



# TAPP surgery with mesh fixation and peritoneal closure using n-butyl-2-cyanoacrylate (LiquiBand® FIX8™) – initial experience

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## Summary

**Introduction** Laparoscopic procedures in groin hernia repair have been established since many years. Adhesive techniques for mesh fixation in the transabdominal pre-peritoneal (TAPP) procedure are now being increasingly discussed. Currently, there are three categories of adhesives available: synthetic adhesives (cyanoacrylate), biological products (e.g. fibrin glue) and genetically produced polymer protein adhesives.

The objective of this observation study was to evaluate the adhesive technique for mesh fixation and peritoneal closure using n-butyl-cyanoacrylate.

**Material and method** Between January and February 2015, 20 consecutive male patients underwent TAPP surgery with mesh fixation and peritoneal closure with cyanoacrylate. The investigations encompassed complication rate and postoperative pain after 6 days and 3 months.

**Results** Postoperative complication rate was low, one haematoma and one bulging. According to a standardised visual analogue scale (VAS 0–10), the average preoperative pain score was 2.8 (0–7), 1.2 (0–3) after 6 days and 0.1 (0–2) after 3 months. The mean operation time was 69 min. No hernia recurrence was detected during follow-up.

**Conclusion** Our initial experience shows that mesh fixation and peritoneal closure using n-butyl-2-cyanoacrylate is safe and sufficient.

**Keywords** TAPP · Mesh fixation · Adhesive technique · Cyanoacrylate

## Introduction

The vast majority of hernias occur in the inguinal region, and the high incidence of this condition means that inguinal hernia repair is the most frequently performed surgical procedure in the United States [1] and in Europe [2]. Non-fixation of the mesh seems the safest and least traumatic method, but there have been reports of higher mesh mobility, lower tensile strength, and increased risk of recurrence, if left unfixated [3]. However, in a systematic review with fixation of the mesh by tacks in both transabdominal pre-peritoneal (TAPP) and totally extra-peritoneal (TEP) compared with no fixation, the results showed no difference in the risk of recurrence, when the mesh was left unfixated ( $p=0.77$ ) [4]. Guidelines from International Endohernia Society (IEHS) recommend that non-fixation of the mesh during TAPP should be considered in types LI, LII, MI and MII hernias (EHS classification). If the TEP technique is chosen, non-fixation can be considered in all types of hernias, except for the largest defects [5]. The use of fibrin sealant for fixation of the mesh has been shown to decrease postoperative complications in addition to shortening procedure time, compared with using tacks [6]. The EHS guidelines state that fibrin sealant has shown signs of less acute and chronic pain compared with staples for fixation of the mesh [5].

The aim of this study was to evaluate early postoperative pain and feasibility of mesh fixation and peritoneal closure using n-butyl-2-cyanoacrylate in patients undergoing laparoscopic groin hernia repair (TAPP).

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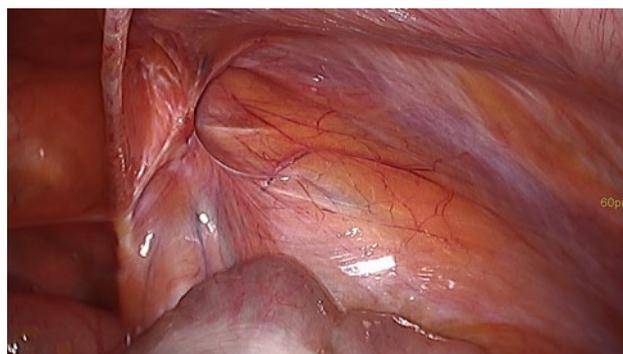
## Methods

Men aged 18–80 years, classified with American Society of Anesthesiologists (ASA) class I–III were consecutively included. The exclusion criteria were women, inguinoscrotal hernia, presumed poor compliance (language disability, dementia psychiatric disorders etc.) and daily intake of opioids within the last week before operation. Patients with systemic use of steroids or other immunosuppressant medicine were also excluded. Mesh fixation was exclusively performed with the adhesive technique using LiquiBand®FIX8™ (Advanced Medical Solution, Plymouth, UK), an adhesive based on cyanoacrylate. The study included patients with direct or indirect hernias as well as bilateral hernias, whereby sonographically the size of the hernial orifice had to be below 3 cm (Figs. 1, 2). Also, peritoneal closure was performed by adhesive technique using LiquiBand®FIX8™. With regard to the literature, this is the first study describing this type of peritoneal closure. After closure of the peritoneum we deflated the capnopneumoperitoneum and waited for at least 10 min, and then we performed a control laparoscopy. Patients received similar general anaesthetic and analgetic regimens. Analgesic treatment was started immediately after the operation and consisted of paracetamol 1 g intravenously 4 times on postoperative day 1 and paracetamol 500 mg orally 3 times daily for another 4 days. We recorded the preoperative pain and early postoperative pain after 6 days and the late postoperative pain after 3 months in accordance with the visual analogue scale (VAS). During these controls, the patients were also clinically examined and in case of suspected recurrence or questionable clinical results, we performed a sonography.

