Wound Complications in Joint Arthroplasty: Comparing Traditional and Modern Methods of Skin Closure

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abstract

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Various methods of skin closure exist in joint replacement surgery. Although subcuticular skin closure techniques offer an aesthetic advantage over conventional skin stapling, no measurable differences have been reported. Furthermore, newer barbed sutures, such as the V-Loc absorbable suture (Covidien, Mansfield, Massachusetts), theoretically distribute tension evenly through the wound and help decrease knot-related complications. The purpose of this study was to evaluate whether wound complication rates were (1) lower in V-Loc closure cases as theoretically suggested, (2) lower for subcuticular closure vs staples, and (3) significantly different for knee and hip joint reconstruction.

A retrospective chart review was conducted of 278 consecutive cases of primary joint reconstruction performed by a single surgeon (L.P.). The study group comprised 106 men and 161 women. Average patient age at surgery was 63 years (range, 18-92 years), and average body mass index of the cohort was 33.7 kg/m² (range, 25-51 kg/m²). Skin was closed via staple gun or subcuticular stitch (3-0 Biosyn [Covidien] vs V-Loc). Seven (3.9%) wound complications occurred in 181 cases closed with staples. Four (7.8%) wound complications occurred in 51 cases closed via subcuticular Biosyn suture. Six (13.0%) wound complications occurred in 46 cases closed with V-Loc suture. The staple group had a lower rate of complications when compared with the suture group as a whole (P= .033) and when compared specifically with the V-Loc suture group (P= .017).

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Joint reconstruction remains a successful and popular surgery, with continuous advances in approaches, implants, and techniques. With pressure placed on surgeons to increase efficiency and reduce the length of hospital stays, patients are mobilized quickly postoperatively. Stress on wounds from early mobilization and accelerated rehabilitation programs highlights the importance of skin closure. Skin closure techniques should minimize wound dehiscence and infection while promoting healthy, rapid healing and acceptable cosmesis. Complications from stitch abscesses to deep infections requiring revision surgery can disrupt patient recovery, increase hospital stays and costs, and cause patient morbidity.

Various methods of skin closure exist to address issues in efficiency, aesthetics, and barrier to infection. Staples and nylon sutures are 2 of the most commonly used skin closure materials in joint reconstruction surgery. Buried and nonburied techniques have also been applied to attempt to improve cosmesis. Although subcuticular skin closure techniques offer an aesthetic advantage over conventional skin stapling, no measurable differences have been reported. Furthermore, newer barbed sutures, such as the V-Loc absorbable suture (Covidien, Mansfield, Massachusetts), theoretically distribute tension evenly through the wound and help decrease knot-related complications (Figure). Studies using barbed sutures in nonorthopedic surgeries report decreased time to achieve closure and less dependency on the operator expertise necessary to secure a knot. However, none of these wound closures involved underlying prosthetic implants, as is the case in joint reconstructive surgery.

To the authors’ knowledge, the rate of wound complications in joint arthroplasty with the use of V-Loc suture for skin closure has not been reported. Therefore, the authors asked whether wound complication rates were (1) lower in V-Loc closure cases as theoretically suggested, (2) lower for subcuticular closure vs staples, and (3) significantly different for knee and hip joint reconstruction.

**MATERIALS AND METHODS**

After receiving Institutional Review Board approval, the records of patients who underwent surgery by a single fellowship-trained adult reconstruction surgeon (L.P.) at a single institution between July 1, 2009, and June 30, 2010, were identified. All cases other than joint reconstruction cases were excluded, leaving 315 consecutive cases. Of these, 37 cases were revision surgeries and were excluded. Ultimately, a retrospective review of 278 consecutive primary joint reconstruction cases was conducted. No cases were excluded based on preoperative diagnosis, patient demographics, or patient age. Preoperative history and physical records were evaluated for comorbidities (eg, diabetes mellitus), medications (eg, steroids), smoking status, and body mass index. Operative reports dictated by the attending surgeon provided information on the surgical procedure, use of a drain, wound closure technique, type of suture/staple used for skin closure, and intraoperative wound complications. Postoperative hospital progress notes and clinic follow-up notes were reviewed to identify indicators of postoperative complications (eg, wound characteristics, persistent drainage, antibiotic usage, clinic procedures, and revision surgery) within 30 days of the index surgery.

