

Cyanoacrylate Dermal Closure in Spine Surgery: Systematic Review and Pooled Analysis

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Abstract

Study Design: Systematic review.

Objectives: Cyanoacrylate glue closure has been utilized for dermal closure in surgical incisions. Its safety and efficacy in spine surgery are not established. The authors perform a systematic review to determine the rate of surgical site infection (SSI), wound dehiscence, and wound erythema with cyanoacrylate dermal closure in spine surgery.

Methods: A systematic review adhering to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines was performed utilizing the PubMed/MEDLINE, EMBASE, and Cochrane databases on patients undergoing spine surgery with cyanoacrylate dermal closure. Pooled analysis was performed with stratification of patients according to spinal level and the presence/absence of instrumentation. Risk-of-bias and methodological quality was appraised using 17 prespecified criteria.

Results: Five articles (1 retrospective cohort study, 4 cases series) with a total of 1282 patients were included. A total of 967 patients, all diagnosed with degenerative spine disease, were suitable for pooled analysis. In 290 patients who underwent anterior cervical discectomy and fusion, and in 23 patients with posterior cervical decompression (without instrumentation), there was 0% rate of SSI, wound dehiscence, and erythema. In 489 patients who underwent lumbar microdiscectomy, there was 0.41% rate of SSI, 0.20% rate of wound dehiscence, and 0.20% rate of wound erythema. In 165 lumbar laminectomy patients, there was a 1.82% rate of SSI, 0.61% rate of wound dehiscence, and 0% rate of wound erythema.

Conclusion: Cyanoacrylate dermal closure for the aforementioned procedures is associated with low rates of wound complications (SSI, dehiscence, and erythema). Further studies should be performed, especially in nondegenerative surgery, instrumented thoracic and lumbar spine surgery.

Keywords

cyanoacrylate, tissue glue, wound closure techniques, spine surgery, risk factors, surgical wound infection, wound complications

Introduction

Cyanoacrylates were first synthesized in the 1940s as part of industrial research during World War II. *N*-butyl cyanoacrylate, and 2-octyl cyanoacrylate are the most commonly forms used in current surgical practice for incisional wound closure. Reported advantages of cyanoacrylate use include the ease of application,¹ decreased time taken for wound closure, potential cost savings,² and a reduced incidence of surgical site infection (SSI).³

The use of cyanoacrylates has been studied extensively in the field of surgery.⁴ However, its safety and efficacy in spine surgery is less established. Incisions employed in spine surgery

are often in mobile body regions (eg, posterior cervical wounds with neck flexion) and risk of wound dehiscence is an understandable concern when cyanoacrylates are used. Furthermore,

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Table 1. Risk of Bias Criterion Analysis.

	First Author, Year				
	Ando, 2014	Wachter, 2010	Tacconi, 2018	Yang, 2009	Hall, 2005
Study design	Cohort	Case series	Case series	Case series	Case series
Study setting recorded	—	—	—	—	+
Time period of study stated	+	—	+	+	+
Eligibility criteria stated	+	+	+	+	+
Method of case identification	+	+	+	+	+
Sample Size calculation	—	—	—	—	—
Indication for surgery recorded	+	—	+	+	+
Type of surgical procedure recorded	+	+	+	+	+
Spinal level recorded	+	+	+	+	+
Use of intravenous antibiotics for SSI prophylaxis	+	+	—	—	—
Definition for SSI stated	+	—	—	—	—
SSI outcome assessors blinded	—	—	—	—	—
Duration of follow-up more than 30 days	+	+	+	—	+
Type of dressing used stated	+	+	—	—	+
Duration of dressings left intact stated	+	+	—	—	+
Known risk factors for SSI recorded	+	+	—	+	—
Univariate analysis undertaken	+	—	—	—	—
Multivariate analysis undertaken	—	—	—	—	—

Abbreviation: SSI, surgical site infection.

while cyanoacrylates have been reported to reduce SSI in non-spinal surgery,⁵ its ability to reduce infections in spine surgery is unclear.

