ABSTRACT

Studies have shown that time in the OR is a factor in occurrence rate of surgical site infections. Suturing methods and materials are also a recognized factor in the incidence of surgical site infections. Two of the frequently used methods (running continuous and interrupted suture) rely on the surgeon’s knot-tying expertise to avoid complication and typically involve incision closure across various dermal layers.

In contrast, barbed sutures require no knots thereby offering potential time savings. Further, anecdotal evidence suggests that barbed sutures are beginning to be utilized by an increasing number of surgeons to close multiple layers simultaneously, also offering additional potential time savings.

The purpose of this study was to compare the time taken for 6 experienced surgeons to close incisions of varying length (2”, 6”, or 9”) in an experimental porcine shoulder model using 4 suture methods: V-Loc™ 180 device system and Quill™ SRS suture devices in a single layer closure and two conventional techniques (running continuous and interrupted) in a double layer closure.

The results showed that the V-Loc™ 180 device, when applied in a single layer continuous closure, was 33% and 37% faster than the conventional and interrupted methods applied in a double layer closure, respectively (both P<0.05). The V-Loc™ 180 device was also numerically faster than Quill™ SRS by approximately 9% (not significant). The V-Loc™ device was faster than the running continuous method across all incision lengths (P<0.05) and faster that the interrupted method at incision lengths of 6” and 9” (P<0.05). Faster incision closure using the V-Loc™ device may have important clinical ramifications, including a reduction in operating room time as well as freeing up the surgeon during the operative procedure allowing greater focus on more complex and demanding technical aspects of the procedure.

COMPARISON OF WOUND CLOSURE TIME USING CONVENTIONAL TECHNIQUES AND KNOTLESS, SELF-ANCHORING SURGICAL SUTURES

INTRODUCTION

Studies (reference infection studies) have shown that time in the OR is a factor in occurrence rate of surgical site infections. Suturing methods and materials are also a recognized factor in the incidence of surgical site infections. Although a wide variety of suturing techniques are used in surgical practice,1-3 two of the frequently used methods include the running continuous suture and the interrupted suture. Both of these methods often involve closing the incision sequentially across various dermal layers (deep dermal tissue first followed by subcuticular and epidermal layers). In addition, both methods critically rely on the knot-tying expertise of the surgeon. Knot tying takes time and improper technique can lead to a variety of problems such as extrusion, knot failure, and a lack of uniform tension along the wound, which, in turn, can lead to pressure-induced tissue ischemia/necrosis, compromised wound strength, inflammation, infection, and dehiscence.4,5

To circumvent these limitations, novel, self-anchoring (or barbed) sutures have been developed as a more efficient means to close soft tissue wounds without the necessity to tie knots.4,6,7 Barbed sutures are being utilized in a variety of surgical applications (including emergency room, general, thoracic, urologic, orthopedic, obstetric/gynecological, plastic/reconstructive and surgical settings) and are generally applicable to multiple-layer closures in the subcutaneous and subcuticular space.4,6,8

Two barbed sutures are currently available: V-Loc™ 180 absorbable wound closure device (Medtronic, North Haven, Connecticut, USA) and Quill™ SRS (Angiotech, Vancouver, British Columbia, Canada). The V-Loc™ 180 device comprises a welded
loop (to securely anchor the suture at the beginning of the incision) and circumferential, unidirectional barbs evenly spaced throughout the suture strand. The V-Loc™ 180 device requires no change to the standard wound closure technique. Quill™ SRS also possesses barbs but, in this device, they are bidirectional and spiraled along the strand but absent in middle of the suture. In contrast to the V-Loc™ 180 device system, the Quill™ SRS device requires that the surgeon begin closure in the middle of the wound, working in either direction using two needles at each end of the suture. Since both products require no knot tying the potential exists for a substantial saving in time to close a wound. In addition, for those surgeons who prefer to close incisions using a single layer technique with barbed suture, additional time savings may arise. However, it should be noted that, at the present time, no randomized clinical studies are available to show that a single-layer closure is equivalent to a double-layer closure in terms of cosmesis or tensile strength. Nevertheless, given the likelihood that at least some surgeons will be using barbed sutures as a single layer closure technique, it was considered appropriate to conduct a time trial directly comparing these novel suture methods with conventional suturing techniques under controlled, standardized conditions.

The purpose of this study was to compare the time taken for 6 experienced surgeons to close incisions of varying length in an experimental porcine shoulder model using 4 suture methods: V-Loc™ 180 device system and Quill™ SRS suture devices and two conventional techniques (running continuous and interrupted)

METHODS

The study involved a total of 6 experienced surgeons with expertise in general surgery and plastic surgery and gynecology. The demographics of the participating surgeons with respect to specialty, years of practice as a surgical consultant, and previous experience with Quill™ SRS is summarized in Table 1.

While approximately half the surgeons had some first-hand experience using Quill™ SRS, only 1 surgeon (on two patients) had previously used the V-Loc™ 180 device system. The study was conducted at the Royal College of Surgeons, London, UK, in a modern, experimental surgery operating room. Each surgeon was assigned to a standard operating table and used identical surgical instruments (e.g., needle forceps, scalpels, etc.) provided by the College. A total of 72 pork shoulders were used in the study. A shaved pork shoulder was placed on each of 6 standard operating tables and, for each shoulder, 4 sites of incision were identified, measured (2”, 6”, or 9”) and marked by a surgical assistant. Individual surgeons subsequently made an incision along the marked lines to a standardized depth of 1.5-2cm; overall, a total of 288 incisions were made.

