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# Superficial Wound Closure Complications with Barbed Sutures Following Knee Arthroplasty

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ABSTRACT

As quality measures may be increasingly used in knee surgery reimbursement, an important focus in outcome assessment will shift toward minimizing complications and increasing efficiency in knee arthroplasty reconstruction. The purpose of this study was to evaluate the efficacy of barbed, absorbable sutures in closure of the longitudinal surgical incision following knee arthroplasty, using post-operative complication occurrences. In 416 operations, primary outcomes assessed were deep infection, superficial infection, dehiscence, or stitch abscesses. Secondary outcomes included self-limiting eschar, severe effusion, arthrofibrosis, and keloid formation. Evaluation of overall primary outcomes showed a higher rate of wound complications using barbed sutures ($P < 0.001$). With increased rates of infection and overall closure related complications, this study shows that barbed suture use for superficial closure after knee arthroplasty should be avoided.



As the incidence of knee arthroplasty surgery continues to rise, focus will begin to shift to minimizing complications and increasing success and efficiency. Wound infection has been cited as one of the most prevalent complications associated with any surgical procedure [1], with infection rates in knee arthroplasty (KA) ranging from <1% to 10% in recent studies [2–6]. Thus, the evaluation of techniques with increased complication risks is prudent.

Currently, there are myriad suture types available, from stainless steel to braided silk, to prevent unguided healing and excessive scarring. Effective wound closure is based on three principles: avoidance of infection, support of healing, and production of an aesthetically pleasing scar [7]. In joint arthroplasty surgery, the deep fascia must be closed to seal the joint space, and the closure of the epidermis/dermis is critical in determining the strength and alignment of the scar, as well as cosmetic outcomes [7].

Wound healing may last up to 12 months, involves several stages, and suture implementation techniques vary significantly with respect to the type of wound [8,9]. Surgical wounds are currently most commonly closed with a subcutaneous, braided, absorbable, synthetic suture, and superficial metal staples [10,11]. Absorbable sutures are made of a synthetic polymer, such as polyglycolide (vicryl) or polydiaxone (PDS), which slowly degrades beneath the skin via hydrolysis. Staples are placed superficially to promote skin eversion and reduce closure time.

A recently introduced implement for wound closure is the barbed suture, designed for precision of skin edges in soft tissue wounds [12]. Covered in uni-directional or bi-directional barbs, these sutures do not require knots, can approximate tissue edges in a similar or shorter amount of time than traditional interrupted suturing, and require less material [12–14]. A previous study done by Rodeheavar et al concluded that barbed sutures may yield improved cosmetic outcomes due to the absence of knots in the wound [12]. Patri et al in 2011 described V-Loc (Covidien, Mansfield MA), a unidirectional barbed suture — as an alternative to common peritoneal closure techniques in hernia repair surgery [14]. Einarsson et al in 2009 described a shortened operative duration, shortened hospital stay, and similar outcomes with use of barbed suture in gynecologic surgery [15,16].

As described above, barbed suturing has been accepted in urologic, gynecologic, abdominal, and plastic surgical fields [14–20]. The V-Loc 90 (Covidien, Mansfield, MA), a unidirectional barbed suture, made of glycolide, dioxanone, and trimethylene carbonate, was intended by the manufacturer to replace braided absorbable (vicryl) sutures for use in orthopaedics, due to similar absorption and strength profiles. Recent studies have shown the use of barbed sutures as an efficient means of closing orthopaedic surgical wounds, including arthroplasty incisions, by saving up to 15 min of operative time and having a lower complication rate [12,13]. Regarding peri-operative complications, one study by Gilliland in 2012 followed patients for six weeks post-operatively and found similar time, cost, and closure-related problem rate between barbed and standard sutures in total knee arthroplasty [13].

Although current literature establishes that barbed absorbable sutures can withstand high tensile stress [21–23], the clinical efficacy

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of the sutures and the safety of the patient undergoing joint arthroplasty have not been clearly demonstrated. Conclusions regarding the complication rates of barbed absorbable for recommended application in orthopaedic surgery have not yet been verified. This study aims to determine the clinical value of these new sutures for orthopaedic purposes by comparing the clinical outcome using barbed sutures compared to a more traditional closure using metallic staples for skin closures in knee arthroplasty.

## Materials and Methods

After obtaining local Institutional Review Board approval, a retrospective chart review of prospectively collected data was performed on subjects meeting inclusion criteria, specifically elective TKA or PKA at our institution and age >18 years. All surgeries were completed by a single, fellowship trained adult reconstruction surgeon with ten years of experience. Partial and total knee arthroplasties have similar infection rates and can be compared in this study [24]. Exclusion criteria included revision knee arthroplasty, previous incision on the operated knee, and history of chronic dementia (<20/30 MMSE) as this has been shown to be associated with perioperative complications after joint arthroplasty [25]. 416 patients fit the inclusion exclusion criteria, with a consecutive group of 247 arthroplasties in the staples cohort followed by 169 consecutive patients in the barbed suture cohort.

Records of all patients fitting the inclusion/exclusion criteria were analyzed for complications. All wounds were closed with the knee positioned at approximately 45° of flexion. There is no learning curve bias, as the frequency of complications remained constant throughout the periods of use. Post-operative protocols were followed per hospital and surgeon's protocol, and independent of wound closure technique. All subjects were weight-bearing as tolerated on the operated side, and began physical therapy either on the day of surgery or on post-operative day one (depending on surgery start time).