Thus, the authors conduct a systematic review and pooled analysis to determine the incidence of wound complications, namely SSI, wound dehiscence and wound discharge when cyanoacrylates are used for dermal closure in spine surgery. Risk of bias is systematically assessed in a structured manner according to 17 prespecified criteria.

Methods

This systematic review was conducted in accordance to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.⁶

Eligibility Criteria

All studies utilizing cyanoacrylates for dermal closure in spine surgery and which included at least one of the following outcome measures were included: incidence of SSI, incidence of wound dehiscence, and incidence of wound erythema/inflammation. To be included, dermal closure has to be achieved solely by use of cyanoacrylates, and not as an adjunct to standard dermal/subcuticular suture closure. Diagnosis of SSI was defined in accordance to the Centers for Disease Control and Prevention (CDC) SSI criteria.

Information Sources

The MEDLINE/PubMed, Web of Science, EMBASE, and Cochrane databases were searched from date of inception to January 2, 2019. Boolean combinations of the following terms,

used as either MeSH (PubMed) terms or keywords were used in the search strategy: “wound closure techniques,” “spine surgery,” “postoperative period,” “risk factors,” “surgical wound infection,” and “cyanoacrylate.”

Study Selection and Data Extraction

Two authors (TT, JT) screened all articles independently for study inclusion, with contested citations absolved by consensus. Database searches were supplemented by manual searches of the bibliographies and citations of included studies to identify further suitable articles.

Data from included studies was extracted onto a preformatted data collection form on Microsoft Excel (Redmond, WA). Extracted data included study design, level of evidence, number of subjects, incidence of SSI, incidence of wound dehiscence, incidence of wound erythema/inflammation, spinal level of operation and type of surgery.

Assessment of Reporting Quality

Risk of bias of included studies was assessed. A prespecified set of 17 items pertinent to the methodological rigor of the included studies, as adapted from the CONSORT⁷ and STROBE⁸ guidelines were recorded. These items include study design, study setting, time frame of study, method of case identification, sample size calculation, indication for surgery, type of surgical procedure, definition of SSI, blinding, duration of follow-up, and statistical analysis with regard to univariate and multivariate analysis (see Table 1 for full criteria).

