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Original article

Concealed cosmetic closure in total knee replacement surgery – A prospective audit assessing appearance and patient satisfaction

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ABSTRACT

Objective: With the trend towards accelerated rehabilitation, the method of skin closure has become increasingly important in orthopedic surgery. It is imperative to evaluate a technique that provides superior clinical and cosmetic results specifically for TKA, due to relatively thin skin anterior to the knee making poor wound healing an issue of concern. We conducted a prospective, single-arm audit evaluating the patient assessments of incision cosmesis for a novel technique in TKA wound closure called Concealed Cosmetic Closure (CCC).

Methods: 570 knees were included in the study whose wound was closed with concealed cosmetic subcuticular interrupted sutures (CCCIS) between January 2014 and May 2016. A validated, ordinal questionnaire, Stony Brooks Scar Evaluation Scale (SBSES) designed to elicit a score evaluating scar satisfaction was interviewed by the investigators to patients 6 months to 3 years postoperatively.

Results: CCC is a simple and relatively rapid single-operator technique that takes about 7–10 min to close 11–17 cm knee incision. In our study, the mean score for Stony Brook Scar Evaluation Scale (SBSES) was 4.4 (SD of 0.73) (range 3–5). The scar was rated highly in terms of cosmesis, patient satisfaction and appearance of the wound.

Conclusion: CCC is an effective modality for skin closure in total knee arthroplasty providing superior cosmetic healing with minimal complications leading to improved long term patient satisfaction.

1. Introduction

An appropriate skin closure during surgery protects the underlying structures from external contamination and leads to rapid healing with an acceptable scar. With the trend towards accelerated rehabilitation, the method of skin closure has become increasingly important in orthopedic surgery. An ideal suturing technique should give functional and cosmetic outcomes to the patient. The technique should reduce the tissue tension to prevent wound gaping, reduce dead space to minimum possible, have appropriate wound placement in relation to tension lines and minimize knot-related complications. The surgical scar evaluation is a fundamental measure to assess the functional outcome of the technique used for wound closure. Limited literature is available on patient attitudes regarding postoperative scar cosmesis.

Evaluation on the basis of early and late post-operative scar related complications, cosmetic appearance, patient satisfaction, ease of use, speed of closure and cost together helps gauge the success of the method used for skin closure.[1] Studies have shown that superficial wound infection may lead to deep (prosthetic) infection.[2] Complications of surgical incision include pathological scars with functional, cosmetic or psychological consequences. Millions of people worldwide suffer from diminished quality of life due to functional impairment, and psychosocial comorbidity. Substantial momentum currently exists in scar research associated with innovative techniques and devices devoted to treating scars.[1]

A surgeon has to choose the best closure method for a particular patient and wound from a multitude of possibilities.[3] Three commonly used methods of closure are staples, sutures and skin adhesives.[4] Any of the modality holds the edges of the skin together while it heals. The increased tensile forces associated with total knee replacement makes tissue adhesive inappropriate, especially when early range of motion (ROM) rehabilitation is started after TKR surgery.[1] Multiple studies have compared different closure techniques in Total Knee Arthroplasty (TKA). The majority of these studies have involved running subcuticular closure versus staple closure and focused on factors such as cost, performance time, patient satisfaction, and wound complications.

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The optimal method of skin closure providing superior clinical and cosmetic outcomes still remains a contested topic and to date the literature remains divided. Considering these factors, it is imperative to evaluate a technique that provides superior clinical and cosmetic results specifically for TKA, due to relatively thin skin anterior to the knee which makes poor wound healing an issue of concern.[5]

Therefore, we conducted a prospective, single-arm study evaluating the long term cosmetic outcomes of a novel technique in TKA wound closure, concealed cosmetic closure (CCC) using the Stony Brook Scar Evaluation Scale (SBSES), a validated ordinal, binary response scale evaluating cosmetic appearance of scar following TKA at six months (range of time since surgery varied from 6 months to 3 years). This is the first study evaluating the long-term cosmetic outcomes of this technique in patients undergoing TKA.

2. Materials and methods

This prospective, single-center, cohort, questionnaire-based audit was conducted at a tertiary care centre between January 2014 and May 2016, after approval by the local institutional review board. Patients presenting for a pre-surgical TKA consultation, were informed by investigators about study evaluating the technique CCCIS and written informed consent was taken. Participation was purely voluntary and withdrawal from the study was allowed.

Inclusion criteria included all patients planned for TKA at out institute. Exclusion criteria were revision knee arthroplasty surgery, a previous scar in the operative field, local signs of infection, skin disorders like psoriasis, eczema or dermatitis, a tendency for keloid formation, and patients whose skin was judged to be too thin.

