

Meta-analysis of skin adhesives versus sutures in closure of laparoscopic port-site wounds

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Abstract

Objective To analyze the effectiveness of skin adhesives and sutures in the closure of laparoscopic port-site wounds.

Methods Electronic databases were searched to find relevant randomized controlled trials and their data was analyzed to generate a summative outcome.

Results Seven trials on port-site wound closure after laparoscopic procedures encompassing 902 patients were retrieved from the electronic databases. Four randomized controlled trials on 404 patients qualified for the review according to inclusion criteria. In both fixed- and random-effects models, there was no difference between the two port-site wound closure techniques in terms of wound infection, wound dehiscence and, patient satisfaction. However, statistically tissue adhesives were quicker in port-site wound closure as compared with sutures.

Conclusions Based on this review, there is insufficient evidence that port-site wound closure technique by tissue adhesives is superior to traditional suture closure technique in terms of wound infection, wound dehiscence, and patient satisfaction. However, tissue adhesives are quicker in port-site wound closure. A multicentre randomized controlled trial is required in order to obtain stronger evidence.

Keywords Acrylate · Cyanoacrylate · Laparoscopy · Port-site wounds · Skin adhesives

Skin adhesives have been used in variety of different specialties to close skin wounds [1–4]. Traumatic lacerations encountered in the emergency department are commonly repaired with skin glue [5]. Surgical wounds are traditionally closed with sutures (polydioxanone, polypropylene, etc.) and imply rapid wound healing by apposing the epidermal and dermal tissue layers [6]. The perceived speed of application and ease of use has meant that tissue adhesives have gained popularity. They were first used in 1959 but their widespread application was limited as a result of concerns over toxicity such as skin irritation and respiratory problems [5]. These issues have largely been resolved with further advances in pharmaceutical formulations [7, 8]. Cyanoacrylate is the generic name for fast-acting cyanoacrylate-based glues such as ethyl-2-cyanoacrylate, *n*-butyl-cyanoacrylate, and 2-octyl cyanoacrylate; the latter is commonly used in medical glues such as Indermil, Histoacryl, Dermabond, Nexaband, and Traumaseal [9]. Tissue adhesives consist of monomers of cyanoacrylate molecules. In the presence of water or hydroxide ions, cyanoacrylate rapidly polymerizes, resulting in the formation of long, strong chains, bringing the bonded surfaces together. For surgical wounds cyanoacrylate sets quickly, often in less than 1 min, making it ideal for port-site wound closure in laparoscopic procedures. A normal bond reaches full strength in 2 h and is waterproof [10]. The breaking strengths of the glue varies from 15–100% of 5/0 monofilament sutures [11]. The purpose of this article is to look at the effectiveness of skin adhesives and sutures in the closure of laparoscopic port-site wounds by using a tool of meta-analysis.

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Methods

All prospective randomized controlled studies comparing sutures with skin adhesives for the closure of laparoscopic trocar wounds from January 1959 to August 2008 were identified through searches of Medline, EMBASE, CINAHL, Cochrane Library, and Pubmed databases. The search terms “skin adhesives”, “acrylate”, “cyanoacrylate”, “monofilament”, “sutures”, “polydioxanone” and “polypropylene” were used in combination with medical subject heading “laparoscopy.” Relevant articles referenced in these publications were also downloaded from databases. The “related article” function was also used to widen the search results. All abstracts, comparative studies, nonrandomized trials, and citations scanned were searched comprehensively. A flow chart of the literature search is shown in Fig. 1.

Each article was critically reviewed by two researchers for eligibility in our review (Table 1). Only randomized controlled studies looking at skin adhesives and sutures for the closure of laparoscopic port-site wound were analyzed. Two researchers extracted data separately, confirmed by a third researcher. Statistical analyses were performed by a senior statistician using Microsoft Excel 2007® for Windows XP. For continuous data (closure time), Hedges *g* statistic was used for the calculation of standardized mean differences (SMD), which explains the combined outcome of the difference in time (seconds) between suture and adhesive closure of the port-site wounds. The SMDs were combined using inverse variance weights in the fixed-effects model and the DerSimonian and Laird method in