Surgeons then proceeded to close the incisions using one of the four closure methods: V-Loc™ 180 device (single layer closure), Quill™ SRS (single layer closure), running continuous (double layer closure) and interrupted (double layer closure). The number of stitches for the double-layer closures was standardized at each closure length such that for deep dermal closures of incision lengths of 2”, 6”, and 9”, a total of 1, 3, and 4 stitches were used, respectively. Similarly, for subcuticular closures of incision lengths of 2”, 6”, and 9”, a total of 4, 12, and 18 stitches were used, respectively.

<table>
<thead>
<tr>
<th>METHOD</th>
<th>LENGTH-OF-CLOSURE</th>
<th>SURGEON A</th>
<th>SURGEON B</th>
<th>SURGEON C</th>
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<th>SURGEON D</th>
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<td>Quill™ SRS</td>
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Each surgeon performed 4 repetitions of each closure technique at each incision length. Thus, overall, 72 wound closures were performed for each closure method and each surgeon performed 48 repetitions, giving an overall study total of 288 repetitions (Table 2). The sequence of closure methods was varied among surgeons to minimize potential effects of fatigue. Recordings of the time taken to close each of the different wound lengths were made for each surgeon using a PDA device equipped with specially designed software. The closure time was defined as time taken from the first insertion of the suture needle to cutting the suture thread with scissors.

In addition to wound closure time, the PDAs captured a number of variables for each surgeon, including the record number, number of closures surgeon had performed up to that point in time, the suturing method, the incision length, the number of knots tied, and any other relevant additional qualitative observations such as any changes to the environment or equipment.

RESULTS

Figure 1 summarizes the overall closure time in seconds for each of the closure methods averaged over the three incision lengths. Overall, the V-Loc™ 180 device was markedly and significantly faster (P<0.05) than the running continuous and interrupted methods by approximately 33% and 37%, respectively. While the V-Loc™ 180 device was also numerically faster than Quill™* SRS by approximately 9%, this difference in overall closure time did not reach statistical significance.

FIGURE 1: Time (seconds) for each closure method averaged over the three incision lengths (2", 6", and 9")

![Figure 1](image1)

**FIGURE 2: Closure time according to the length of incision in the four suturing groups**

Across the incision lengths evaluated, the V-Loc™ 180 device system was numerically faster than all comparison closure methods, although a significant difference in speed was apparent only in relation to the running continuous and interrupted methods. The V-Loc™ 180 device system was significantly faster than the running continuous method across all incision lengths but significantly faster than the interrupted method at the longer incision lengths (6" and 9") only. This study chose to compare the V-Loc™ 180 device and Quill™* SRS systems with double-layer (rather than single-layer) closure using running continuous and interrupted techniques as this is a preferred method of surgeons who are experienced with barbed suture.

A single layer closure, when compared to a double layer closure, allows for faster suture placement and offers the greatest time savings. However, it should be noted that, at the present time, no randomized clinical studies are available to show that a single layer closure is equivalent to a double-layer closure in terms of cosmesis or tensile strength. Thus, the clinical significance of our finding that the V-Loc™ 180 device system was significantly faster in relation to the running continuous and interrupted methods has to be interpreted with caution until these clinical study data are available.

In addition, not all surgeons use a double-closure technique and, thus, in the setting of single-closure conventional and interrupted techniques, the time advantage of the V-Loc™ 180 device and Quill™* SRS would be attenuated.

Nevertheless, it is anticipated that barbed sutures would still be faster than single layer closures using conventional techniques because they obviate the need for knot tying, although this aspect was not addressed in this study.

Despite the fact that 3 of the 6 participating surgeons had previous first-hand experience using Quill™* SRS (compared with only 1 surgeon who had used the V-Loc™ 180 device on 2 patients), the V-Loc™ system was faster than Quill™* SRS by an...
average of 22 seconds across all lengths (although none of these differences was statistically significant).

In fact, the longer the incision, the greater the difference in closure time between the two products—at the longest incision length of 9”, the difference averaged 27 seconds among the 6 surgeons. This numerically faster closure time using the V-Loc™ 180 device may relate, in part, to the fact that no change to the standard wound closure technique, (i.e. continuous running suture pattern), is required. Even with no prior experience of the device, the V-Loc™ device is intuitive to use and, thus, requires little time to learn and use proficiently.

In contrast, Quill™ SRS is counterintuitive in that surgeons must modify their usual suturing technique by first identifying the middle of the device (critical since the barbs are bi-directional) and then closing the incision outwards in both directions from the middle of the wound.

This necessitates backhanded suturing, which can be awkward and slower for some surgeons, or alternatively, switching to the contralateral side of the operating table, or engaging an assistant surgeon to assist with closure.

Faster closure of incisions using the V-Loc™ 180 device has several important ramifications. Operating room time may be reduced, thereby offering the potential for cost savings. Reduction in OR time may have a positive impact on the incidence of surgical site infections. Studies have shown that less time in the OR results in less surgical site infections.

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REFERENCES