

Cyanoacrylate Surgical Glue for Mesh Fixation in Laparoscopic Total Extraperitoneal Hernia Repair

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Abstract: In an attempt to find the ideal surgical technique for mesh fixation during laparoscopic total extraperitoneal inguinal hernia repair, we evaluate the use of a synthetic surgical glue (*N*-butyl-cyanoacrylate—Glubran 2) in an effort to reduce postoperative pain and the complications associated with the use of staples. We have prospectively evaluated 61 consecutive patients (73 hernias) with a minimum follow-up period of 18 months and an average of 29.7 months, without any significant complications present. The majority (59%) only required low dosages of painkillers during the first 24 hours after surgery and have not experienced any cases of chronic pain or recurring hernias in the time period described. On the basis of this initial experience, the use of the surgical glue used to repair inguinal hernias with the laparoscopic total extraperitoneal technique has been proved to be a simple and effective surgical method for mesh fixation.

Key Words: inguinal hernia, cyanoacrylate glue, TEP repair, mesh fixation

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Inguinal hernia repair is, until today, one of the most frequent surgical procedures practiced in general surgery in countries with modern health care services.¹ Minimally invasive techniques using a laparoscopic approach in hernia repair have gained acceptance in the last 20 years, and it is no surprise that the laparoscopic approach has become the first choice of treatment in many centers.²

The laparoscopic total extraperitoneal (TEP) hernia repair brought about a complete revolution in the treatment of inguinal hernia when Dulucq³ published his initial experience in 1991. In recent years, some studies have demonstrated that the TEP technique provides excellent results with fair postoperative morbidity and an early recovery to daily activities when compared with open and other laparoscopic techniques [transabdominal preperitoneal (TAPP)] in hernia repair.^{4–6} Small variations have been introduced in the original TEP technique in an attempt to simplify the surgical process, reducing postoperative discomfort, recurrence rates, and the surgical cost. The convenience of mesh fixation as a measure to reduce the rate of recurrence is actually one of the most talked-about issues in the TEP technique^{7–9} with some authors in favor and others against. The technique of

dissection, the size and characteristics of the mesh, and, more importantly, personal experience^{2,8} are arguments that could lead to one technique being favored over the other. In contrast, the presence of chronic pain in patients operated on for inguinal hernias has not been avoided by using the laparoscopic technique, although it has been reduced in comparison with open surgery.⁴ This situation can be related to the use of tack staples to fix the mesh.^{8–10}

Although the discussion regarding whether there is the necessity to fix the mesh or not is ongoing, most surgeons agree that the mesh should be secured in all cases, or selectively in cases of direct or bilateral hernias,⁷ assessing the need for it in patients with small hernial orifices.^{10,11} For this reason, the usage of a nontraumatic method of fixation supposes a significant advance, aiming to prevent mesh dislocation and reducing the index of postoperative chronic pain.

In 1998, Jourdan and Bailey¹² described his initial experience in the use of a synthetic surgical glue (*N*-butyl-cyanoacrylate glue) to fix a polypropylene mesh in the TEP technique. However, this glue was not approved for internal use at that time and Jourdan abandoned its use.

In 2001, Katkhouda et al¹³ described the advantages of using fibrin glue as a method of mesh fixation in the laparoscopic TEP technique in an animal model. The mechanical properties of the fibrin glue showed similar results to the use of staples and superior to the nonfixing methods. From that time, many clinical studies have described good results using fibrin glue in mesh fixation in both TAPP and TEP techniques.^{11,14–16} Compared with the use of tack staples, postoperative chronic pain reduced significantly^{10,11,15,16} without adverse effects and without increasing morbidity or the rate of recurrence.

As an alternative to mechanical fixation and biological glue, modern synthetic glues with a modified cyanoacrylic base have been used in mesh fixation in cases of open inguinal hernia repair^{17,18} with comparable results in terms of postoperative complications, postoperative pain, chronic groin pain, and length of hospital stay.

