

# The use of cyanoacrylate for mesh fixation in inguinal hernia repair – literature review

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## ABSTRACT

**Introduction.** Surgical mesh procedures addressed to inguinal hernia leads to better results in term of recurrence, but the problems of postoperative pain still remains, and mesh fixation is considered to be one of the factors. Our objective is to determine the impact of cyanoacrylate glues for mesh fixation in clinical results considering postoperative acute and chronic pain, complications and recurrence.

**Material and methods.** We performed a systematic review of literature, searching for "cyanoacrylates" (MeSH Terms) AND "hernia" (MeSH Terms) AND "herniorrhaphy" (MeSH Terms) in order to find papers that discuss the use of cyanoacrylate glues in mesh fixation for hernia repair.

**Results.** We found 27 articles: 17 randomized trials (RT), 8 case series, 1 review and 1 meta-analysis. The authors of these papers come from only two regions: Europe and Asia.

4 surgical procedures were used in combinations with cyanoacrylate mesh fixation: Lichtenstein, plug and patch technique, TAPP and TEP.

No studies showed the inferiority of glue over the other methods of fixation considering all four postoperative outcomes (acute pain, complication, chronic pain and recurrence).

The synthetic glue fixation achieves better results in terms of acute and chronic pain for both open and minimally-invasive surgical procedures for inguinal hernia repair.

**Conclusions.** Although synthetic glue mesh fixation for inguinal hernia is not widely used over the world, it is a safe and effective way for mesh fixation both in open and minimally-invasive inguinal hernia repair and significantly decreases postoperative acute and chronic pain.

**Keywords:** inguinal hernia, mesh, cyanoacrylate, review

## INTRODUCTION

Inguinal hernia is a wide-spread problem which affects almost 25% of men during their life-time (1).

Multiple surgical procedures have been developed to address this condition and in recent years, ones using meshes proved to have better results than tissue repairs in terms of hernia recurrence and compliance to the procedure.

Nevertheless, mesh fixation is still under debate. Today there are multiple options which vary from no-fixation to sutures, permanent or absorbable tackers, self-fixating mesh to biological or synthetic glues.

Our objective is to determine the spread of cyanoacrylate glue usage for inguinal hernia mesh fixation and the clinical results in terms of postoperative pain, complications, chronic pain and hernia recurrence.

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## METHODS

Systematic review of the literature with US National Library of Medicine and National Institutes of Health International PubMed using abstracts and articles available in PubMed and Cochrane databases, searching for (“cyanoacrylates” (MeSH Terms) OR “cyanoacrylates” (All Fields) OR “cyanoacrylate” (All Fields)) AND (“hernia” (MeSH Terms) OR “hernia” (All Fields) AND “herniorrhaphy” (MeSH Terms) OR “herniorrhaphy” (All Fields))

Our focus is on adult inguinal hernia repair by a surgical procedure using a mesh. We take into consideration all the studies without a time limit, but we analyzed only the ones designed for humans and written in the English language; we include both the ones with an abstract or full-text available.

All the remaining articles after the electronic filters were applied were individually reviewed by the authors to meet the including criteria and provide the information needed to fulfil our objective.

## RESULTS AND DISCUSSION

The first electronic search returned 462 articles and 21 duplicates were removed. 411 of the remaining papers were excluded according to our criteria following manual screening. From the remaining 30 articles three were not taken into consideration as they couldn’t provide most of the data needed. The study flow dia-

gram is represented in Fig. 1 and was created using PRISMA Guideline (2).

27 articles met the selection criteria and were written by 26 authors. These papers and their main characteristics are summarized in Table 1.

The authors of the articles come from only two regions: Europe (19 authors – 73%) and Asia (7 authors – 27%) – Fig. 2. There isn’t a large spread of this method around the globe as three quarters of the reporting surgeons are working in Europe. Even here most of the reports come from only four countries: Switzerland, Spain, Italy and Poland.

Cyanoacrylate is the generic name of a group of fast-acting adhesives such as ethyl-2-cyanoacrylate, n-butyl cyanoacrylate, 2-octyl cyanoacrylate. Cyanoacrylate is an acrylic resin that polymerizes exothermically in the presence of water, especially with hydroxide ions, joining the bonded surfaces in 5–6 s and reaching the final stage in 60s. It bonds body tissue excellently and shows bacteriostatic effects. The use of such synthetic glues has become general practice and they are used today in surgery, digestive endoscopy or vascular interventional radiology. The n-butyl-2-cyanoacrylate (NBCA) is the most used glue for mesh fixation in hernia repair and it is produced under different brand names (Histoacryl and Glubran are the most well-known in Europe).