The study group comprised 106 men and 161 women. Average patient age at surgery was 63 years (range, 18-92 years), and average body mass index of the cohort was 33.7 kg/m² (range, 25-51 kg/m²).

**SURGICAL TECHNIQUE**

Overall, 153 procedures were at the knee (including total knee arthroplasty, unicompartmental arthroplasty, and patellofemoral arthroplasty), and 125 procedures were at the hip (including total hip arthroplasty and hemiarthroplasty) (Table 1). All knee procedures involved a less-invasive midline incision (average, 4-6 inches) with a medial parapatellar arthrotomy and included placement of a hemovac suction drain that exited the skin at a remote site and was removed at bedside on postoperative day 1. All knee procedures, except patellofemoral arthroplasty, were performed with computer-assisted navigation, and all trackers were placed within the primary surgery wound. All hip procedures involved a less-invasive posterolateral approach with a skin incision that averaged 4 to 6 inches depending on the patient size and difficulty of the procedure. Hip procedures were performed without navigation or placement of drains.

Wound closure was completed simultaneously by the surgeon (L.P.) and his chief resident. In hips, the capsule and external capsule were closed using a combination of 3-0 Vicryl and 2-0 PDS suture, and a nonabsorbable suture was placed through the adductor magnus to approximate the capsule to the external capsule. A 2-0 polypropylene suture was used to approximate the capsule to the external capsule in cases in which the capsule could be avoided (eg, in the presence of an inflammatory process). In knees, the capsule was closed using a combination of 3-0 Vicryl and 2-0 PDS suture, and a nonabsorbable suture was placed through the patellar tendon to approximate the capsule to the patellar tendon. A 2-0 polypropylene suture was used to approximate the capsule to the patellar tendon in cases in which the capsule could be avoided (eg, in the presence of an inflammatory process). A subcuticular closure of the skin was attempted in all cases, but in cases with large defects, skin staples were used. In this case, the suture was selected based on the type of implant and the type of closure desired.

**Table 1**

<table>
<thead>
<tr>
<th>Primary Joint Reconstruction Cases</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip</td>
<td></td>
</tr>
<tr>
<td>Primary THA</td>
<td>121</td>
</tr>
<tr>
<td>Hemiarthroplasty</td>
<td>4</td>
</tr>
<tr>
<td>Knee</td>
<td></td>
</tr>
<tr>
<td>Primary TKA</td>
<td>150</td>
</tr>
<tr>
<td>Bilateral TKA</td>
<td>11</td>
</tr>
<tr>
<td>Unicompartmental arthroplasty</td>
<td>3</td>
</tr>
<tr>
<td>Patellofemoral arthroplasty</td>
<td>1</td>
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</tbody>
</table>

Abbreviations: THA, total hip arthroplasty; TKA, total knee arthroplasty.
rotators were repaired to the greater trochanter, followed by a closure of the fascia with interrupted figure-of-eight 1-0 Vicryl suture (Ethicon, Inc, Somerville, New Jersey). The subcutaneous tissue was closed with 2-0 simple interrupted Vicryl stitches. The knee fascia and subcutaneous tissue were closed in a similar sequential manner, with the knee in 30° of flexion (including skin). Skin was consecutively closed with a staple gun with metal staples for the first 7 months of the study period, for a total of 160 cases. Surgeon preference changed to a subcuticular closure in February 2010, and 51 consecutive cases were closed with a 3-0 monofilament Biosyn absorbable suture (Covidien). The surgeon subsequently switched to the 3-0 V-Loc subcuticular stitch for 46 consecutive cases. Staples served as the original preferred method of skin closure. The surgeon applied subcuticular suture closure for consecutive cases (first Biosyn, then V-Loc) until increased concern for wound complications led the surgeon to revert to staple skin closure for the final 21 cases.

The Biosyn and V-Loc sutures are composed of glycolide, dioxanone, and trimethylene carbonate to form an absorbable compound. Average duration until absorption is 90 days. The V-Loc contains unidirectional barbs that project from the longitudinal axis of the suture. The surgical skin staple (Covidien) held stainless steel staples.