However, there are few studies^{19,20} on their use in laparoscopic hernioplasty, and those that exist refer exclusively to the TAPP technique.

With the aim of improving our laparoscopic TEP technique for the treatment of inguinal hernias, we decided to test the use of a synthetic surgical glue (Co-monómero *N*-butyl-cyanoacrylate-MS) in a prospective observational study.

Our choice in the use of this glue was considered according to the following criteria:

- Choosing a synthetic glue, thus avoiding the minimum but unavoidable risk inherent in the use of biological glue.
- Using a surgical glue whose essential function consists in its high binding capacity, which is easy to apply, dries rapidly, and is bioabsorbable.

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- Avoiding the use of sealants using pulverization devices to minimize the possible risk of gas embolism described in the literature^{21,22} and by the European Medicines Agency http://www.ema.europa.eu/docs/en_GB/document_library/EPAR_-_Procedural_steps_taken_and_scientific_information_after_authorisation/human/000898/WC500089450.pdf.

MATERIALS AND METHODS

Patients

Sixty-one consecutive patients were included and assessed prospectively from September 2009 to June 2011. All of them had been diagnosed with inguinal hernias and had chosen to undergo the TEP technique in our center.

We explain patients diagnosed with inguinal hernia who were offered with the option of undergoing either open surgery (with regional anesthesia) or laparoscopic TEP (with general anesthesia), according to their preferences with respect to the surgical technique and anesthesia. Laparoscopic hernia repair is recommended in cases of recurrent and bilateral inguinal hernias and in cases of young patients with an active working life who prefer an early recovery.

Checkups were conducted after 1 week, 1 month, and 1 year following surgery. Complications during and after surgery were evaluated, along with the amount of time spent in hospital, postoperative analgesic needs, and the long-term results. With a minimum follow-up period of 18 months, the patients have been cited in the records from December 2012 to February 2013 to evaluate their recent state.

Surgical Technique

Preoperative antibiotics were not routinely administered except in the presence of risk factors for wound infection based on patient or surgical factors. In these patients, we usually administered 1g cefotaxime intravenously. An empty bladder is recommended before the operation. All patients were placed in a supine position and given general anesthesia. The surgeon stood on the opposite side of the hernia. In cases in which the patients suffered bilateral hernias, the larger hernia was operated on first. To minimize the cost of the operation, the use of Foley catheters, totally disposable trocars, balloon dissectors, irrigator aspirators, and stapling devices was avoided.

The rectus abdominis muscle was separated by making a 1.5 to 2 cm transversal infraumbilical incision on the same side as the hernia and an incision in the fascia. A small tunnel was made between the posterior fascia and the muscle through digital dissection. Thereafter, with the aid of a reusable Hasson trocar, which we fixed to the fascia using stitches, we introduced a 10 mm and 0-degree optic. With the assistance of CO₂, we created a space that allowed us to progress with the camera toward the pubic arch. Another 2 partially disposable 5-mm trocars were placed between the pubis and the first trocar, according to the usual technique.

The dissection of the preperitoneal space was carried out through blunt dissection with the pair of forceps introduced through the 5-mm trocars. The structures in the Retzius retropubic space and the Bogros space (pubis, the Cooper ligament, femoral canal, epigastric vessels, and iliopubic tract) were progressively identified. This allowed us to identify the level of the herniary defect, to reduce and completely dissect the contents of the herniary sac.

We used a 15 × 10 cm anatomic polypropylene mesh, which was introduced through the 10-mm trocar, while

carefully checking that its position was correct, with the Fruchard miopectineous hole completely covered from the pubic symphysis to the anterior superior iliac spine. The lower edge of the mesh must cover the Cooper ligament, the iliac vessels, the spermatic cord, and the psoas muscle. It is important that the upper edge covers the posterior surface of the rectus abdominis muscle completely, especially in the case of direct hernias. Two overlapping meshes in the midline were used in bilateral hernias.