With wound healing occurring up to 12 months [8,9], patients were examined for complications throughout this time period. Every patient was seen by the attending surgeon in the office at 4–6 week, 3 month, and 1 year time points postoperatively at which time incisions were examined thoroughly. If more frequent office visits were required to monitor a worrisome incision, additional visits were scheduled. Primary outcomes comprised superficial infection, deep infection, dehiscence, and suture abscess. Deep infection was defined by the MSIS criteria and required operative management and/or IV antibiotics in our cohorts [26]. Superficial infection included cellulitis or purulent drainage requiring antibiotics, as described by the CDC criteria for superficial incisional surgical site infection [27]. Endpoints were compared between suture types because all patients followed the same post-operative follow-up protocol, and all exams were recorded in our institution's outpatient electronic medical records. Secondary outcomes were mild, general adverse events: self-limited eschar, severe effusion defined as greater than 2+, arthrofibrosis, and keloid.

Intraoperatively, each group had the arthrotomy closed with #1 Maxon polyglyconate sutures. In the 'staple' group, the subcutaneous tissue was closed with an interrupted 2.0 vicryl (braided polyglycolic acid) suture and metallic skin clips superficially. In the 'barbed suture' group, a running 2.0 V-Loc suture closed the subcutaneous tissue, and a running 3.0 V-Loc barbed suture was used to close the skin. Operative time was defined as from initial incision to final suture; closure only time was not available. Statistical analysis was performed using SPSS v.20 (rel. 20.0.0, IBM Corporation, Armonk, NY). Fisher's exact tests and student t-tests were used to compare the rates of perioperative adverse events between groups as well as subgroup analyses assessing the impact of operative time, age, procedure, and comorbidities. Pearson's chi squared analyses were utilized for larger sample sizes. A power analysis determined that each cohort should have at least 189 patients; however, patient accrual in the barbed suture group was stopped early due to perceived patient safety.

## Results

From November 2007 through October 2011, 416 patients met the inclusion/exclusion criteria and were subdivided into the two groups: 247 stapled closures and 169 barbed sutured closures. The average patient ages at the time of operation were 67.6 years, and 65.3, for the 'staple' and 'barbed suture' groups, respectively. The 'staple' group patients were significantly older than 'barbed suture' patients ($P = 0.03$). As the average age is higher in the 'staple' group, this group should exhibit higher complication rates based on the association between advanced age and perioperative complications [28]. There was no significant difference between number of comorbidities and Charlson Comorbidity Index between groups. The gender distribution for each group broke down into the following percentages: 'staple,' 75% female/25% male and 'barbed suture,' 78% female/22% male. These proportions are in agreement with the overall gender distribution for knee surgeries at this urban, tertiary care, teaching hospital. Table 1 shows the baseline demographics.

In the 'staple' group, 80.1% of the patients received a TKA and the remaining 19.9% underwent a partial knee arthroplasty. The distribution for the 'barbed suture' group was 81.2% TKA, 18.8% PKA; the differences in distributions between the groups were not statistically significant.

## Primary Outcome: Closure-Related Adverse Events

There were 18 patients who experienced complications (dehiscence or infection) out of 247 patients with stapled closure, while 33 of 169 patients with barbed sutures experienced at least one complication. The number of patients with overall complications was significantly higher in the 'barbed suture' group than in the 'staples' group ($P < 0.001$). Furthermore, two deep infections required full revision in the barbed suture group, while no revisions were required in the staples group. Statistical analysis showed clinically significant difference in both superficial infection ($P < 0.001$) and deep infection ($P < 0.001$). No clinically significant difference was found with regards to dehiscence ($P = 0.098$). Table 2 shows the rates of primary outcomes for each closure group. Individual rates of complications within the superficial infection group (cellulitis, purulent drainage) did not show statistically different results.

Within each group, the proportion of patients receiving partial knee arthroplasty compared to total knee arthroplasty was compared between patients experiencing adverse events and those without. In each suture closure group, the distribution rates of partial to total knee arthroplasties experiencing complications were not significantly different than the distribution within the group not experiencing

**Table 1**
Baseline Demographics.

| Variable | Staples (n = 247) | Barbed (n = 169) | P |
|---|---|---|---|
| Age (years) | 67.6 (21–97, 11.7) | 65.3 (36–86, 10.0) | 0.030 |
| Gender | | | 0.451 |
| Female | 185 (74.9%) | 132 (78.1%) | |
| Male | 62 (25.1%) | 37 (21.9%) | |
| Operative Side | | | 0.533 |
| Right | 129 (52.3%) | 83 (49.1%) | |
| Left | 118 (47.7%) | 86 (50.9%) | |
| Operative Time (min) | 99.9 (62–220, 18.9) | 106.9 (67–207, 20.9) | <0.001 |
| Charlson Comorbidity Index | 3.89 (0–7, 1.41) | 3.98 (1–9, 1.36) | 0.517 |
| Diabetes | 48 (19%) | 39 (23%) | 0.369 |
| Smoking | 19 (7.6%) | 12 (7.0%) | 0.852 |
| Morbid Obesity | 43 (17.3%) | 22 (13.0%) | 0.226 |
| RA/Connective Tissue Disease | 1 (0.4%) | 3 (1.8%) | 0.308 |