NBCA glue was used for mesh fixation in 24 out of 26 articles (92.3%).

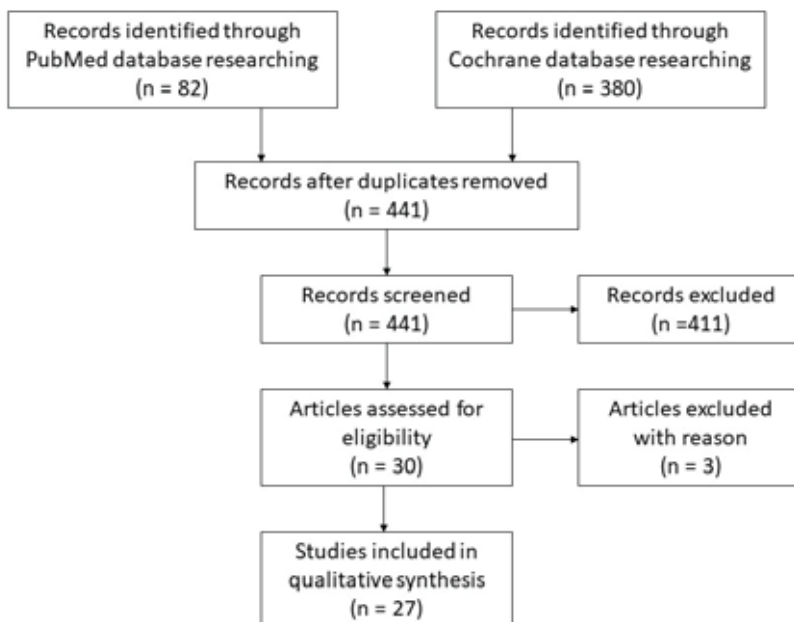


FIGURE 1. Study flow diagram

TABLE 1

	Year	Author	Country	Study	Procedure	Glue	Comparison
1	2017	Liew W (3)	Malaysia	RT	TEP	NBCA	Glue vs Tackers
2	2017	Shen YM (4)	China	RT	TEP	NBCA	Glue vs No-fixation
3	2017	Hoyuela C (5)	Spain	RT	Lichtenstein	NBCA	Glue vs Suture
4	2017	Matikainen M (6)	Finland	RT	Lichtenstein	NBCA	Glue vs Suture
5	2016	Antoniou SA (7)	Germany	Meta-Analysis	TAPP/TEP	cyanoacrylate fibrin	Glue vs mechanical fixation
6	2016	Jani K (8)	India	RT	TEP	NBCA	Glue vs suture
7	2015	Rönkä K (9)	Finland	RT	Lichtenstein	NBCA	Glue vs Self-grip mesh vs Suture
8	2014	Garcia-Vallejo L (10)	Spain	Case series	TEP	NBCA	61 consecutive case series
9	2014	Moreno-Egea A (11)	Spain	RT	TEP/Lichtenstein	n-hexyl- $\alpha$ -cyanoacrylate	Glue vs sutures glue vs tackers
10	2014	Burza A (12)	Italy	Case series	TAPP	NBCA	Glue vs tackers
11	2014	Sanders DL (13)	UK	Review	Lichtenstein	NBCA	Glues, self-grip mesh, tackers, suture
12	2013	Subwongcharoen S (14)	Thailand	RT	TEP	NBCA	Glue vs tackers
13	2013	Moreno-Egea A (15)	Spain	Case series	TEP/Lichtenstein	n-hexyl- $\alpha$ -cyanoacrylate	Glue vs suture
14	2013	Wang MG (16)	China	Case series	TAPP	NBCA	Glue vs tackers
15	2012	Eldabe Mikhail A (17)	Spain	RT	Plug and patch	NBCA	Glue vs suture
16	2012	Treepongkaruna SA (18)	Thailand	Case series	TEP	NBCA	15 case series
17	2012	Dabrowiecki S (19)	Poland	RT	Lichtenstein	NBCA	Glue vs suture
18	2012	Shen YM (20)	China	RT	Lichtenstein	NBCA	Glue vs suture
19	2012	Brügger L (21)	Switzerland	RT	TAPP	NBCA	Glue vs tackers
20	2012	Kukleta JF (22)	Switzerland	Case series	TAPP	NBCA	1336 case series
21	2012	Kim-Fuchs C (23)	Switzerland	RT	Lichtenstein	NBCA	Glue vs suture
22	2011	Paajanen H (24)	Finland	RT	Lichtenstein	NBCA	Glue vs suture
23	2010	Testini M (25)	Italy	RT	Plug and Mesh	NBCA	Glue vs fibrin vs suture
24	2007	Agresta F (26)	Italy	Case series	TAPP	NBCA	76 case series glue and fibrin
25	2004	Nowobilski W (27)	Poland	RT	Lichtenstein	NBCA	Glue vs suture
26	2003	Helbling C (28)	Switzerland	RT	Lichtenstein	NBCA	Glue vs suture
27	1998	Jourdan IC (29)	UK	Case series	TAPP	NBCA	7 case report