The wounds closed with a subcuticular suture then had Mastisol (Eloquest Healthcare, Ferndale, Michigan) and adhesive skin closure strips applied superficially. The staples group had no adhesive skin closure strips. All wounds were then dressed with sterile Xeroform dressing (Covidien), gauze, ABD pads, and cast padding.

Original operating room dressings were changed on postoperative day 2. Drains were removed on postoperative day 1 in patients undergoing total hip arthroplasty. The surgeon’s standard anticoagulation protocol included nightly warfarin starting the day of surgery, with a goal of reaching a therapeutic international normalized ratio of 2.0 to 3.0 for 4 weeks. The dosage of warfarin was managed by pharmacists in the anticoagulation dosing service at the hospital. Patients undergoing total knee arthroplasty, but not those undergoing total hip arthroplasty, received prophylactic dose low-molecular-weight heparin on postoperative day 1 as a bridge until international normalized ratio levels were therapeutic.

Patients returned to the clinic approximately 2 weeks postoperatively for routine clinical follow-up, including wound inspection. Subsequent outpatient follow-up consisting of clinical and radiographic evaluation occurred at 4 and 8 weeks postoperatively.

Results were analyzed by Pearson’s chi-square test for equality of 2 independent proportions to determine whether the incidence of complications had achieved a statistically significant difference. For all analyses, a statistical confidence level of 95% was used. Post-hoc analysis indicated that our study population provided sufficient power to delineate, with significance at the α=0.05 level, differential complication rates of >6% for staple vs suture contrasts, >7% for staple vs V-Loc contrasts, >6% for staple vs Biosyn contrasts, and >14% for Biosyn vs V-Loc contrasts. The Wilson/Ghosh method was used to formulate 2-sided confidence intervals for complication rates, which accounts for the statistical complication inherent in generating confidence intervals for small binomial distributions. Data analysis was conducted using SPSS version 19.0 software (SPSS, Inc, Chicago, Illinois) and the R software platform (R Foundation for Statistical Computing, Vienna, Austria).
When looking at all complications by joint (ie, hip vs knee), a higher trend of complications existed in knees compared with hips for all methods of skin closure (Table 4). Regardless of joint, the complication rate was highest for V-Loc suture, followed by Biosyn suture and, lastly, staples. Again, given the small proportions, statistical significance was not achieved.

### Discussion

The purpose of this study was to report our experience with the V-Loc barbed suture for skin closure in joint reconstruction, as well as overall subcuticular suture skin closure compared with that of metal staples. Changes in skin closure technique are secondary to multiple factors, including surgeon preference, patient marketabil-