Table 1 Inclusion criteria

Inclusion criteria

- All prospective randomized controlled trials comparing skin adhesives with sutures in the closure of laparoscopic wounds.
- Trials on patients of any age and sex.
- Trials in all languages

the random-effects model [12]. Binary data (wound infection, wound dehiscence, satisfaction) were summarized as risk ratios (RR) indicating less relative risk of wound infection, wound dehiscence, and patient dissatisfaction using either glue or suture for port-site wound closure. Binary data was combined using the Mantel–Haenszel method under the fixed-effects model and the DerSimonian and Laird method under the random-effects model. In each case a heterogeneity test was carried out to see whether the fixed-effects model was appropriate. In a sensitivity analysis, 0.5 was added to each cell frequency for trials in which no event occurred in either technique of wound closure, according to the method recommended by Deeks et al. [13]. Forest plots were used for the graphical display of results from the meta-analyses: subgroup and sensitivity analyses were not feasible due to the limited number of studies. Publication bias was also difficult to assess due to the small number of studies and patients.

Results

Seven trials [11, 14–19] on port-site wound closure after laparoscopic procedures encompassing 902 patients were

Fig. 1 Flow chart of literature search

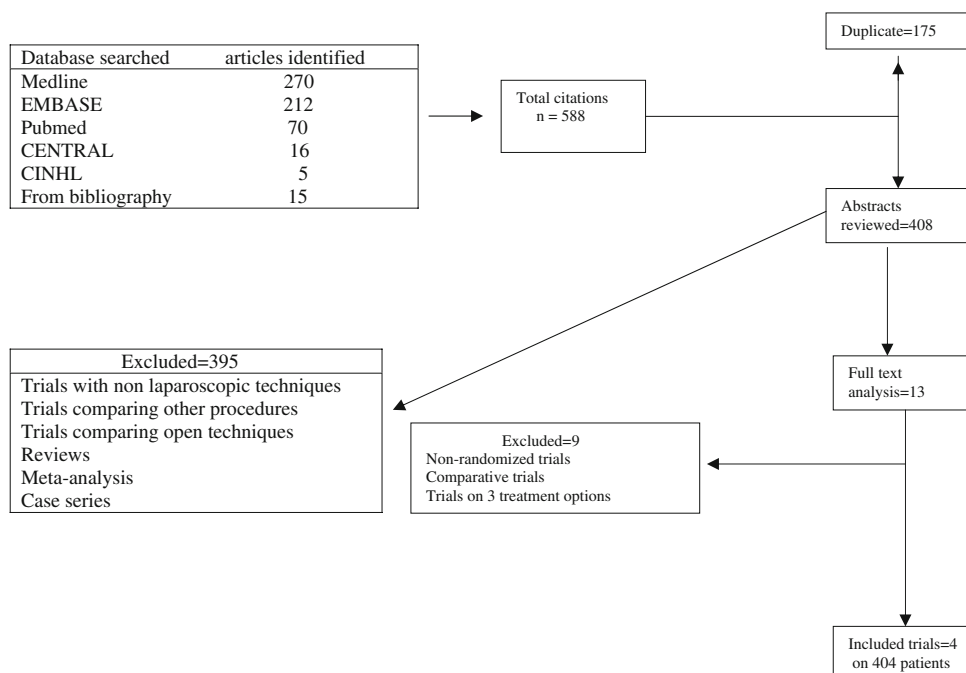


Table 2 Excluded studies

Trial	Reason for exclusion
Harold KL et al. [17]	Trial on three wound closure techniques
Maartense et al. [18]	Trial on three wound closure techniques
Qureshi et al. [19]	Nonrandomized controlled trial

retrieved from the electronic databases. Four randomized controlled trials [11, 14–16] on 404 patients qualified for the review according to inclusion criteria (Table 1). Three trials [17–19] were excluded due to the reasons mentioned in Table 2. Characteristics of each trial are given in Table 3. Port-site wounds were closed by glue in 204 patients and by suture in 200 patients. Standard deviations were not reported in the majority of studies; where necessary these were estimated either from ranges or *P*-values. Different wound closure protocols used in these studies are given in Table 4. The outcome variables extracted from these trials are shown in Table 5. Thorough skin suturing technique was not clearly mentioned in most of the trials. Subcuticular technique was used in all trials except one [11]. Whether they used continuous or interrupted subcuticular technique was not clearly mentioned. All ports were closed either by sutures or by skin adhesives. In one trial [14] steristrips were used after subcuticular suture closure of the port-site wounds.