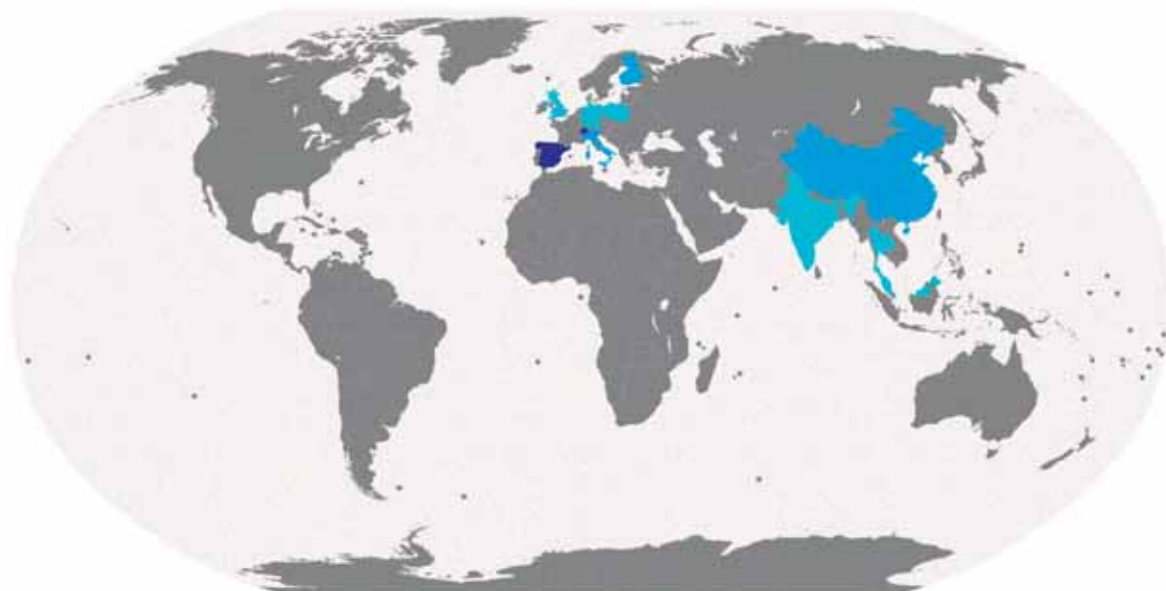


FIGURE 2. The world distribution of authors (the map was created using GunnMap application)

The first article mentioning the use of cyanoacrylate for mesh fixation in laparoscopic hernia repair was in 1998 and the authors (Jourdan and Bailey) described the prototype glue dispenser and the application method (29).

After that pioneer report it took almost 10 years for the next article to be published. In 2007, Agresta, an Italian author, presented a series of 76 patients operated for inguinal hernia using a light mesh fixed by glues (fibrin sealant and n-butyl-2-cyanoacrylate) (26). The definitive acknowledgement of this method came in 2012 when Kukleta communicated positive results using n-butyl-cyanoacrylate glue to fix meshes in over 1300 TAPP repairs of primary and recurrent inguinal hernias (22). This is the largest series published so far in the literature.