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**Table 2**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex/Age, y</th>
<th>Joint</th>
<th>Procedure</th>
<th>Closure Technique</th>
<th>Comorbidity</th>
<th>Smoking Status</th>
<th>BMI, kg/m²</th>
<th>Complication</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>F/53</td>
<td>Knee</td>
<td>TKA</td>
<td>Staples</td>
<td>Rheumatoid arthritis</td>
<td>Y</td>
<td>34</td>
<td>Superficial infection</td>
<td>I&amp;D</td>
<td></td>
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<tr>
<td>M/74</td>
<td>Knee</td>
<td>TKA</td>
<td>Staples</td>
<td>None</td>
<td>N</td>
<td>38</td>
<td>Hematoma</td>
<td>Observation</td>
<td></td>
</tr>
<tr>
<td>M/58</td>
<td>Knee</td>
<td>TKA</td>
<td>Staples</td>
<td>None</td>
<td>N</td>
<td>27</td>
<td>Cellulitis</td>
<td>Oral antibiotics</td>
<td></td>
</tr>
<tr>
<td>M/53</td>
<td>Knee</td>
<td>TKA</td>
<td>Staples</td>
<td>None</td>
<td>N</td>
<td>36</td>
<td>Stitch abscess</td>
<td>Oral antibiotics</td>
<td></td>
</tr>
<tr>
<td>M/82</td>
<td>Knee</td>
<td>TKA</td>
<td>Staples</td>
<td>None</td>
<td>N</td>
<td>27</td>
<td>Stitch abscess</td>
<td>Oral antibiotics</td>
<td></td>
</tr>
<tr>
<td>F/30</td>
<td>Hip</td>
<td>THA</td>
<td>Staples</td>
<td>Avascular necrosis</td>
<td>Y</td>
<td>29</td>
<td>Cellulitis</td>
<td>Oral antibiotics</td>
<td></td>
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<tr>
<td>M/64</td>
<td>Knee</td>
<td>TKA</td>
<td>Staples</td>
<td>None</td>
<td>N</td>
<td>38</td>
<td>Wound infection</td>
<td>I&amp;D, polyethylene exchange</td>
<td></td>
</tr>
<tr>
<td>M/67</td>
<td>Knee</td>
<td>TKA</td>
<td>Subcuticular: Biosyn</td>
<td>Posttraumatic arthritis</td>
<td>Y</td>
<td>29</td>
<td>Wound dehiscence, infection</td>
<td>I&amp;D and closure</td>
<td></td>
</tr>
<tr>
<td>M/70</td>
<td>Knee</td>
<td>TKA</td>
<td>Subcuticular: V-Loc</td>
<td>None</td>
<td>N</td>
<td>36</td>
<td>Thigh hematoma</td>
<td>Observation</td>
<td></td>
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<tr>
<td>F/79</td>
<td>Knee</td>
<td>TKA</td>
<td>Subcuticular: V-Loc</td>
<td>None</td>
<td>N</td>
<td>42</td>
<td>Wound infection</td>
<td>I&amp;D, polyethylene exchange</td>
<td></td>
</tr>
<tr>
<td>F/60</td>
<td>Knee</td>
<td>TKA</td>
<td>Subcuticular: V-Loc</td>
<td>Rheumatoid arthritis</td>
<td>N</td>
<td>40</td>
<td>Stitch abscess</td>
<td>Bedside exploration</td>
<td></td>
</tr>
<tr>
<td>F/63</td>
<td>Hip</td>
<td>THA</td>
<td>Subcuticular: V-Loc</td>
<td>None</td>
<td>N</td>
<td>26</td>
<td>Superficial wound opening</td>
<td>Sterile suture reinforcement at bedside</td>
<td></td>
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<tr>
<td>M/71</td>
<td>Knee</td>
<td>TKA</td>
<td>Subcuticular: Biosyn</td>
<td>None</td>
<td>N</td>
<td>31</td>
<td>Cellulitis</td>
<td>Oral antibiotics</td>
<td></td>
</tr>
<tr>
<td>F/28</td>
<td>Hip</td>
<td>THA</td>
<td>Subcuticular: Biosyn</td>
<td>Avascular necrosis, diabetes mellitus type II, SLE with chronic steroid use</td>
<td>Y</td>
<td>29</td>
<td>Hematoma/wound infection</td>
<td>I&amp;D, polyethylene exchange</td>
<td></td>
</tr>
<tr>
<td>F/56</td>
<td>Knee</td>
<td>TKA</td>
<td>Subcuticular: Biosyn</td>
<td>None</td>
<td>N</td>
<td>30</td>
<td>Cellulitis</td>
<td>Oral antibiotics</td>
<td></td>
</tr>
</tbody>
</table>

*Abbreviations: BMI, body mass index; I&D, irrigation and debridement; N, no; SLE, systemic lupus erythematosus; THA, total hip arthroplasty; TKA, total knee arthroplasty; Y, yes.*

*a Covidien, Mansfield, Massachusetts.*

When looking at all complications, statistical significance was not achieved. To demonstrate these trends, the confidence intervals are displayed in Table 3. For the confidence intervals, the relevant interval used is 90% because comparing 2 proportions (the lower bound of one to the upper bound of another) is a 1-sided test for equality of the 2 proportions at the 95% confidence level.
ity, hospital standards, and wound tension. Theoretical advantages of a barbed suture include distribution of tension throughout the wound, decreased knot-related complications, and faster application.5-8