2.1. Patient profile

A total of 655 TKA were done during the study period, but 85 knees had to be excluded from the study for the following reasons – 61 patients were lost to follow-up because of non-attendance of phone call, change of phone number, 10 revision knees were excluded, 4 patients had skin disorders, 4 had infections, 1 had tendency to keloid formation and for 5 patients, the investigator judged the skin to be too thin (Table 1). Thus, a total of 570 knees were evaluated. 460 patients had unilateral TKAs, and 55 patients had bilateral TKA. The average age of patients was 71 years, with a range of 45 to 91 years.

Before surgery, basic demographic data, including age, gender, ethnicity, side of surgery, body mass index (BMI), diagnosis and previous other joint surgery, were collected. All patients had the same post-operative care pathways. In-patient assessment took place on second post-operative day. A researcher collected information on the presence of oozing and suspected wound infection. Patients were discharged between three to five days post-operatively.

At six months to three years, data was collected on scar appearance. Patients were evaluated on a five point scale – SBSES for cosmetic appearance, where 0 indicated the worst outcome and 1 the best (Table 2). An independent orthopedic surgeon who was not part of the study conducted the follow-up, asking objective questions about the scar cosmetic appearance. The idea behind conducting a patient assessed evaluation of scar was to capture patient's own view of the scar which may be very influential in determining the patient's quality of life.

2.2. Surgery details

CCC is the standard method of skin closure at our centre. The *peri*-operative care was standardized, including antibiotic prophylaxis, thromboprophylaxis and use of same dressings for the wound. All patients had a midline anterior approach to the knee, and two layers of sutures prior to the skin closure method; the extensor mechanism was closed with No. 1 polyglactin and fat with interrupted No. 1 polyglactin.

2.3. Patient-centered outcome

The SBSES was proposed in 2007 by Singer et al.[6] and is a wound evaluation scale developed to measure cosmetic outcome of wounds (Table 2). In this study, we calculated the mean score for the entire evaluable patient population (570 patients), standard deviation and the range of SBSES. Inter-rater reliability demonstrated good agreement, ranging from 0.73-0.85. In orthopaedic surgery, the increasing popularity of patient-driven rather than surgeon-driven functional outcomes is observed. Little information exists on the incidence of patient-perceived cosmetic wound outcomes in orthopaedic surgery.[7]

2.4. Antibiotic and DVT prophylaxis

Antibiotic prophylaxis with Injection Cefazolin (Reflin) 2 g intravenously first dose is given 30 mins before surgery and 2 other doses are given after surgery 8 h apart as per centre's current protocol. Injection Dalteparin Sodium was prescribed post-operatively at 5000 IU subcutaneously as a prophylaxis for deep venous thrombosis (DVT).

Table 1
Baseline characteristics.

Patients	Number
Total number of TKA cases	655
Excluded from analysis –	
• Lost to follow-up	61
• Patients requiring revision knees	10
• Knees with skin disorders	4
• Knees with wound infections	4
• Tendency to keloid formation	1
• Thin skin	5
• Number of TKA cases included in final analysis	570

Table 2
Stony Brook Scar Evaluation Scale.

The Stony Brook Scar Evaluation Scale
• Width: >2 mm = 0, ≤2 mm = 1
• Height: Elevated/depressed in relation to surrounding skin = 0, Flat = 1
• Colour: Darker than surrounding skin = 0, Same colour or lighter than surrounding skin = 1
• Hatch marks/Suture marks: Present = 0, Absent = 1
• Overall appearance: Poor = 0, Good = 1
• A total cosmetic score was then calculated by adding the individual scores on each of the five categories ranging from 0 (worst) to 5 (best).

2.5. Sutures

Polyglactin 910 is a synthetic, absorbable, undyed, braided suture (Lotus sutures) made of polyglactin 910 coated with a copolymer of L-lactide and glycolide (Polyglactin 370) and calcium stearate. It is derived from polyglactin 910 that is partially hydrolyzed in a buffer solution and sterilized with gamma irradiation. This processing speeds absorption, leaving the mechanical properties of the suture intact. Absorption occurs by hydrolysis in 7 to 14 days.[8] Polyglactin 910 retains 65% of its tensile strength at 2 weeks and 40% at 3 weeks.[8] Complete absorption occurs between 60 and 90 days by hydrolysis. There is less of an inflammatory response due to the absorption of Polyglactin acid by hydrolysis if compared with the proteolytic absorption of sutures prepared with surgical gut.