Methodological quality of included studies

The methodological quality of included trials is explained comprehensively in Table 6. The Mantel–Haenszel fixed-effect model was used to compute robustness and susceptibility to any outliers among these trials. The allocation concealment, intention-to-treat analysis, and blinding of investigator or assessor were not clearly reported; consequently the methodological quality of all three trials was considered inadequate and the results of our review may be considered biased. Furthermore, in all these studies different types of glues and sutures were used to close port-site wounds, which can be another reason for possible contamination of the results. The weighted effect of these trials was also variable.

Table 3 Characteristics of trials included in this review

Trials	Year	Speciality	Patients–glue	Patients–suture	Follow-up (days)
Dowson et al. [11]	2006	Hepatobiliary	76	78	90
Sebesta et al. [14]	2004	Urology	30	29	14
Jallali et al. [15]	2004	Hepatobiliary	48	51	56
Matin et al. [16]	2003	Combination of above	50	42	21

Table 4 Treatment protocol adopted in trials

Dowson et al. [11]	Glue: <i>n</i> -butylcyanoacrylate Suture: polyamide
Sebesta et al. [14]	Glue: octyl cyanoacrylate Suture: polyglactin 910 or poliglecaprone 25
Jallali et al. [15]	Glue: 2-octylcyanoacrylate used Suture: 3/0 polydioxanone
Matin [16]	Glue: octyl cyanoacrylate Suture: not stated

Wound closure time

In the both fixed- and random-effects models, statistically wound closure by using glue was quicker than using the suture [fixed-effects SMD -1.66 s, 95% CI $(-1.90, -1.43)$, $z = -13.79$, $p < 0.000$; random effects SMD -2.13 s, 95% CI $(-3.27, -1.00)$, $z = -3.69$, $p < 0.0002$; Fig. 2] indicating skin adhesive will take approximately 166–185s less than suture in port-site wound closure. However, there was significant heterogeneity ($Q = 59.09$, $df = 3$, $p < 0.000$) among trials.

Wound infection

In the fixed-effects model, statistically there was no difference in wound infection rate between the two wound closure techniques [RR 0.77, 95% CI (0.37, 1.59), $z = -0.68$, $p < 0.49$; Fig. 3] indicating both groups will have same risk (approximately 0.7%) of wound infection. There was no significant heterogeneity among trials ($Q = 1.0$, $df = 3$, $p = 0.31$).