A randomized equivalency study of 188 patients evaluated bidirectional barbed suture vs conventional polydioxanone suture for dermal closure of Pfannenstiel incisions in gynecologic cases and reported similar cosmesis, infection, and dehiscence scores and comparable pain scores and closure time.5 Reports of decreased adverse events associated with the use of barbed suture are based on studies performed in minimally invasive facelift surgery.9,10 An explanation for this difference in outcomes may be secondary to the relationship of the barb stiffness and direction with the native soft tissue.11,12 The current study’s results in orthopedic joint reconstruction demonstrate similar incidences of major wound complications in the conventional subcuticular suture and V-Loc suture groups. However, an increased rate of minor complications occurred with the V-Loc suture. Potentially, the tightness and water-tight seal provided by the V-Loc suture is less forgiving than a conventional suture to the high stresses of postoperative mobilization and normal physiologic drainage after joint replacement. Given the same material composition of V-Loc and Biosyn sutures (glycolide, dioxanone, and trimethylene carbonate), the difference in complications is unlikely to be attributable to a biologic response. Moreover, the authors are unaware of any studies comparing biological and histological soft tissue responses to stainless steel staples with those to absorbable suture in skin closure.

The current study found a statistically significant higher rate of complications in the V-Loc group compared with the staple group. Whether staples or sutures lead to lower rates of wound inflammation is controversial, perhaps dependent on the location of the wound on the body.2,13-16 Graham et al17 reported that staple closure resulted in better blood perfusion to wound sites compared with suture closure. Increased blood perfusion and decreased disruption of the wound site could enhance healing. Further investigation is needed on soft tissue disruption in V-Loc sutures, particularly compared with skin staples.

Although the V-Loc suture represents a relatively recent advance and subject of research, multiple studies have evaluated suture vs staple closure in joint arthroplasty.1,2,18 However, debate exists on which is the optimal method of closure. Khan et al2 investigated skin closure in joint arthroplasty and reported that skin staples were superior to subcuticular suture. They concluded that staple closure was faster than suture closure, with no difference in complication rate, patient satisfaction, or cosmesis.2 A recent meta-analysis by Smith et al19 reported that staples were associated with a higher rate of infection in hip surgery compared with suture closure. The meta-analysis included all orthopedic procedures of the hip and knee and did not differentiate between superficial and deep infections—intrinsic limitations to that type of study.1 The current study’s results showed decreased rates of major and minor complications in the staple group compared with the subcuticular suture group.

The overall complication rate in the current study was higher in knees than in hips, but given the small proportions, no statistical significance was achieved. Khan et al2 attributed this to the fact that incisions at the knee are longer than those at the hip and that the skin at the knee is more mobile than that at the hip. They reported no statistically significant difference in their late complication rate (hip, 14.7%; knee, 18.8%).2

The current study did not measure cosmetic outcomes, pain scores, or closure
time. Furthermore, although cost can be a driving force for many surgeons and institutions, the authors did not include that in their analysis. The literature reports that metal staples are more expensive than conventional suture; however, the authors of the current study we found no comparison with V-Loc suture. Although a consecutive series, the current study faces the intrinsic limitations of a retrospective analysis, including data collection limited to medical records. Also, not all factors related to wound healing could be accounted for, including nutrition, amount of drainage, and hygiene. However, the authors of the current study analyzed 2 known risk factors for wound complications, particularly in orthopedic surgery: obesity and smoking. Patients with these risk factors deserve special attention with regard to wound closure and may benefit from a skin closure associated with fewer surgical-site complications.

Another limitation of the current study is the power. A significantly larger number of patients made up the staple cohort than the conventional suture and V-Loc suture cohorts. However, the limited number of skin closures by subcuticular means was secondary to the surgeon’s heightened concern for wound complications. Although subcuticular suture closure may require more technical skill than staple placement, the authors do not believe a learning curve would occur, given the seniority and experience of the surgeon. Lastly, all complications in this study may not be directly attributed to skin closure method, indicating the need for further randomized, prospective trials.

The incidence of wound complications in surgical joint reconstruction ranges from 0.33% to 50%, with the mode deviating toward the lesser number. The complication rate in the current study varied depending on the type of skin closure used. Early surgical intervention for total knee arthroplasty wound healing has been associated with further complications, including deep infections, resection arthroplasty, and flap coverage. Wound complications in patients undergoing joint reconstruction can cause myriad problems and should be minimized by all means available.

**Conclusion**

Aesthetics and efficiency often are the driving forces of innovation. Based on the authors’ clinical experience, wound and infectious complications should be considered when choosing a method of skin closure in joint reconstruction procedures.

**References**