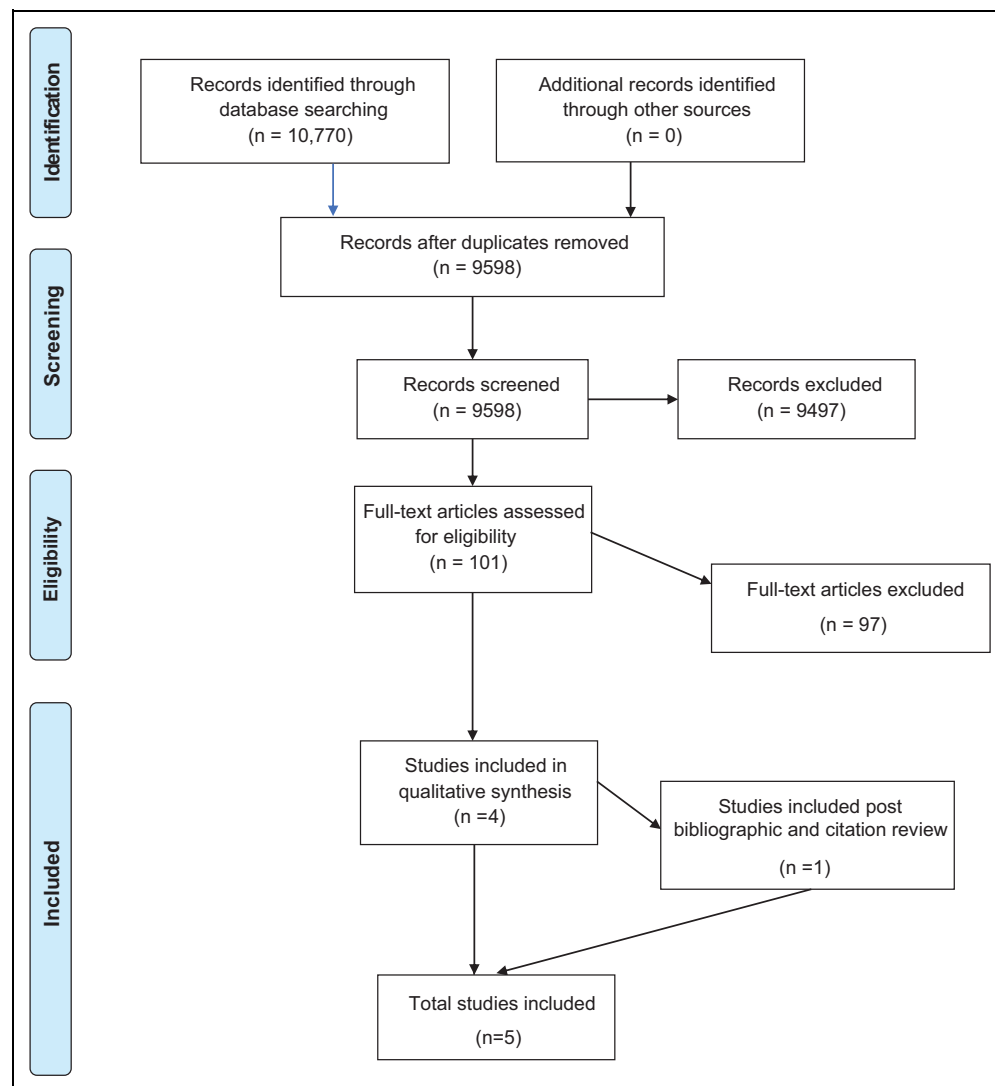


Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram of study inclusion.

Analysis of Data

As the key purpose of this review is to determine incidence of wound complications with cyanoacrylates, no comparative statistics was used. Results from included comparative studies are qualitatively analyzed. A pooled analysis of suitable available data from all included studies was performed. Outcome measures are calculated from pooled analysis and were stratified in accordance to spinal level of surgery (cervical, thoracic, lumbosacral) and type of procedure (including the presence/absence of instrumentation).

Results

A total of 10 770 citations were derived from the electronic search strategy. After screening of titles and abstracts, 101 remaining potential articles underwent full-text screening. In all, 97 articles were excluded after full text screening. The study by Howard et al⁹ was excluded as patients with

cyanoacrylate wound closure also simultaneously underwent skin closure with subcuticular monocryl suture. A citation and bibliographic search of the remaining articles resulted in one additional article for inclusion.¹⁰ As such, a total of 5 articles^{2,10-13} were included in this review (Figure 1).

Study Characteristics

Of the 5 articles, 1 was a retrospective cohort study,² and the remaining 4 studies¹⁰⁻¹³ were surgical case series. The number of subjects in the included studies ranged from 57 to 609 (median: 308). Four studies used 2-octyl-cyanoacrylate, and 1 study¹⁰ used butyl-cyanoacrylate for dermal closure. All 5 studies were conducted at teaching university hospitals. Two studies^{2,11} reported no conflicts of interest or industry sponsorship, while the remaining studies^{10,12,13} did not report on conflicts of interest.

In the only retrospective cohort study by Ando et al,² a total of 609 consecutive patients undergoing spinal surgery were

Table 2. Pooled Analysis in Accordance to Spinal Level and Procedure Type.

