

Time to closure of orthopaedic surgical incisions: a novel skin closure device versus conventional sutures

Objective: New technologies are being developed to optimise healing of surgical incisions. BandGrip (US) is a micro-anchor skin closure device that replaces the need for subcutaneous suturing and further dressing. The purpose of this study is to perform a matched cohort analysis comparing time to closure of surgical incisions between sutures and the novel skin closure device.

Method: Patients undergoing orthopaedic surgery in 2019 underwent skin closure with either conventional sutures or the novel skin closure device. Patients were divided into three groups according to their procedural incisions: anterior cruciate ligament reconstruction (ACLR); simple arthroscopy; and general incisions. Patients who underwent closure of their surgical incision with the novel skin closure device were matched with patients undergoing superficial closure with sutures. Statistical analysis was performed to compare time to closure per centimetre of skin incision between the groups.

Results: A total of 86 patients were included in the study. Overall mean time to closure using the novel skin closure device was less than with sutures (8.6 seconds/cm versus 42.8 seconds/cm, respectively, $p < 0.001$). Mean time to closure for ACLR incisions was 3.7 seconds/cm using the novel skin closure device and 35.5 seconds/cm using sutures ($p < 0.001$). Mean time to closure for simple arthroscopy portals was 19 seconds/cm using the novel skin closure device and 47.6 seconds/cm using sutures ($p < 0.001$).

Conclusion: BandGrip is a novel skin closure device that allows for efficient surgical incision closure. Time to surgical skin incision closure is significantly less with the use of when compared with conventional sutures.

Declaration of interest: BJC has financial interests in/relative to BandGrip, Inc., which could potentially benefit from the outcomes of this research. All other authors have no conflict of interest to declare.

BandGrip • dressing • incision closure • infection • skin closure • wound • wound care • wound healing

Each year, millions of orthopaedic surgeries are performed, all with a common requirement of surgical incision closure.¹⁻³ The often overlooked medical and financial implications of prolonged incision closure can be significant. Studies have shown that longer closure time may be associated with wound infection.⁴ There are estimates of hundreds of dollars in operating room time dedicated to wound closure for each surgical case.⁵ Owing to these factors, there has been increased interest in the development of novel closure techniques that are both efficacious and efficient.^{6,7}

Traditional wound closure has been achieved using either staple or suture placement, with varying results based upon technique and experience. A significant amount of time is often required to close incisions using sutures, with a direct consequence of prolonged time under anaesthesia in each surgical case. To address these issues, BandGrip (US) has developed a novel incision closure device using micro-anchor technology. This device, which is applied over an open incision in the same manner as an adhesive bandage, has received US Food and Drug Administration (FDA) approval and is being increasingly used. The novel skin closure device eliminates needle manipulation of the skin and subcuticular tissues during wound closure, minimises trauma and ischaemia associated with sutures and their placement, and lowers the intraoperative risk of

perforation of the surgeon's glove.⁸ However, direct comparisons of closure time between suture and the novel skin closure device have yet to be reported.

The purpose of this investigation was to compare incision closure times of orthopaedic surgical incisions using either traditional suture or the novel skin closure device technique. It was hypothesised that the novel skin closure device would provide reliable closure with significantly lower time burden when compared with suture closure.

Methods

Patient identification and study procedure

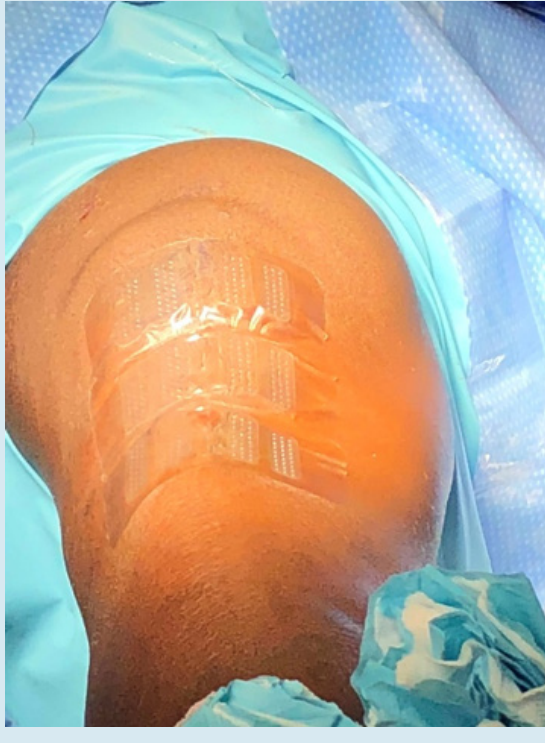
Patients of a single surgeon (BJC) (blinded for peer review) were included in this investigation, which was carried out at Midwest Orthopaedics at Rush University Medical Center, Chicago, US between August 2019 and January 2020. Both the novel skin closure device and suture closure were routinely used for incision closure

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Fig 1. Closure of a surgical incision using the novel skin closure device, following anterior cruciate ligament (ACL) reconstruction of the knee (the patient has given oral informed consent to publish this case image and details)



as standard of care. Timing of incision closure and measurement of incision length were performed in a non-randomised fashion for clinical quality improvement purposes. The closure times obtained were then retrospectively reviewed for comparative analysis. Rush University Medical Center institutional

review board approval was obtained before study initiation (ORA20022701) and a waiver of consent was granted.

