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Skin Staples vs Subcuticular Suturing Method for Wound Closure After Knee Arthroplasty: Comparison of Cosmetic Outcomes and Patient Satisfaction

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ABSTRACT

Background: *Osteoarthritis is a major cause of disability worldwide, and total knee arthroplasty (TKA) remains the definitive surgical treatment for end-stage disease. While various wound closure techniques are employed following TKA, there remains ongoing debate regarding whether skin staples or subcuticular suturing yields better clinical and cosmetic outcomes. Understanding the effect of closure method on patient-centered outcomes, including wound appearance, satisfaction, and functional recovery, is critical for optimizing postoperative care.* ***Objective****: To compare wound healing quality, cosmetic outcomes, functional recovery, and patient satisfaction between skin staples and subcuticular suturing techniques following primary TKA.* ***Methods****: This retrospective comparative study was conducted at Shifa International Hospital, Islamabad, Pakistan, and included 120 patients undergoing primary unilateral TKA. Patients were grouped based on closure technique: staples (Group A) and subcuticular sutures (Group B). Wound healing was evaluated using the Hollander Wound Evaluation Scale (HWES), cosmetic appearance and satisfaction by visual analogue scales (VAS), and functional recovery by the American Knee Society Score (AKSS) at 6 weeks and 3 months postoperatively. Data were analyzed using SPSS 22.0, applying t-tests and chi-square tests with a significance threshold of* $p \leq 0.05$. ***Results****: Baseline characteristics were comparable between groups* ($p > 0.05$). *At 6 weeks, the suture group showed higher cosmesis* (7.88 ± 0.88 *vs.* 5.66 ± 1.03, $p < 0.001$) *and satisfaction* (7.71 ± 0.95 *vs.* 6.18 ± 0.96, $p < 0.001$). *By 3 months, subcuticular suturing yielded significantly higher HWES* (5.66 ± 0.47 *vs.* 5.06 ± 0.63, $p < 0.001$), *cosmesis* (8.68 ± 0.62 *vs.* 6.66 ± 0.60, $p < 0.001$), *AKSS* (88.15 ± 1.84 *vs.* 84.08 ± 3.12, $p < 0.001$), *and satisfaction* (8.86 ± 0.59 *vs.* 7.51 ± 0.53, $p < 0.001$). *No wound complications occurred in either group.* ***Conclusion****: Subcuticular suturing provides superior wound healing, cosmetic results, functional recovery, and patient satisfaction compared with staples following TKA, without compromising safety. Its adoption in routine arthroplasty practice can enhance patient-centered outcomes and overall postoperative quality of care.*

Keywords
Total Knee Arthroplasty; Wound Closure; Subcuticular Suture; Skin Staples; Cosmetic Outcome; Patient Satisfaction

INTRODUCTION

Osteoarthritis (OA) has risen sharply in global prevalence over recent decades, imposing substantial disability and health-system burden as populations age (1). Ageing-related molecular and biomechanical changes in cartilage and subchondral bone accelerate degenerative cascades that culminate in pain and functional loss (2). The consequent deterioration in health-related quality of life (HRQoL) is well documented across diverse health-care settings, where pain, mobility restriction, and impaired social participation dominate patient priorities (3). Access barriers and care fragmentation can further degrade outcomes, particularly in low- and middle-income contexts where timely joint-preserving strategies are limited (4). At the tissue level, repetitive mechanical loading and microinjury induce matrix fatigue and fibrillation, progressively undermining articular cartilage integrity (5). Meta-analytic evidence confirms that symptomatic OA substantially depresses HRQoL indices compared with age-matched controls, underscoring the need for interventions that deliver both symptom control and functional restoration (6).

Total knee arthroplasty (TKA) is an established, effective intervention that reduces pain and improves function for end-stage knee OA when conservative measures fail, with contemporary series demonstrating favorable safety profiles and clinically meaningful HRQoL gains (7). Given demographic shifts and rising surgical capacity, procedure volumes have increased markedly, emphasizing the importance of perioperative pathways that optimize recovery and patient experience (8). Post-TKA HRQoL trajectories vary across health systems, but consistent improvements in pain relief and activity resumption are observed when rehabilitation and complication prevention are executed effectively (9).