The first meta-analysis of randomized trials comparing glues (both fibrin and biosynthetic) versus mechanical fixation in laparoscopic inguinal hernia repair was published in 2016 by Antoniou (7).

Today the recommended surgical procedures for inguinal hernia use a mesh. For the open access Lichtenstein is the choice procedure and for minimally invasive approach both TAPP (transab-

dominal preperitoneal) and TEP (total extraperitoneal) are accepted with equal results (30).

Because there are different techniques the results were analyzed according to each procedure.

### Open hernia repair

We identified 9 randomized trials (RT) from 2003 to 2017 which compare the use of NBCA and sutures for Lichtenstein hernia repair and the results are presented in Table 2.

Considering acute pain in the immediate postoperative period the NBCA produce less pain in 5 RT and similar pain in 3 RT compared to sutures. The sutures used for comparison were absorbable (5 RT) and non-absorbable (4 RT). Chronic pain is defined as postoperative pain lasting more than 3 months. NBCA produce similar chronic pain as suture (7 RT) or less (1 RT).

Regarding postoperative complication the use of NCBA produce similar events (8 RT) or less (1 RT).

Hernia recurrence was equal (4 RT) or similar (5 RT) for both groups regardless of short term (3-5 months) or long term (5-7 years) follow-up.

**TABLE 2.** RT comparing NBCA in Lichtenstein hernia repair

	Author/year	Study	Pt (n)	Comparison	Acute pain	Complications	Chronic pain	Recurrence	Other
1	Hoyuela C, 2017	RT	370	NBCA vs perm. suture	Favor glue	Similar	Similar	Similar 1-year follow-up	Less operative time in glue
2	Matikainen M, 2017	RT	236	NBCA vs abs. suture	Not done	Similar long-term complication	Similar	Similar 7-year follow-up	Equal foreign body sensation
3	Rönkä K, 2015	RT	625	NBCA vs SG mesh vs perm. suture	Similar	Similar	Similar	Similar 1-year follow-up	Equal foreign body sensation
4	Dabrowiecki S, 2012	RT	41	NBCA vs perm. suture	Favor glue	Similar	Similar	Similar 1-year follow-up	Quicker return to activity for glue
5	Shen YM, 2012	RT	110	NBCA vs perm. suture	Favor glue	Favor glue	Favor glue	Equal	Less operative time in glue
6	Kim-Fuchs C, 2012	RT	264	NBCA vs abs. suture	Similar	Similar	Similar	Similar 5-years follow-up	Less operative time in glue
7	Paajanen H, 2011	RT	302	NBCA vs abs. suture	Similar	Similar	Similar	Equal 1-year follow-up	Similar operative time
8	Nowobilski W, 2003	RT	46	NBCA vs abs. suture	Favor glue	Similar	Not done	Equal 4,7-month follow-up	Similar operative time
6	Helbling C, 2003	RT	46	NBCA vs abs. suture	Favor glue	Similar	Similar	Equal 3-month follow-up	Better results for glue

Equal – the results are identical.

Similar – the results are different but not statistical significant.

Favor – the results have a positive meaning for a specific method in a statically way or it is the author conclusion

Beside these advantages the use of glue in Lichtenstein repair also decreases the operative time (3 RT) or didn't prolong it (2 RT).

We identified two more RT for open inguinal hernia repair using plug and patch technique and NBCA.

Eldabe Mikhail in 2012 also reports better outcome for glue group regarding short term morbidity, chronic neuralgia and similar recurrence at 1 year follow-up in a randomized trial conducted on 198 patients, the postoperative stay was significantly shorter for the glue group (31).

Testini in 2010 compared 156 patients with inguinal hernia repaired by a plug and patch technique, the mesh fixation by sutures, human fibrin glue or n-butyl-2-cyanoacrylate. Short term morbidity was lower in the glue groups compared with suture, two cases of chronic pain in the suture group, the recurrence was equal in all the groups (25).

Moreno-Egea showed that the use of another synthetic glue (n-hexyl-a-cyanoacrylate) has better results in term of pain and analgesic use while the postoperative complications and recurrence rates are the same compared with standard suture (11,15).

In 2014, Sanders published a systematic review of randomized trial assessing mesh fixation

in open inguinal hernia repair in which he included 12 randomized trials and 1992 patients. The overall conclusion was that suture and glues are substantially equivalent and suggested that glues may have a beneficial effect of reducing immediate post-operative pain and chronic pain (13).