	Pooled N	No. of SSI (%)	No. of Dehiscence (%)	No. of Wound Erythema (%)
Cervical				
ACDF	290	0	0	0
Posterior, noninstrumented	23	0	0	0
Posterior, instrumented	0	NA	NA	NA
Thoracic				
Posterior, noninstrumented	0	NA	NA	NA
Posterior, instrumented	0	NA	NA	NA
Lumbosacral				
Microdiscectomy	489	2 (0.41)	1 (0.20)	1 (0.20)
Lumbar laminectomy	165	3 (1.8)	1 (0.61)	0
Posterior, instrumented	0	NA	NA	NA

Abbreviations: ACDF, anterior cervical discectomy and fusion; NA, not applicable.

included. A total of 315 patients underwent 2-octyl cyanoacrylate dermal closure, compared with 294 patients who underwent staple closure. Subdermal wound closure between the 2 groups were similar; that is, 2-0 absorbable suture closure of subdermal layer. Staples were removed 10 to 14 days after the operation and postsurgical dressings were left intact for 7 to 10 days after surgery. SSI was the primary outcome in this study, with none of the 2-octyl-cyanoacrylate patients, and 8 (2.72%) of the patients with skin staples developing a SSI ($P < .01$). There were no cases of wound dehiscence or wound inflammation/erythema in the cyanoacrylate group. Furthermore, the average time taken to close a 10-cm wound was shorter when cyanoacrylate was used rather than staples (19.9 ± 10.7 vs 48.0 ± 12.6 seconds, respectively, $P < .001$). This study included patients who underwent surgery at all spinal levels, mainly for degenerative conditions (>90% of patients). Overall, 30% of patients in each group underwent instrumented spinal fusion. Unfortunately, the presented data in this study, while suitable for calculation of overall wound complication rates, is not amenable to subgroup analysis in accordance to level and type of spinal surgery.

Data Pooling and Subgroup Analysis (Table 2)

A total of 1282 underwent cyanoacrylate dermal closure. The overall rate of SSI in the five included studies is 0.39% (5 of 1282 patients). This included 2 superficial SSI and 1 deep SSI (type of SSI not recorded in remaining 2 cases). The overall rate of wound dehiscence is 0.16% (2 of 1282 patients), and that of wound erythema/inflammation is 0.08% (1 of 1282 patients).

Data from 4 of the 5 studies (Ando et al² excluded due to lack of subgroup analysis) totaling 967 patients was pooled for further analysis. Coincidentally, it should be noted that all patients included in this subgroup analysis were operated on for degenerative spine conditions. In the cervical spine, a total of 290 patients underwent anterior cervical discectomy and fusion (ACDF), and 23 patients underwent posterior cervical decompression (without instrumentation). In these 2 patient

subgroups, there was a 0% rate of SSI, wound dehiscence, and wound erythema.

In the lumbosacral spine, a total of 489 patients underwent lumbar microdiscectomy. 0.41% (2 of 489) of patients developed an SSI. The incidences of wound dehiscence and wound erythema are 0.20% (1 of 489 patients) and 0.20% (1 of 489 patients), respectively. A total of 165 patients underwent lumbar laminectomy, with an SSI rate of 1.82% (3 of 165 patients), wound dehiscence rate of 0.61% (1 of 165 patients), and no patients with wound erythema/inflammation.

From the 4 included studies in the subgroup analysis, there were no patients who underwent thoracic spine surgery or posterior lumbosacral fusion surgery. As such, it is not possible to determine the wound complication rates for these procedures.

Risk of Bias and Methodological Assessment (Table 1)

Reporting of the 17 criteria pertinent to methodological quality and risk of bias of the included studies was assessed, as summarized in Table 1. In general, the study by Ando et al² satisfied most of the criteria, reporting on 13 of 17 (76.5%) of the criteria. Hall et al¹³ reported on 10 of 17 (58.8%) and Wachter et al¹¹ reported on 9 of 17 (52.9%) of the criteria. The remaining two studies reported on less than half of the stipulated criteria (7 of 17; 41.2%). All the studies utilized consecutive patients as their method of case identification. Sample size calculation was not performed for all studies, a factor mitigated by the fact that 4 of the 5 included studies are case studies. The general type of surgical procedure was recorded in all studies. Use of perioperative antibiotics, a major measure to reduce postoperative SSI, was only recorded in 2 of 5 studies^{2,11} (40%). Similarly, an attempt to record patient and clinical variables known to influence wound outcomes was recorded in 3 of 5 studies^{2,11,12} (60%).