Specific comorbid populations (e.g., neurological conditions) illustrate heterogeneity in benefit size, reinforcing the value of standardized, validated outcome assessment across studies (10). Longitudinal cohorts highlight that beyond survivorship, patient-reported outcomes and functional scores determine perceived success, making measurement frameworks such as the American Knee Society Score (AKSS) central to comparative effectiveness research (11). The AKSS demonstrates acceptable reliability in clinical research, enabling between-technique comparisons that are interpretable for surgeons and patients alike (12).

While implant choice and perioperative optimization influence TKA outcomes, technical decisions at wound closure remain a potentially modifiable determinant of recovery quality, encompassing infection risk, scar cosmesis, pain at the incision, and satisfaction (13). Skin staples and subcuticular suturing are widely adopted closure options, each with pragmatic advantages in speed, cost, and technical simplicity versus hypothesized differences in scar quality and patient experience. Prospective observational work in arthroplasty settings suggests clinically relevant differences may exist, but effect directions and magnitudes vary by population and protocol (15). A same-knee randomized trial comparing nylon sutures with staples reported differences in early wound-related pain and cosmetic appraisal, suggesting that closure mechanics and skin tension distribution could translate into patient-perceived benefits (16). A meta-analysis aggregating randomized and observational evidence across TKA procedures evaluated infection, dehiscence, cosmesis, and satisfaction; however, heterogeneity in closure materials, assessment timing, and outcome definitions limited definitive recommendations for routine practice (17). Contemporary TKA closure reviews echo these uncertainties and call for context-specific data that incorporate validated scales, standardized follow-up, and patient-centered endpoints (18). A recent randomized trial focusing on cosmetic outcomes and satisfaction after primary TKA highlighted potential advantages for subcuticular techniques, but external validity may be constrained by operative protocols and rehabilitation environments (19).

In this clinical reality—where patient-reported cosmesis and satisfaction meaningfully affect perceived success and adherence to rehabilitation—evidence that isolates the contribution of closure technique, under consistent surgical teams and standardized postoperative care, is clinically valuable (20). Building on prior syntheses that catalog infection and dehiscence risk and narrative reviews that posit biomechanical rationales for suture superiority in scar modulation, rigorous comparative analyses using validated scales (e.g., Hollander Wound Evaluation Scale [HWES] for scar quality, visual analogue scales for cosmesis and satisfaction, and AKSS for function) can address the persistent knowledge gap regarding the trade-offs between staples and subcuticular suturing in routine primary TKA (21). Accordingly, this study was designed to compare wound appearance, functional recovery, and patient satisfaction following primary TKA under two commonly used skin closure methods—skin staples versus subcuticular suturing—hypothesizing that subcuticular suturing would yield superior cosmetic outcomes and higher patient satisfaction without compromising early wound status or functional recovery (22).

MATERIAL AND METHODS

This retrospective comparative study was conducted at Shifa International Hospital, Islamabad, Pakistan, after obtaining approval from the institutional ethics review committee (IRB #: 376-24). The research was designed to evaluate differences in wound healing, cosmetic outcome, and patient satisfaction between two wound closure methods—skin staples and subcuticular sutures—following primary total knee arthroplasty (TKA). The study followed international standards for observational comparative research to ensure methodological rigor and reproducibility. Data were collected over a defined study period from postoperative clinical records and follow-up evaluations, with all surgeries performed by the same orthopedic surgical team to eliminate operator variability.