Wound dehiscence

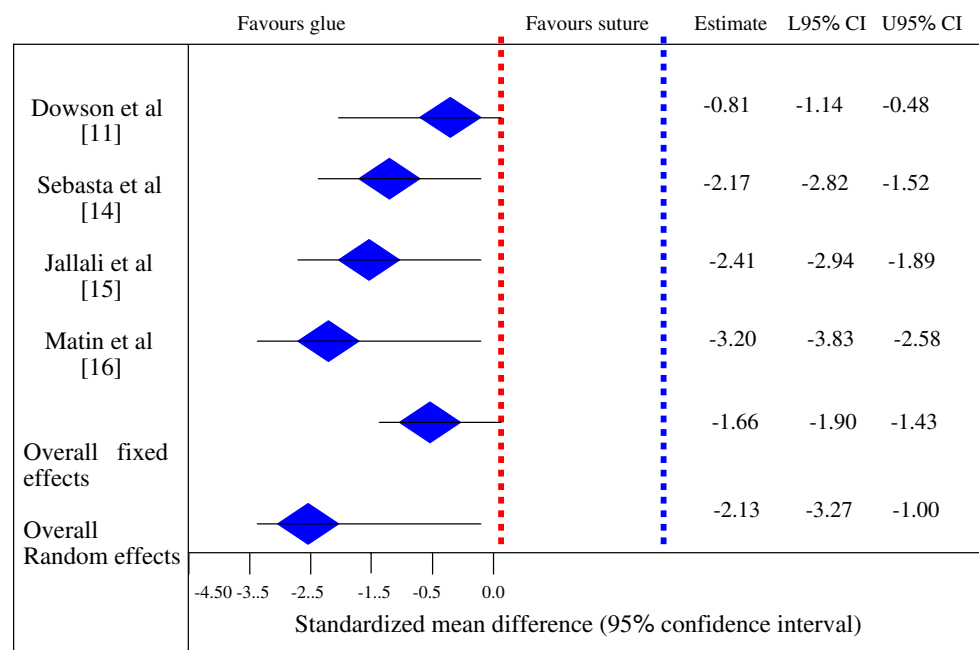
In the both fixed- and random-effects models, statistically there was no difference in wound dehiscence rate between the two wound closure techniques [fixed effects RR 1.14, 95% CI (0.40, 3.19), $z = -0.25$, $p < 0.79$; random effects RR 1.18, 95% CI (0.39, 3.51), $z = 0.30$, $p < 0.76$; Fig. 4] indicating both groups will have same risk (approximately 1%) of wound dehiscence. There was no significant heterogeneity among trials ($Q = 2.77$, $df = 3$, $p = 0.09$).

Table 5 Outcome variables

Trial	Type	Closure time (s)	Wound infection	Dehiscence	Satisfaction
Dowson et al. [11]	Glue	125 ± 105	6/61	4/61	76/76
	Suture	220 ± 125	10/58	2/58	76/78
Sebesta et al. [14]	Glue	222 ± 73	1/29	2/29	No data
	Suture	790 ± 360	1/30	0/30	No data
Jallali et al. [15]	Glue	165 ± 45	0/12	0/12	No data
	Suture	356 ± 100	0/13	0/13	No data
Matin et al. [16]	Glue	150 ± 55	5/48	1/48	27/48
	Suture	360 ± 75	3/37	3/37	23/37