Patients were classified into three separate groups according to their surgical procedure and typical incisions: simple knee or shoulder arthroscopy (portals); anterior cruciate ligament reconstruction (ACLR) with patellar tendon autograft; and miscellaneous knee and shoulder procedures. Each incision was measured intraoperatively before closure. Portals were closed with 3-0 nylon sutures in an inverted figure of eight fashion and formal incisions were closed with running 3-0 Monocryl (Ethicon Inc., US) sutures in knotless fashion with tails at each end for tensioning by orthopaedic-trained surgical fellows or physician assistants. Depending on incision length, either large or small-sized the novel skin closure adhesives were applied (Fig 1).

At a standardised starting point (either at initial loading of suture or removal of the novel skin closure adhesive covers), timing was started using a stopwatch until either the final suture was cut or the final novel skin closure adhesive was placed. Closure times were then normalised by length into units of centimetre closed per second through the use of intraoperative measurements.

Device application technique

Before application of the novel skin closure device the wound and the surrounding skin were cleaned and dried. The novel skin closure device was applied by laying down the anchors firmly on one side of the wound. Once one side was secured, the skin edges were held together and slight traction was applied to the novel skin closure device across the incision, as the second set of anchors was laid down on the other side of the wound.

Statistical analysis

Descriptive statistics were used to report demographic characteristics. Independent samples t-testing was performed to assess the difference in mean closure time between the cohorts. Significance was assessed with a p-value of <0.05.

Results

A total of 86 patients were included in the study. Of these, 30 patients underwent ACLR, 30 underwent simple arthroscopy, and 26 underwent miscellaneous orthopaedic procedures. There were 51 patients who underwent closure with the novel skin closure device and 35 patients who underwent closure with conventional sutures.

There were 36 (41.9%) female patients and 50 (58.1%) male patients, with a mean age of 36.3±18 years. None of the patients were current smokers, but there were 12 (14%) former smokers. The mean body mass index (BMI) was 26.3±4.9kg/m² (range: 17.6–40.9kg/m²) (Table 1).

Table 1. Patient demographics

	Overall	ACLR	Portals	Other
Age, years, mean±SD	36.3±18	26.8±12	44.9±17	37.2±19
Gender, n (%)				
Female	36 (41.9)	12 (40.0)	8 (26.7)	16 (61.5)
Male	50 (58.1)	18 (60.0)	22 (73.3)	10 (38.5)
Laterality, n (%)				
Left	50 (58.1)	13 (43.3)	22 (73.3)	15 (57.7)
Right	36 (31.9)	17 (56.7)	8 (26.7)	11 (42.3)
Smoker, n (%)				
Non-smoker	74 (86.0)	27 (90.0)	24 (80.0)	23 (88.5)
Smoker	0 (0)	0 (0)	0 (0.0)	0 (0)
Former smoker	12 (14.0)	3 (10.0)	6 (20.0)	3 (11.5)
BMI, kg/m ² , mean±SD (range)	26.3±4.9 (17.6–40.9)	24.7±2.9 (20–31.3)	27.9±5.7 (19.8–40.9)	25.9±4.9 (17.6–37.7)

ACL—anterior cruciate ligament; BMI—body mass index; SD—standard deviation

Overall incisions

Overall average length of incision was 5.7cm, and average time to closure of incisions was 102seconds. Overall mean time to closure was 22.7seconds/cm. Overall mean time to closure per cm using the novel skin closure device was faster than with conventional sutures (8.6seconds/cm and 42.8seconds/cm, respectively, $p<0.001$) (Fig 2).

ACLR incisions

A total of 15 patients underwent closure with the novel skin closure device and were matched to 15 patients who underwent closure with conventional sutures. Overall average length of incision was 7.3cm and average time to closure of incisions was 145.5 seconds. Overall mean time to closure was 20.2seconds/cm. Mean time to closure for ACLR incisions was 3.7seconds/cm using the novel skin closure device and 35.5seconds/cm using conventional sutures ($p<0.001$) (Fig 2).