Once the mesh was positioned, we proceeded to fix it using 1 mL (1 to 2 mL in the case of bilateral hernias) of cyanoacrylate-based surgical glue (co-monomer *N*-butyl-cyanoacrylate-MS: Glubran 2, GEM-Italy, CARDIOLINK-Spain). The glue was applied directly with a specific laparoscopic device that was introduced using one of the 5-mm trocars, usually the one situated in the middle. The surgical glue was applied directly over the pubis, the Cooper ligament, and the posterior surface of the rectus abdominis muscle, the mesh was slightly displaced, and then the mesh was placed in the ideal position. It is extremely important to achieve a good position and a strong fixation of the mesh in its upper edge, especially in direct hernias with larger holes. After 1 to 2 minutes, the correct fixation of the mesh is tested and desufflation is carried out checking that the mesh is in the correct position.

Liquid intake was initiated 6 hours after the operation. Analgesic protocol consists of the intravenous administration of paracetamol (1000 mg every 6 h) along with dextropropofol trometamol (50 mg every 8 h) if needed. When the patient is discharged, 500 to 1000 mg of paracetamol every 6 to 8 hours is prescribed (orally) if needed.

RESULTS

Seventy-three hernias were operated in 61 patients. Twelve patients presented bilateral hernias, and in 49 cases the hernia was unilateral. Ten cases showed recurrences after open surgery repair (Table 1). Most of the patients were male individuals (88.5%), with a mean age of 49.2 years (minimum 19 y, maximum 73 y). Indirect hernias were most common (60.3%).

We experienced no significant intraoperative or immediate postoperative complications. All patients were operated on in the afternoon and were discharged the next day in the morning (12 to 16 h after surgery).

TABLE 1. Patients and Characteristics of the Repaired Hernias

Variables	N (%)
No. patients	61
No. hernias	73
Sex	
Male	54 (88.5)
Female	7 (11.5)
Age, mean (y)	
Male	49.6
Female	45.8
Global	49.2 (19-73)
Types of hernias	
Indirect hernia	44 (60.3)
Direct hernia	29 (39.7)
Recurrent hernia	10 (13.7)
Site of hernias	
Unilateral	49 (80.3)
Left/right	49/51
Bilateral	12 (19.7)

Regarding analgesic requirements at home after hospital discharge, 59% of patients were required to be on analgesia in the first 24 hours after hospital discharge, 34.4% in the next 24 hours, and only 6.6% were required to be on painkillers after >48 hours of surgery (3 to 5 d).

The minimum follow-up period was 18 months, with a mean of 29.7 months (18 to 39 mo). There were no cases of recurrence or chronic pain in the periodical evaluations conducted before the conclusion of this study.

DISCUSSION

The most suitable approach to inguinal hernia repair is still debated, but the TEP technique has been proved to have a greater effect on reducing postoperative complications, improving postoperative comfort, and allowing an early recovery to normal activities in patients undergoing a minimally invasive approach.⁴⁻⁶

Mesh fixation in the TEP technique is currently under discussion.^{7,8} Although the TEP technique provides a superior and early recovery compared with the Lichtenstein and other open techniques,^{4,5} it has been observed that a small number of patients experienced some postoperative discomfort. This has been attributed to the use of metallic tacks because of nerve entrapment, osteitis pubis, or postoperative hematoma.^{13,15,16} Some authors have found no advantage in fixing the mesh (staples) in the TEP technique with regard to complications, morbidity, postoperative pain, and recurrences.^{2,7,8} However, it has been stated that nonmesh fixation often requires larger or more complex meshes, and, in fact, most surgeons anchor the mesh to avoid any kind of displacement and reduce the theoretical risk of recurrence.¹¹ It is likely that the good results obtained without fixing the mesh could be also explained because of the great experience of the groups^{2,8} that practice this modification of the procedure. However, in the current literature, there is no definitive evidence-based study supporting nonmesh fixation in the TEP technique.