Table 6 Methodological qualities of included trials

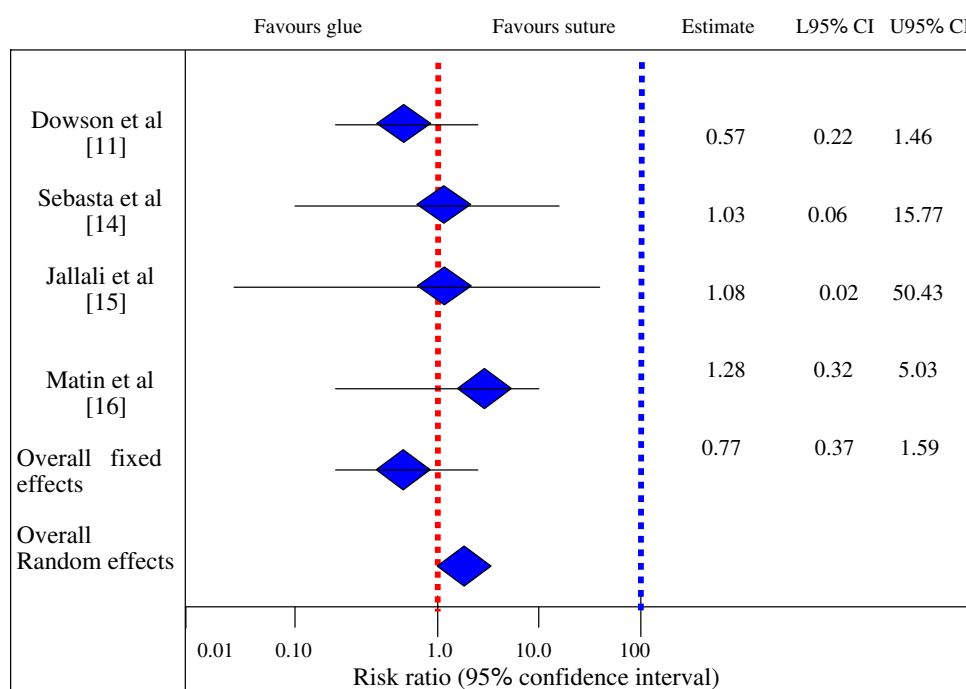
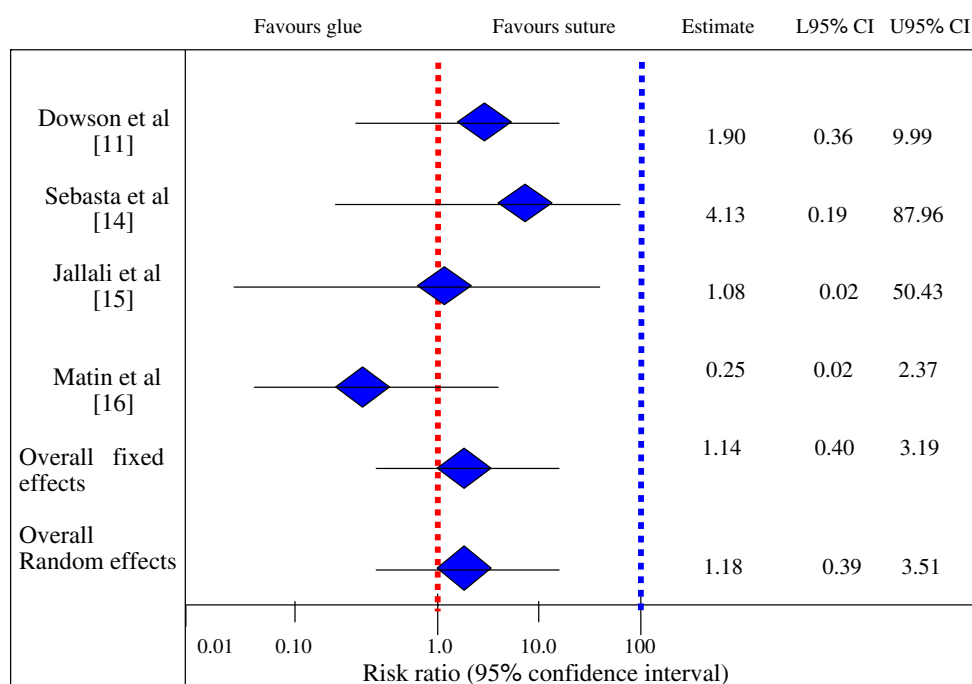
Quality variables	Dowson [11]	Sebesta [14]	Jallali [15]	Matin [16]
Inclusion criteria	Stated	Stated	Stated	Stated
Exclusion criteria	Stated	Not stated	Not stated	Stated
Randomization technique	Stated	Not stated	Stated	Stated
Sample size calculation	Stated	Not stated	Not stated	Stated
Baseline comparable	Stated	Stated	Not stated	Stated
Masked/blinded	Stated	Not stated	Stated	Not stated
Crossover	Stated	Not stated	Not stated	Stated
Lost to follow-up	Stated	Not stated	Not stated	Stated
Allocation concealment	Stated	Not stated	Stated	Not stated
Intention-to-treat analysis	Stated	Not stated	Not stated	Stated

Fig. 2 Closure time

Patient satisfaction

Two trials [11, 14] contributed to the calculation of patient satisfaction with the wound scar. In the fixed-effects

model, statistically there was no difference in patients satisfaction with wound scar after the use of the two wound closure techniques [RR 0.99, 95% CI (0.90, 1.00), $z = -0.10$, $p < 0.91$; Fig. 5] indicating patients in both groups