2.6. Subcuticular interrupted suture

This suture provides an excellent way to achieve accurate skin edge apposition without external sutures or cross-hatching. They are useful in linear or irregular wounds. This method allows the width of the suture at its base in the dermis to be wider than the epidermal entrance and exit points. An advantage of interrupted sutures is that more selective adjustments of wound edges can be made.[9]

2.7. Procedure

The technique is interrupted, concealed (deep-buried) sutures. The subcutaneous closure is done with the No. 1-0 polyglactin suture and then interrupted sub-cuticular sutures are taken with

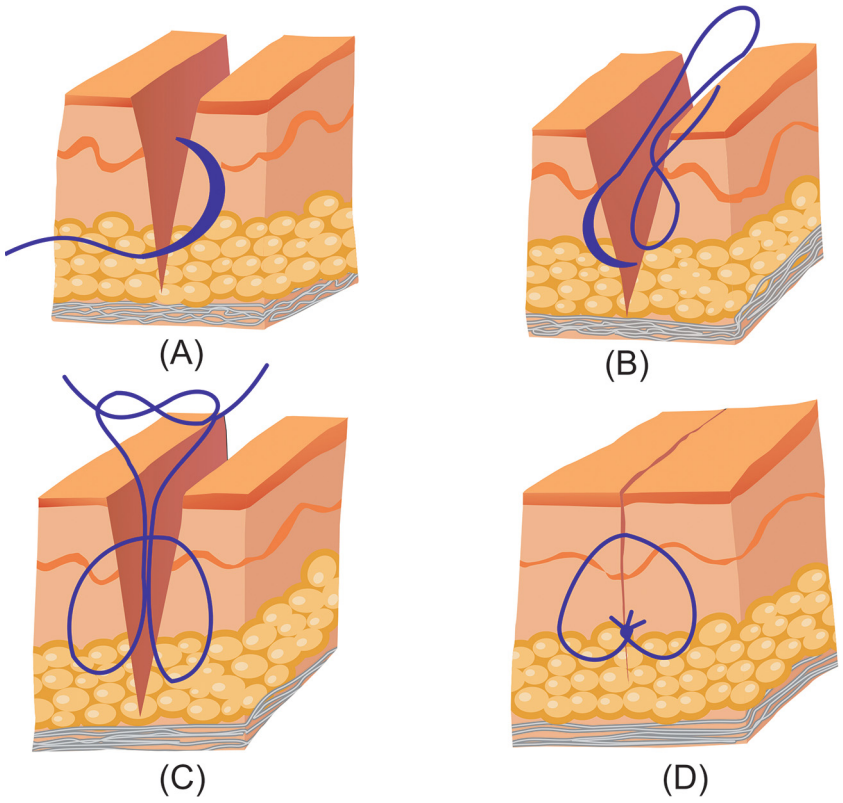

Fig 1. Technique of Concealed Cosmetic Closure performed for TKA in this study.

absorbable undyed braided 2-0 polyglactin 910 (Lotus Sutures) with a half reverse cutting needle. Buried knots are created with absorbable subcuticular sutures by taking the first bite on the near side of the wound from deep to superficial (Fig. 1). The bite includes tissue at the base of the wound to close the deep space. The needle is then placed in the needle holder upside down and backwards, and a reverse bite is created going from superficial to deep on the far side. The free end of the suture and the needle end must exit the wound on the same side of the suture across the top of the wound. This technique allows the final knot to be buried deep in the wound base.

3. Results

Total 655 consecutive elective TKA were done in our unit during a two and a half year period starting from Jan 2013 (Table 2). Out of which, 85 cases were excluded from the analysis. Therefore, 570 knees were available for the final outcome study.

3.1. Surgery outcomes

The average length of incision was 13.2 cm (11 to 17 cm). All surgeries had an anterior approach. Skin closure with CCC was relatively fast with an approximate time of 7–10 min. The closure technique was rated by surgeons to have good ease of use.

3.2. Costs

The sutures cost for the absorbable undyed braided 2-0 polyglactin 910 (Lotus Sutures) is $ 6.6. It is 90 cm long. One such material was used per patient. Therefore, the cost to close a wound with CCC technique was $ 6.6.

