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A comparison of three methods of skin closure following repair of Achilles tendon rupture

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ABSTRACT

Meticulous skin closure is required to avoid wound problems after Achilles tendon surgery. The purpose of our study was to compare postoperative complication rate, operation time, clinical outcome and patient satisfaction with the wound among two topical skin adhesives (2-octyl cyanoacrylate and n-butyl cyanoacrylate) and conventional nylon skin sutures in Achilles tendon repair surgery. We retrospectively reviewed the records 122 consecutive patients (40 patient in nylon skin suture, 43 patients in 2-octyl cyanoacrylate and 39 patients in n-butyl cyanoacrylate) who underwent surgical repair for acute Achilles tendon rupture between 2012 and 2016. The primary outcome measure was the development of complications in the wound. Secondary outcome measures included the operative time, the Achilles Tendon Total Rupture Score (ATRS) and patient satisfaction with the wound. There was no difference in complication rate in the wound ($p = 0.694$) and in ATRS ($p = 0.824$) among patients in the three groups. Mean operative time in nylon skin suture group was significantly longer than in the 2-octyl cyanoacrylate group and n-butyl cyanoacrylate group ($p = 0.018$ and $p = 0.002$, respectively). Patient satisfaction in the 2-octyl cyanoacrylate and n-butyl cyanoacrylate groups was significantly higher than in the nylon skin suture group ($p = 0.015$ and 0.018, respectively). The use of 2-octyl cyanoacrylate and n-butyl cyanoacrylate topical skin adhesives for skin closure following repair of Achilles tendon rupture has equivalent effectiveness and safety compared to conventional nylon skin suture, but higher patient satisfaction. Despite its higher cost, these topical skin adhesives are viable alternatives for wound closure in patients who regard cosmetic outcomes as important.

Introduction

Wound complications rates following open surgical repair of Achilles tendon rupture have been reported to range from 1.4% to 18% [1–5]. These wound complications might lead to catastrophic results; meticulous skin closure is therefore required to avoid wound problems after Achilles tendon surgery. Traditionally, the most commonly employed skin closure methods after repair of Achilles tendon rupture include skin staples and nylon sutures. However, despite their widespread use over a long period of time, these conventional methods have presented fundamental drawbacks such as cosmetic problems, being time consuming, and the need for staple or suture removal. Recently, topical skin adhesives which are popular in many types of surgery have been used to compensate for these problems. These skin adhesives could replace the tedious suturing technique with a simple, non-operator-dependent, safe and rapid method, resulting in the optimal cosmetic appearance of the scar and avoiding infections by immediately sealing the wounds [6–12].

Over the past 50 years, 2-octyl cyanoacrylate and n-butyl cyanoacrylate have been used in wound closure as a tissue adhesive. These materials are highly viscous, flexible adhesives which polymerize immediately upon exposure to weak bases such as water and blood. They adhere the skin and form a clean, strong adhesive bond that holds together the corners of the skin wound so that it heals normally under the film [13,14].

There has been an increased interest in the use of topical skin adhesives in the field of orthopaedic surgery, and many studies have been performed to address their effectiveness. However, despite the promising results in other surgical fields such as abdomen or obstetric surgery, the benefits of topical skin adhesives in orthopaedic surgery are still being discussed [10,15,16]. In particular, since Achilles tendon is located close to the skin, it has a vulnerable vascularity and high mobility compared to other tissues, so it has been reluctant to the use of topical skin adhesives

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for skin closure following surgery. To our knowledge, there has been no study evaluating the effectiveness and safety of topical skin adhesive for skin closure in repair of Achilles tendon rupture. Therefore, the purpose of present study was to evaluate postoperative complication rate, operation time, clinical outcome and patient satisfaction for wound after repair of Achilles tendon rupture with the use of 2-octylcyanoacrylate, n-butyl cyanoacrylate, and monofilament nylon suture.

Material and methods

We retrospectively reviewed prospectively collected data of consecutive patients who underwent surgical repair for acute Achilles tendon rupture at our institution between March 2012 and December 2016. A total of 144 patients underwent surgical treatment for acute Achilles tendon rupture during this period. Exclusion criteria included patients with less than 12 months follow-up, incompletely documented medical chart, age below 18 years (skeletally immature), history of previous surgery at the Achilles tendon, bilateral Achilles tendon rupture, deviation from post-operative protocol, significant medical co-morbidity that would potentially delay wound healing (e.g., end stage renal failure, peripheral vascular disease) [17,18], history of keloid formation, open rupture, or notable skin injury around the Achilles tendon combined with rupture. Twenty-two were excluded according to these criteria, so that 122 patients with acute Achilles tendon rupture were enrolled in this study.