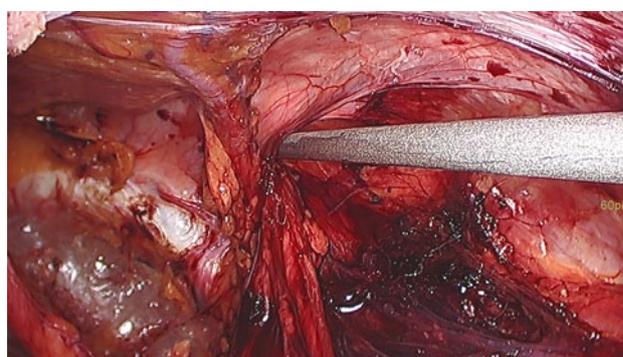
## Surgical technique

The TAPP procedures were performed by experienced laparoscopic surgeons. We used a polypropylene mesh TiO2Mesh™ (BioCer, Bayreuth, Germany) with a pore size of 2.4 mm and a thickness of 0.25 mm, which was adjusted to a size of 13 to 15 cm (Figs. 3, 4). Mesh fixation was performed with LiquiBand®FIX8™ (Figs. 5, 6). To fixate the mesh we installed eight fixation points, while omitting the lateral nerve regions (Fig. 7). Peritoneal closure was implemented with the adhesive technique using LiquiBand®FIX8™ at a reduced intra-abdominal pressure of 8 mmHg (Fig. 8). This usually required five to eight applications. The success of peritoneal adhesion using cyanoacrylate was controlled by relaparoscopy after a minimum waiting period of 10 min, during which intra-abdominal gas was deflated (Fig. 9).

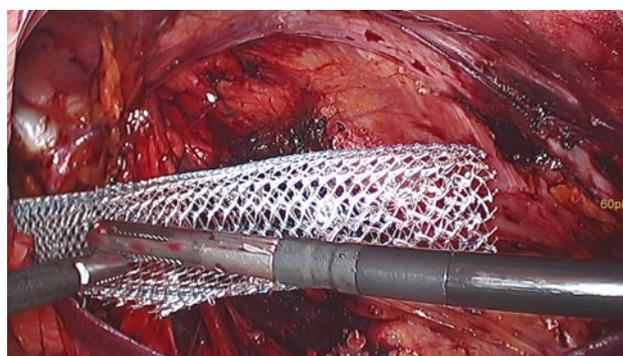
The three trocar sites were injected with local anaesthetic bupivacaine 0.5%, (5 ml). The patients were discharged on the second postoperative day.



**Fig. 1** Intraoperative view of an inguinal hernia



**Fig. 2** Instrument shows the region of the inguinal hernia



**Fig. 3** Rolled up mesh is introduced intra-abdominal



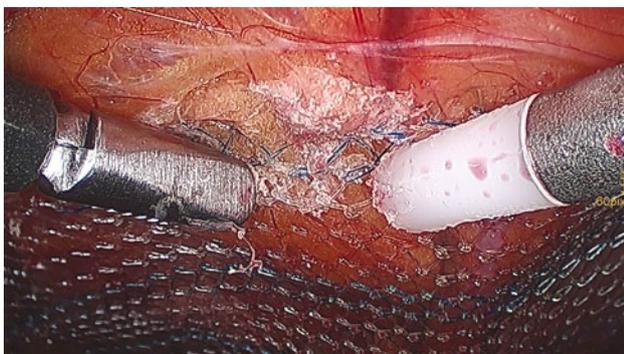
**Fig. 4** Positioning of the mesh



**Fig. 5** Mesh fixation using the cyanoacrylate glue



**Fig. 8** Peritoneal closure using the cyanoacrylate glue technique



**Fig. 6** Close-up view of the cyanoacrylate glue



**Fig. 9** Intraoperative documentation after relaparoscopy (10 min delay): permanent peritoneal closure using the cyanoacrylate glue technique



**Fig. 7** Mesh fixation after using the cyanoacrylate glue

## Results

Between January and February 2015, 20 male patients underwent hernia repair at our department following the TAPP technique. A total of four patients had a hernia on both sides, seven patients only on their right side and nine patients only on their left side. According to a standardised visual analogue scale (VAS 0–10), the average preoperative pain score was 2.8 (0–7), 1.2 (0–3) after 6 days and 0.1 (0–2) after 3 months (Table 1). The mean operation time was 69 min, including delay of 10 min for relaparoscopy. We did not detect any recurrence during postoperative follow-up. In all, one patient showed a bulging, which disappeared after 4 weeks. One patient

reported pain (VAS 2) 3 months after operation. The reason therefore was a sonographically detected haematoma. In one case, peritoneal closure was only possible using two LiquiBand<sup>®</sup>FIX8<sup>™</sup> instruments. This occurred during one of the first glue peritoneal closures, so we assumed a technical handling problem. All peritoneal defects had been closed successfully by using the cyanoacrylate glue technique.