3.3. SBSES patient outcome

Follow-up and audit took place at a mean of 14 months (6 to 36 months) post-operatively. In our study, the mean score for SBSES was 4.4 (SD of 0.73) (range 3–5) (Table 3). The patients rated highly in terms of cosmesis, patient satisfaction or appearance of the wound (Figs. 2–4). None of the patients reported other rare scar related symptoms like hyper/hypohydrosis or pruritis. There were 4 cases of superficial infection and no case of dehiscence. All 4 cases required no wound debridement and improved eventually. One patient had dysaesthesia. The absorbable suture wound closures were typically uncomplicated and low maintenance without the inconvenience, expense, or discomfort of suture removal. Patients described their scars as comfortable and satisfying in appearance.

Table 3
Pie chart showing the proportion of cases with different SBSES.

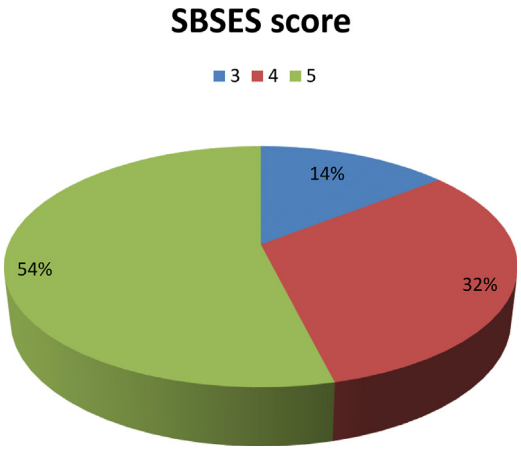

Fig. 2. A 65 year old female patient 'A' suffering from knee arthritis operated with CCC technique two weeks post operative in flexed position.

4. Discussion

Numerous options for skin closure have become available in the last 30 years. It is paramount to choose a method tailored to each patient and wound. The factors to be considered while selecting the modality of skin closure are ease and speed of closure, the level of patients' discomfort, the complication rate, the final cosmetic result, and the cost.[10]

Fig. 3. Follow-up photograph of patient 'A' operated with CCC technique one year post operative in flexed position.

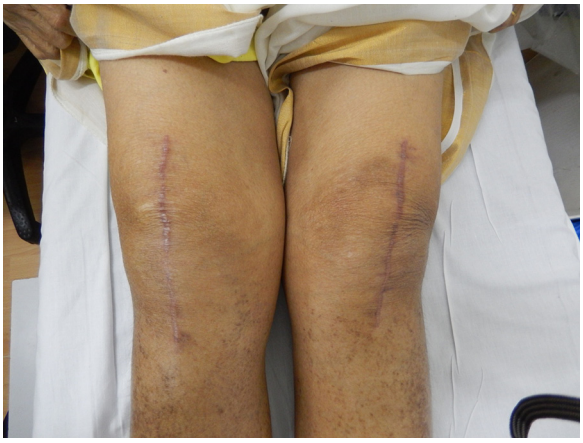

Fig. 4. Follow-up photograph of patient 'A' operated with CCC technique one year post-operative in extended position.

To the best of authors' knowledge, this is the first study evaluating long-term wound outcomes of CCC after TKA. This prospective single-arm audit showed better results with CCC method of skin closure in terms of cosmetic appearance of the scar, patient satisfaction, or complications after surgery. The surgeons observed speed and ease of closure. The primary outcome measure used was scoring by the validated tool SBSES for the cosmetic appearance of the scar at six months to three years. This period has been shown to reflect long-term cosmetic outcome.

Patients own view of the scar may be very influential in determining the quality of life, irrespective of the actual physical characteristics of the scar. Patient self-assessment of scar characterization (length, width, color) has been compared with evaluation by a clinician without the finding of significant discrepancy. That is, patients' follow-up visits to clinic only to obtain scar data offer no benefit beyond that obtained from patient self-reported measurement and scar evaluation for the purposes of data collection for outcome measurements.[11] Hence we conducted a telephonic interview of patient assessment of scar on SBSES scale.

Halstead was the first surgeon to introduce subcuticular sutures in 1887 in order to reduce infection in operation of inguinal hernia.[12] Dr. J.S.Davis was the first surgeon to elaborate the role of subcuticular sutures in wound aesthetics.[12] Polglase and Nayaman first proved that subcuticular sutures are associated with lower rates of infection compared to transdermal silk sutures.[13]

The accuracy of suture or staple closure and choice of closure method can have an effect on the accuracy of coaptation of the dermal margins.[14] Poor technique can lead to suboptimal/delayed healing causing oozing from wound edges and increases the potential for infection. Superficial infection in hip and knee arthroplasty is a worrying clinical sign because of the risk of the infection spreading through the dermal layers to the implant. The most common complications of skin closure are wound infection and dehiscence. In our study, there was no dehiscence and low infection rates (4 knees) in elective total knee replacement.