For closure of skin incisions, the 3-0 nonabsorbable monofilament nylon suture (Ethilon, Ethicon Ltd, Edinburgh, UK) was used in 40 patients in the first third of the study period (from March 2012 to October 2013) and the 2-octyl cyanoacrylate Surgiseal® (Adhezion Biomedical LLC, Wyomissing, PA) was used in 43 patients during the middle third of the study period (from November 2013 to June 2015). The last third of the study period (from July 2015 after December 2016), n-butyl cyanoacrylate LiquiBand® (Advanced Medical Solutions, Windsford, UK) was used in 39 patients. Closure of incisions were performed by senior orthopaedic residents at the time of surgery.

Following surgical repair using the Krackow suture method [19], closure of the paratenon and subcutaneous layers was completed with 2-0 and 3-0 synthetic absorbable braided sutures (VICRYL Plus, Ethicon Ltd., Edinburgh, UK) in order to remove skin tension and align the wound. This technique was performed identically in all groups. In the monofilament nylon suture group, simple interrupted suture was applied. In topical skin adhesive groups, adhesive agents were applied in two layers with a 15-second delay between applications to allow polymerization. The width of application was approximately 3 mm on either side of the incision. A standard identical absorbent dressing Medifoam® (Mundipharma Ltd, Seoul, Korea) was applied and changed on the second day after surgery.

An identical post-operative protocol was implemented for all patients. A non-weight bearing short leg splint in 20° plantar flexion was applied during surgery and remained in place for two weeks. Patients were transitioned to tolerable weight-bearing activity with a controlled ankle motion (CAM) boot two weeks postoperatively, which was initially set at 20° plantar flexion and gradually increased to neutral at five week following surgery. During six weeks after surgery, ankle range of motion (maximum plantar flexion to neutral) exercises were initiated. Patients were weaned from the CAM boot beginning on postoperative week nine, and were instructed to perform a home exercise program for one month. First generation intravenous cephalosporin was administered for three days following surgery as an antibiotic prophylaxis.

The patients were visited monthly for the first six months after the surgery, and a final time twelve months after the surgery. If signs of complications appeared, additional follow-up was performed. The primary outcome measure was the development of complications in the wound. All wounds discharging during follow-up were swabbed for microbiological culture. In case of positive cultures or if there was clinical evidence of infection, the patients were treated with a course of antibiotics and recorded as having a 'surgical site infection (SSI)'. SSI was classified according to extension of infection. Superficial SSI was defined as infections involving only the skin or subcutaneous tissue of the incision. Deep SSI was defined as infections involving the deep soft tissues (e.g., fascial and muscle layers) of the incision [20]. Wounds with a persistent ooze but with negative cultures were recorded as having 'prolonged discharge'. Breaking open of the surgical incision was described as 'wound dehiscence'. Erythema, pruritus, small bumps or blisters around contact site of suture or adhesive were recorded as an 'allergic reaction' [21].

Secondary outcome measures included the operative time, clinical outcome score, and patient satisfaction with the wound. As a clinical outcome measurement, a comprehensive telephone assessment was performed to evaluate the current condition of the injured tendon. Patients were asked to respond to the Achilles Tendon Total Rupture Score (ATRS) which is a self-administered rating system that records both symptoms and physical activity level [22]. The final scores range from 0 to 100, with higher scores indicating lower symptoms and good physical activity. Patients were also asked about their current satisfaction with the wounds. They answered with one of the following scale values which were used to assess patient satisfaction with the wound: 'much better than expected', 'better than expected', 'as expected', 'worse than expected', and 'much worse than expected' [16,23]. After giving informed consent, a total of 98 patients (80.3%) answered to the telephone assessment. Sixteen declined to respond and eight had changed their telephone number, so they could not be reached.

Statistical analysis

The results were analyzed for normal distribution using Kolmogorov-Smirnov test. To determine the significance of intergroup differences across three groups, analysis of variance (ANOVA) was used for continuous variables. Bonferroni correction was used for post-hoc analysis in ANOVA. When appropriate, chi-squared test was used to assess the association between categorical variables; in the other cases, Fisher's exact test was used. Statistical analyses were performed using SPSS v23.0 (SPSS Inc., Chicago, Illinois), and significance was set at $p < 0.05$.

Results

There was no statistically significant difference in the demographics among patients in the three groups (Table 1). The complications developed in the wound as a primary outcome are listed in Table 2. There was no significant difference among the three groups in terms of the number of patients with complications ($p = 0.694$). There was one re-admission that occurred with a nylon skin suture which had a deep wound infection requiring debridement. After repeated debridement and intravenous antibiotics treatment, the patient made a full recovery, but the final ATRS was 69 points. In patients with prolonged discharge, all wounds were healed with daily compressive dressing. For dehiscence of wound, Steri-Strip (3 M, St Paul, MN) was additionally applied to adhere to the margin of wound. If needed, local debridement was performed. All wounds were healed without sequelae.

Mean operative time was significantly longer in nylon suture group than in topical skin adhesives groups; seven minutes longer than 2-octyl cyanoacrylate group and nine minutes longer than n-

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