## Discussion

Standard methods of repair include open (e.g. Lichtenstein procedure) or laparoscopic techniques using a mesh fixated with tissue-penetrating methods (sutures, staples or tacks), non-penetrating methods such as fibrin sealant, or no fixation [6–10]. Major long-term concerns regarding hernia surgery are mainly from open repair techniques and include postoperative chronic pain in 5–20% of patients [11, 12], sexual dysfunction in 9.4% of patients [13], and recurrence in up to 5% of patients [14, 15]. Tissue adhesives have the ability of fixating tissue-to-tissue or tissue-to-mesh, without causing additional damage to the surrounding tissue [16–19]. Tissue adhesives may even enhance wound healing, lower the inflammatory response, be bacteriostatic [19–21], and

**Table 1** Postoperative pain according to visual analogue scale

Patients	Right	Left	Bilat- eral	VAS pre-OP	VAS day 6	VAS month 3	Recur- rence	Surgery time in min.
1	1	0	0	2	1	0	0	60
2	1	1	1	2	1	0	0	91
3	0	1	0	2	3	0	0	66
4	0	1	0	3	1	0	0	65
5	1	0	0	5	1	0	0	84
6	0	1	0	2	2	0	0	60
7	0	1	0	2	0	0	0	65
8	1	0	0	1	1	0	0	64
9	1	1	1	3	2	0	0	88
10	0	1	0	5	1	0	0	80
11	1	0	0	4	1	0	0	64
12	0	1	0	1	0	0	0	63
13	1	1	1	1	2	0	0	88
14	0	1	0	3	1	0	0	68
15	1	0	0	5	1	0	0	75
16	0	1	0	7	3	2	0	46
17	0	1	0	2	0	0	0	70
18	1	1	1	3	1	0	0	85
19	0	1	0	1	1	0	0	50
20	1	0	0	2	1	0	0	65

has been shown to lower the reoperation rate [15]. Reduction of pain during the first days after laparoscopic groin hernia repair may shorten the duration of the convalescence period since pain is an important determinant of duration of convalescence [22–24]. Duration of convalescence and sick leave is of major socioeconomic interest because inguinal hernia repair is the most often conducted gastrointestinal surgical procedure [22, 24–26]. Various kinds of tissue sealants have been proposed for the fixation of hernia meshes with the aim of eliminating the aforementioned threats. These products can be divided into three main categories: synthetic glues (e.g. cyanoacrylate based), biologic products (e.g. fibrin sealant) and genetically engineered polymer protein glues [27]. Synthetic glues such as n-butyl-2-cyanoacrylate are promoted for hernia mesh fixation. However, their surgical use is not widely accepted because of reported cytotoxicity and the lack of published studies outlining the potential side effects of cyanoacrylate glue for mesh sealing [28, 29]. Due to good results regarding the dreaded chronic postoperative pain with simultaneously low rates of recurrence, the glue mesh fixation technique is asserting itself more and more [30]. The LiquiBand®FIX8™ is a laparoscopic instrument with an n-butyl-2-cyanoacrylate adhesive used to fixate the hernia mesh. This instrument can be used to accurately place anchors applied in liquid form, whereby every one of the 33 prefabricated portions can be precisely dispensed by activating a lever. In experiments on 20 rats in 2007, Fortelny et al.

[29] observed micro-abscesses and more complicated mesh integration when using a synthetic glue applied extensively in larger volumes. In 2012, Kukleta et al. [31] published a major series of more than 1300 TAPP operations with mesh fixations using n-butyl-cyanoacrylate. He demonstrated a precise fixation technique with a considerably smaller volume (up to 4 ml per square centimetre), showed excellent mesh integrity without a single mesh or wound infection. He also demonstrated that the excellent biocompatibility of n-butyl-cyanoacrylate was sufficiently tested. The glue based on cyanoacrylate also permits an excellent stability, which is achieved after only a few seconds [31]. Our point of view is that only few dots of cyanoacrylate are necessary for a sufficient mesh fixation and therefore only one LiquiBand®FIX8™ instrument is necessary for functionally adequate mesh fixation and for closure of the peritoneal defect.

## Conclusion

This study showed that TAPP surgery using the adhesive technique with n-butyl-cyanoacrylate is suitable for mesh fixation and closure of the peritoneal defect. Furthermore, the adhesive technique with n-butyl-cyanoacrylate may presumably contribute to the prevention of chronic postoperative pain.

However, further studies are required to substantiate the usability of n-butyl-cyanoacrylate for both mesh fixation and peritoneal closure.

## Conflict of interest

Reinhard Mittermair, Gerhard Jenic, Raimund Kolenik and Christian Sorre declare that they have no conflict of interest.

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