**Minimally invasive hernia repair**

The minimally invasive procedures addressed to inguinal hernia repair (TAPP or TEP) use tacks as the first choice to fix the mesh in position or to close the peritoneal fold. Although it is less invasive than the open approach it also produces pain associated with mesh fixation. New methods of fixation were developed to decrease that complication varying from suture to glue or no-fixation at all.

In Table 3 and Table 4 we summarize the results of 7 RT comparing NBCA with other mesh fixation methods in TEP and TAPP procedures.

Considering acute pain as end-point NBCA provided superior (4 RT) or similar (3 RT) results to tacks. It has similar results with no-fixation (2 RT). The same thing happens in chronic pain: 3 RT report superior results and 4 similar results in the use of NBCA. Specific surgical complications are also similar in most of the studies (6 RT).

**TABLE 3.** RT comparing NBCA in TEP hernia repair

	Author/year	Study	Pt (n)	Comparison	Acute Pain	Complications	Chronic Pain	Recurrence	Other
1	Liew W, 2017	RT	66	NBCA vs tackler	Similar	Similar	Similar	Similar 3-month follow-up	Elevated ESR at 3 months in glue group
2	Shen YM, 2017	RT	160	NBCA vs no-fixation	Similar	Similar	Similar	Favor glue 1-year follow-up	Similar costs
3	Jani K, 2016	RT	251	NBCA vs suture	Similar	Similar	Similar	Similar 2 years follow-up	Less pain at 7 days in glue group
4	Subwongcharoen S, 2013	RT	60	NBCA vs tackler	Favor glue	Similar	Favor glue	Similar 1-year follow-up	1 recurrence in tackler group

**TABLE 4.** RT comparing NBCA in TAPP hernia repair

	Author/year	Study	Pt (n)	Comparison	Acute Pain	Complications	Chronic Pain	Recurrence	Other
1	Burza A, 2014	RT	70	NBCA vs tacks	Favor glue	Favor glue	Favor glue	Equal 2-years follow-up	Shorter hospital stays for glue group
2	Wang MG, 2013	RT	1027	NBCA vs no-fixation vs tacks	Favor glue and no-fixation	Similar	Favor glue and no-fixation	Equal 2-years follow-up	---
3	Brugger L, 2012	RT	80	NBCA vs tacks	Favor glue	Similar	Similar	Similar 3-years follow-up	Hypoesthesia was higher in tacks group

Recurrence rate is equal (2 RT), similar (4 RT) or favor the glue group (1 RT) in a 3 month to 3 years follow-up.

The first article that proposed the use of cyanoacrylate in TEP repair was published in 2012 and the authors noted that early postoperative pain was similar to other cases and they didn't record any early recurrence or chronic pains; in addition, an innovative instrument for glue delivery was described (18).

Garcia-Vallejo, in a case series of 61 consecutive patients (TEP procedure and NBCA mesh fixation), found that majority of patients (59%) required low dosages of painkillers in the first 24 hours after surgery. The patients were followed for a minimum 18-month period (average 29.7 months) and no case of chronic pain or hernia recurrence was noticed (10).

There are also two more articles by Moreno-Egea (11,15). The author uses a similar glue (n-hexyl- $\alpha$ -cyanoacrylate) for TEP inguinal hernia repair and he found significant differences in favor of the glue in postoperative pain and analgesic use while the morbidity and recurrence rate are similar at 1-year follow-up. He also performed a financial analysis that showed potenti-

al annual savings of €123,916 by using the glue instead of suture and tackers. These articles also support the idea that the use of glue instead of mechanical fixation is beneficial to postoperative outcome.

After all the papers were reviewed we can say that no studies showed the inferiority of glue over the other methods of fixation considering all four postoperative outcome (acute pain, complication, chronic pain and recurrence). Furthermore, synthetic glue fixation has better results in terms of acute and chronic pain for both open and minimally-invasive surgical procedures for inguinal hernia repair.

## CONCLUSIONS

Synthetic glue mesh fixation for inguinal hernia is not a very popular or commonly-used method of fixation over the world.

It has been proved that it is a safe and effective method of mesh fixation both in open or minimally invasive inguinal hernia repair and significantly decreases the postoperative acute and chronic pain.

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