Nontraumatic fixation using surgical glues is an interesting idea that can be introduced as an intermediate option between nonmesh fixation and fixation with tack staples. On the basis of their composition, surgical glues have been classified into 3 different categories: synthetic glues (cyanoacrylates), biological sealants (fibrin-based), and genetically engineered polymer protein glue. These glues have been tested for years with different surgical purposes. Skin closure, cementation of small bone fragments,²³ or hemostasis in uncontrolled bleeding²⁴ are only a sample of the initial applications for surgical sealants. They have also been tested in laparoscopic inguinal hernia repair (TEP and TAPP techniques), especially fibrin-based sealants, providing different series^{10,11,13,14} and recent meta-analysis^{15,16} excellent results in mesh fixation without increasing recurrence rates and producing less postoperative chronic pain and an early recovery compared with anchoring using tack staples.

Jourdan and Bailey¹² were the first to use a cyanoacrylate glue, Indermil, to anchor a polypropylene mesh in 7 laparoscopic hernia repair with good result, but, at that time, they had to end their study because the US Food and Drug Administration considered Indermil to be for external use only.²⁵ Later, Glubran 2 (co-monomer NBCA-MS) was the first synthetic surgical glue to be European EC certified (93/42/CEE) as a class-III surgical device for external and internal use. It is a synthetic sealant that provides a strong

and fast polymerization when in contact with organic tissues and liquids. Its polymerization temperature is 45°C, so thermal injury is avoided as an undesirable side effect. Full degradation of the glue takes place through hydrolysis in a variable time depending on the type of tissue and quantity of glue, so permanent glue adherence is avoided unlike the case of tack staples.

Cyanoacrylate-based surgical glues have been successfully applied in open free tensional inguinal hernia repair to fix the mesh. Experimental²⁶ and clinical studies^{17,18} in which the glue was used in open hernioplasty, demonstrated that it does not affect tissue healing and generates a physiological inflammatory reaction in the surrounding tissues. The glue was tolerated better compared with sutures or staples, thus reducing chronic postoperative groin pain without increased rates of recurrence and undesirable side effects like inadequate tissue adherence.

In vitro cytotoxicity has been described with the undiluted cyanoacrylate glue,²⁷ but it was avoided when dilution was carried out, as occurs in clinical practice by applying the glue in small and well-distributed amounts in contact with biological fluids. Some authors have demonstrated the absence of cytotoxicity when using *N*-butyl-cyanoacrylate, which provides excellent histocompatibility, good epithelialization, and a low local inflammatory reaction.^{20,28} Similarly, Glubran 2 presents excellent adhesive properties by high polymerization rate due to its different chemical composition, which allows for strong mesh fixation with a physiological inflammatory reaction similar to sutured meshes.²⁶ Excellent adhesive and tensile properties were shown in mechanic studies when compared with fibrin glue.²⁹

Only 2 retrospective studies have been published using this surgical glue and in the TAPP technique: a series that includes 36 patients¹⁹ and other recently studied with a wide experience of >1300 fixations of mesh,²⁰ referring a good control of postoperative pain and low recurrence rate.

The results and the clinical experience obtained from the patients included in our initial prospective study using a new surgical cyanoacrylate glue in the TEP technique confirm the results of the initial study conducted in 1998 by the Jourdan group, and we strongly believe that it is a simple, safe, and nontraumatic technique. Excellent immediate and long-term postoperative pain control, without surgical complications and hernia recurrence in a mean follow-up period of nearly 2 and a half years, was observed. These results have led us to use Glubran 2 as the glue of choice in the TEP technique instead of the previous method of mesh fixation with tack staples. However, randomized prospective studies with a larger number of patients are necessary to conclude and recommend its use with scientific evidence.

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