Simple arthroscopy portals incisions

There were 15 patients who underwent portals closure with the novel skin closure device who were matched to 15 patients who underwent portals closure with conventional sutures. Overall average length of incision was 2.3cm, which was equivalent to between two and three arthroscopic portals. Average time to closure of portals was 102seconds. Overall weighted mean time to closure was 34.4seconds/cm. Mean time to closure for simple arthroscopy portals was 19seconds/cm using the novel skin closure device and 47.6seconds/cm using conventional sutures ($p<0.001$) (Fig 2).

Discussion

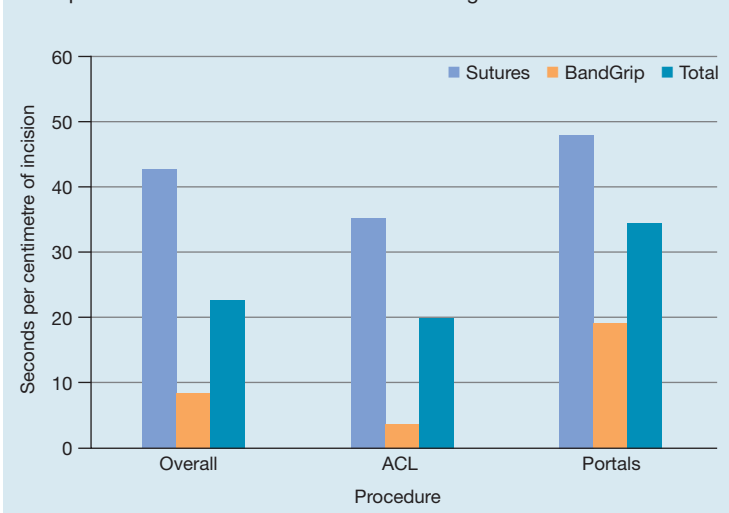
The main findings of this study are that the novel skin closure device used is an efficient wound closure device. Time to closure of surgical skin incision per centimetre with the novel skin closure device is approximately five times faster for all incisions, approximately 9.6 times faster for ACLR incisions and approximately 2.5 times faster for arthroscopic portals closure.

As described above, BandGrip is a micro-anchor skin closure device that replaces the need for subcutaneous wound suturing and further dressing.⁹ The novel skin closure device aims to enhance wound closure and decrease wound complications in several ways, according to the biologic principles of wound healing. The use of the novel skin closure device reduces the use of needle suturing and thus minimises trauma and ischaemia to the wound margins, and limits the intraoperative risk of perforation of the surgeon's glove.⁸

While using novel closure technologies, surgeons may decrease skin closure time associated with the use of conventional sutures by up to 75%,^{10,11} and also avoid relying on their expertise to secure suture loops and knots.¹² Such novel technologies have also demonstrated shorter removal times when compared with sutures.¹³

Tanaka et al.¹¹ performed a randomised controlled trial (RCT) of 214 patients undergoing sternotomy.

Fig 2. Mean incision closure time per centimetre comparison between the novel skin closure device and conventional sutures for different types of orthopaedic incisions. ACL—anterior cruciate ligament reconstruction



They found the ZipLine closure device (ZipLine Medical Inc., US) to be 3.3 times faster than sutures with 113 ± 9.1 seconds for closure with the closure device versus 375.9 ± 60.2 seconds for closure with sutures ($p<0.001$).

Singer et al.¹⁰ performed a multicentre randomised trial to evaluate the use of an octylcyanoacrylate tissue adhesive when compared with standard wound closure. They found the adhesive to be faster than standard closure (2.9 minutes versus 5.2 minutes, respectively, $p<0.001$).

This study shows the novel skin closure device is approximately five times faster than conventional sutures. The differences in closure times may differ between products for several reasons, including inherent product properties, surgeon experience, body part affected, patient positioning and finally, type, length and number of incisions.

Limitations

There are several limitations to the current study. It was not a prospective RCT, and therefore the level of evidence is lower and bias is possible. Closure of incisions was not performed by a single surgeon, and therefore heterogeneity in time to closure between surgeons may exist due to variability in expertise and skills. However, all surgeons were highly trained, with years of operative experience. Reporting on timing of the novel skin closure device or suture removal was not performed; however, estimated time for removal is also much faster with the novel skin closure device.

Conclusions

BandGrip is a novel skin closure device that allows efficient surgical incision closure. Time to surgical skin incision closure is significantly faster with the use of the novel skin closure device when compared with conventional sutures. **JWC**

Reflective questions

- Why has there been only minimal progress in wound closure technology over the past thousands of years?
- Will novel technologies eliminate the need for suturing of surgical incisions or will sutures prevail?
- Will expedited wound closure, as seen with BandGrip, decrease wound complications and operating room-related costs?
- How will the use of novel wound closure technologies affect cosmesis?

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