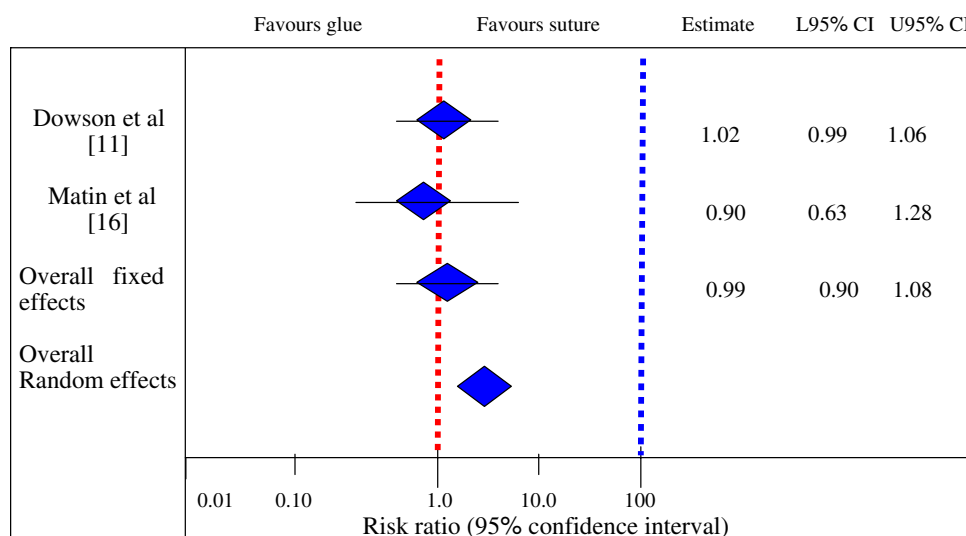
Fig. 3 Wound infection**Fig. 4** Wound dehiscence

will have very little dissatisfaction with either technique. There was no significant heterogeneity between trials ($Q = 3.10$, $df = 1$, $p = 0.07$).

Discussion

Closure of surgical wounds using sutures has been a well-established and reliable technique for many decades.

However, closure of port-site wound using sutures is not without problems such as tissue trauma resulting from frequent skin handling, wound infections, keloid formation, and wound dehiscence. It is therefore important to consider alternatives methods of port-site wound closure from new developments in biomedical technology. Tissue adhesives and adhesive tapes are among many other wound closure techniques, in particular small wounds after laparoscopic surgery. As these tissue adhesives have been developed to

Fig. 5 Patient satisfaction

improve effectiveness, one may have expected to find a difference in wound closure times, infection rate, wound dehiscence, and cosmetic outcome.

Postoperative wound infection is a common problem that has significant psychological impact on patients and financial impact on healthcare system. More than 70% of procedures are now performed on day-case basis, mainly by laparoscopic technique, which poses significant challenge for the surveillance of surgical-site infection [19]. The incidence of surgical wound site infection (for both open and laparoscopic wounds) has been reported from 1.0% to 20% [20–25]. One may presume that a tissue adhesive offers a barrier to microorganisms at the site of incision and may reduce the incidence of wound infection. However, studies identified for this review [11, 14–16] did not demonstrate any significant difference in wound infection rate between sutures and tissue adhesives. Similarly summative outcome of included trials was also not different from this conclusion, indicating no superiority of either wound closure technique.

Patient satisfaction and cosmetic outcome is an important variable to analyze when comparing alternative wound closure techniques. Patient's satisfaction may include appearance of the scar, comfort at wound site, ability to shower, ability to move around, dressing changes, wound tension, hygiene problems, and allergic reactions. Frequent dressing change and need for removal after suture closure is expected to favor the use of tissue adhesives. The studies in this review did not demonstrate any statistically significant difference in patient satisfaction. Wound closure time was reported in all included [11, 14–16], excluded [17–19], and few other trials [26–28]. This was one of the outcomes of interest in this review. The use of tissue adhesive is associated with quicker wound closure as compared with suture. Faster wound closure by tissue adhesive may enhance

surgeon satisfaction and may also be attractive for patients when surgery is undertaken under local anaesthetic. This variable might not influence patients undergoing laparoscopic surgery.

Tissue adhesives cost more than suture closure of port-site wounds. An ampoule of adhesive may be three times or more the cost of a suture [29] required to close an incision of the same length. A dressing is not required over a wound closed by tissue adhesive, but this will not make much difference to the overall cost of wound closure by tissue adhesive. Based on this review, there is insufficient evidence that port-site wound closure technique by tissue adhesives is superior to traditional suture closure technique in terms of wound infection, wound dehiscence, patient satisfaction or surgeon satisfaction. A multicentre randomized controlled trial is required in order to obtain stronger evidence.

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