In our study, the mean score for SBSES was 4.4 (SD of 0.73) (range 3–5). Sundaram RO et al. evaluated patient satisfaction of the surgical scar and resulting hypoaesthesia following TKA.[15] Group 1 consisted of 91 patients who underwent primary TKA using a medial parapatellar incision and trivector arthrotomy with a mean follow up of 2.8 years. Group 2 consisted of 76 patients who underwent primary TKA using a midline incision and medial parapatellar arthrotomy with a mean follow up of 2.7 years. The scars were assessed using the validated Manchester Scar Proforma (MSP). The mean MSP for Group 1 and Group 2 was 11.7 and 11.9 respectively and the difference was not statistically significant.

Mutnal A.B. et al. evaluated SBSES in direct anterior total hip arthroplasty in 50 patients and found that age more than 65 years and pre-albumin less than 20 mg/dl are associated with poor SBSES scores.[17] Our study did not include such analysis.

Zhang et al. through a systematic review of *meta*-analysis, reported that barbed suture is preferable for TKA wound closure given its shorter wound closure time, lower total cost, lower risk of complications.[18] A systematic review of methods of skin closure in caesarean section reported that use of absorbable sub-cuticular sutures resulted in less postoperative pain and yielded a better cosmetic result than staples.[19]

Interrupted subcuticular or buried suturing provides a better environment for skin healing as no skin interruption is provided by the suturing tool and better blood circulation is maintained to the skin due to better approximation.[20] Ideally uniform assessment of the scar should be done more than a year after surgery for the scar to contract and fully mature.[20] In our study, three fourth of the patients' scars are evaluated after a year with a range of 6 months to 3 years.

In terms of time required for skin closure, our process takes longer than continuous sutures or stapler and hence would require fractionally more theatre time. The time required for CCC is around 7–10 min. Hlubek R et al. reported median time for closure by staples to be 81 s in comparison with 290 s for conventional suture.[21] The entire TKA procedure using CCC technique for wound closure requires a total surgical time of 100 min whereas in clinical studies, the mean surgical time with sutures was 122.3 min (SD = 33.4) and with staples was 114 min (SD = 24.4). Follow-up studies focusing on surgical time suggested that staples could save up to 80% of the time required for suturing with equal cosmetic results. Two comparative studies from 1987 and 1992 reported faster wound closure time with staple but at the cost of wound inflammation, discomfort, and diminished cosmetic results in laparotomy and general wound closure.[22,23] The use of dressings and the amount of primary care follow-up required would also need to be taken into consideration. TKA wounds closed with CCC would not incur the additional cost or pain of the suture/staple remover and may also require fewer dressings although this is an investigator observation and not established in comparative trial.

Other suturing methods like staples or skin closure with Nylon or Ethilon requires staple/suture removal which causes anxiety of pain to the patient and discomfort. In our closure technique, as there is no suture removal required, the patient did not feel any anxiety of suture removal or discomfort during suture removal.

Further, this technique does not produce a typical ladder-shaped scarring seen with the staple or other suture techniques.

In our study, the cost of absorbable suture material was calculated to be $ 6.6 per knee. Metal staples have been regarded as a more expensive option for wound closure though costs could be reduced by reduced theatre time and ease of clip removal compared with suturing wounds.[24] Furthermore, it has been mentioned in previous literature, that removal of staples is perceived as painful by the patients.[24] Given the difference in the incidence of wound infection, and the limited empirical evidence for patients' or surgeons' preference for staple closure, there is insufficient evidence to justify the use of staples over sutures.[25]

The study has the intrinsic limitations of a patient assessed analysis and a lack of control group, although having a single setting and surgeon, eliminates many confounding variables for evaluation of the closure technique. Further, there are multiple potential factors like age, skin tensile strength, use of medications, tissue handling and patient innate features which might play a role in wound healing are not included in this study. We do realize this as a limitation of our study. Strengths of this study are the high sample size so as to draw a confident conclusion on efficacy of technique in Indian patients to produce superior cosmesis which has not been undertaken in much detail previously.

5. Conclusion

CCC is an effective modality for skin closure in TKA providing superior cosmetic healing with minimal complications and improved long term patient satisfaction. A blinded prospective randomized comparative trial of CCC versus absorbable staples and other modalities could provide significant qualitative measures for comparisons. Further studies could also involve a comprehensive study of a detailed cost analysis, complications, cosmesis, patient convenience and surgeon preference of each modality of skin closure following TKA.

Conflict of interest

The authors have none to declare.

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