Discussion

Results from this systematic review demonstrate that cyanoacrylate dermal closure for anterior cervical discectomy and fusion, lumbar microdiscectomy, and lumbar laminectomy is

associated with a low rate of SSI and wound dehiscence as demonstrated in a relatively large number of patients. There was a 0% rate of SSI in patients who underwent posterior cervical decompression (without fusion), although the number of included patients is small (23 patients).

The rate of SSI for cyanoacrylate dermal closure compares favorably to that in the contemporary literature for the procedures described (Table 2). Cyanoacrylates have not only been found to provide a mechanical barrier against bacterial infection,¹⁴ they have also been found to possess bactericidal properties against Gram-positive bacteria.¹⁴ Given the potentially devastating consequences of SSI in spine surgery, any measure that can reduce SSI should be rigorously studied and implemented as appropriate. A Cochrane review of randomized trials⁴ investigating the use of tissue adhesives in all surgical incisions demonstrated no difference in rate of SSI when compared to suture closure. However, none of the trials included in this Cochrane review included spinal surgery patients.

While the rate of SSI with cyanoacrylate dermal closure in noninstrumented lumbar surgery is low, there exists no data in the current literature with regard to instrumented thoracic and lumbar instrumented surgery. Wound complications, especially in the form of SSI and wound dehiscence, are major concerns in long-segment thoracolumbar instrumented spine surgery, where incisions are longer and surgical invasiveness increased compared with noninstrumented surgery. A recent systematic review of adult spinal deformity surgery reported a perioperative SSI rate (requiring surgical debridement) of 2.24% and wound dehiscence rate (requiring surgical closure) of 0.25%.¹⁵ Given the paucity of evidence, the authors are unable to comment on the impact of cyanoacrylate dermal closure in instrumented thoracic and lumbar spine surgery.

The risk of wound dehiscence remains a concern for cyanoacrylate dermal closure. Shapiro et al,¹⁶ in an ex vivo porcine study, found no significant difference in wound tensile strength when 2-octyl cyanoacrylate was compared with 4-0 poliglecaprone subcuticular sutures. However, in the aforementioned Cochrane review,⁴ there was a lower risk of wound dehiscence with suture closure when compared with tissue adhesive. While the rate of wound dehiscence in the present review is remarkably low, spinal surgeons should be cognizant of the potential risk of wound dehiscence when using cyanoacrylate for dermal closure.

Limitations

The limitations of this systematic review stems primarily from the quality of the included articles. Four of the 5 articles included are surgical case series, which have traditionally been of variable quality. Indeed, a structured methodological and risk of bias assessment reveals the reporting deficiencies of each included study (Table 1). The study by Ando et al² is the only (retrospective) cohort study included in this review. While it reports on the highest number (13 of 17) of risk of bias criteria, deficiencies still exist in this study. For example, this study included patients with a myriad of underlying

pathologies (degenerative, spine trauma, spine tumor) which confounds analysis of wound outcomes.

The pooled analysis in this review included patients who underwent surgery for degenerative conditions only. As such, the safety of cyanoacrylate dermal closure for nondegenerative pathologies (eg, spine trauma, spine tumors) cannot be verified. Further studies should be performed in this area, as wound complications, including infection, dehiscence, and cerebrospinal fluid leak are potentially increased in these pathologies. Furthermore, due to inadequacy of data in the included studies, results from this review do not take into account confounding variables that can have an impact on wound outcomes.

Conclusion

Cyanoacrylate dermal closure for ACDF, posterior cervical decompression, lumbar microdiscectomy, and lumbar laminectomy is associated with low rates of wound complications (SSI, dehiscence, and erythema). Further studies should be performed in nondegenerative spine surgery, instrumented thoracic, and lumbar surgery. High-quality comparative studies in the form of randomized controlled trials should be undertaken to compare relative efficacy of cyanoacrylate versus other wound closure methods with regard to wound outcomes.


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