hernia repair using an anatomically contoured three-dimensional mesh. *Surg Endosc* 2003;17:1784–8. [\[CrossRef\]](#)
18. Kang AY, Lee SR, Son BH, Jung KU. Achieving the preperitoneal space in totally extraperitoneal inguinal hernia repair: Dissection with or without a Balloon Dissector. *J Minim Invasive Surg* 2014;17:62–7. [\[CrossRef\]](#)
19. Bringman S, Ek A, Haglind E, Heikkinen TJ, Kald A, Kylberg F, et al. Is a dissection balloon beneficial in bilateral, totally extraperitoneal, endoscopic hernioplasty? A randomized, prospective, multicenter study. *Surg Laparosc Endosc Percutan Tech* 2001;11:322–6. [\[CrossRef\]](#)
20. Misra MC, Kumar S, Bansal VK. Total extraperitoneal (TEP) mesh repair of inguinal hernia in the developing world: Comparison of low-cost indigenous balloon dissection versus direct telescopic dissection: A prospective randomized controlled study. *Surg Endosc* 2008;22:1947–58. [\[CrossRef\]](#)
21. Krishna A, Misra MC, Bansal VK, Kumar S, Rajeshwari S, Chhabra A. Laparoscopic inguinal hernia repair: Transabdominal preperitoneal (TAPP) versus totally extraperitoneal (TEP) approach: A prospective randomized controlled trial. *Surg Endosc* 2012;26:639–49. [\[CrossRef\]](#)
22. Kwon KH, Son BH, Han WK. Laparoscopic totally extraperitoneal repair without suprapubic port: Comparison with conventional totally extraperitoneal repair. *J Korean Surg Soc* 2011;80:319–26. [\[CrossRef\]](#)
23. Choi YY, Han SW, Bae SH, Kim SY, Hur KY, Kang GH. Comparison of the outcomes between laparoscopic totally extraperitoneal repair and prolene hernia system for inguinal hernia; Review of one surgeon's experience. *J Korean Surg Soc* 2012;82:40–4.
24. Haidenberg J, Kendrick ML, Meile T, Farley DR. Totally extraperitoneal (TEP) approach for inguinal hernia: The favorable learning curve for trainees. *Curr Surg* 2003;60:65–8. [\[CrossRef\]](#)
25. Lau H, Lee F. Seroma following endoscopic extraperitoneal inguinal hernioplasty. *Surg Endosc* 2003;17:1773–7. [\[CrossRef\]](#)
26. Weiser HF, Klinge B. Endoscopic hernia repair—experiences and characteristic features. *Viszeralchirurgie-Stuttgart* 2000;35:316–20. [\[CrossRef\]](#)
27. Lau H, Patil NG, Yuen WK, Lee F. Prevalence and severity of chronic groin pain after endoscopic totally extraperitoneal inguinal hernioplasty. *Surg Endosc* 2003;17:1620–3. [\[CrossRef\]](#)