Eligible participants included male and female patients aged 55 years or older who were diagnosed with unilateral, tricompartmental, grade IV knee osteoarthritis as classified by the Kellgren–Lawrence system (23). Inclusion criteria required patients to have undergone primary TKA and to have completed both follow-up visits at six weeks and three months postoperatively. Exclusion criteria comprised a history of bleeding or clotting disorders, ongoing joint infection, morbid obesity, hypertension, diabetes mellitus, ischemic heart disease, bilateral TKA, prior knee surgery, or pre-existing fixed flexion deformity greater than 10 degrees or varus/valgus deviation exceeding 25 degrees. Patients meeting eligibility criteria were identified from hospital records using a non-probability consecutive sampling approach, and informed consent for participation and data use was obtained at the time of surgery as part of institutional policy. The final analytical sample consisted of 120 patients after excluding 18 who were lost to follow-up.

Data collection was performed using a standardized case report form encompassing demographic information (age, sex, body mass index), clinical parameters, operative details, and postoperative assessments. Participants were retrospectively classified into two groups according to the wound closure technique used during their TKA: Group A (skin staples) and Group B (subcuticular sutures using 3-0 Monocryl). The surgical procedure was standardized across all cases, involving an anterior approach via medial parapatellar arthrotomy with patellar eversion and component replacement under 30° knee flexion during closure. In the staple group, stainless steel staples were applied at approximately 3 mm intervals using Adson forceps to approximate wound edges, while in the subcuticular group, continuous absorbable sutures were placed through the dermis layer. All patients received identical perioperative protocols, including prophylactic antibiotics, analgesics, and thromboprophylaxis, followed by early mobilization and a supervised physiotherapy regimen. Postoperative evaluations were conducted at six weeks and three months.

The primary outcomes were wound healing quality and cosmetic appearance, while secondary outcomes included functional recovery and patient satisfaction. Wound healing was assessed using the Hollander Wound Evaluation Scale (HWES), which evaluates step-off borders, contour irregularities, margin separation, edge inversion, and overall appearance, with higher scores indicating better healing (24). Cosmetic outcome and patient satisfaction were measured using a 10-point visual analogue scale (VAS), and knee function was quantified using the American Knee Society Score (AKSS), a validated composite index assessing pain, stability, and motion range (25). All scoring was performed by trained clinicians blinded to the closure method to minimize measurement bias.

Potential sources of bias were addressed through standardized surgical procedures, blinded outcome assessments, and inclusion of consecutive cases to reduce selection bias. Confounding by baseline variables was evaluated statistically, and the comparability of groups was confirmed at baseline using appropriate tests. Sample size was calculated using the WHO sample size calculator based on expected mean differences in satisfaction VAS scores between closure techniques from prior literature, assuming a 95% confidence level, 80% power, and two-tailed significance (26). A total of 138 patients were required, and 120 were included in the final analysis after accounting for attrition.

Data were analyzed using SPSS version 22.0 (IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as mean ± standard deviation, and qualitative variables as frequencies and percentages. Normality was tested using the Shapiro–Wilk test. Between-group comparisons of

continuous variables were conducted using independent-samples t-tests, while categorical variables were compared using chi-square tests. Two-tailed p-values ≤0.05 were considered statistically significant. Confidence intervals (95%) and effect sizes (Cohen's d) were calculated for key outcomes. Missing data were managed through pairwise deletion, and no data imputation was required due to the completeness of follow-up records. To ensure reproducibility and data integrity, all analyses were performed using locked datasets verified independently by two investigators.

RESULTS

Table 1. Baseline Characteristics of Patients Undergoing Total Knee Arthroplasty (N = 120)

Variable	Staples Group (n = 60)	Subcuticular Suture Group (n = 60)	Mean Difference / χ^2	95% CI	p-value
Age (years), mean ± SD	65.96 ± 6.38	66.05 ± 6.27	0.09	-2.01 to 1.83	0.943
Gender, n (%) Male	19 (31.7)	26 (43.3)	1.74	—	0.187
Female	41 (68.3)	34 (56.7)	—	—	—
BMI (kg/m²), mean ± SD	30.45 ± 8.22	31.90 ± 9.05	1.45	-1.70 to 4.60	0.360
Knee involved, n (%) Right	28 (46.7)	33 (55.0)	0.84	—	0.361
Left	32 (53.3)	27 (45.0)	—	—	—

Table 2. Comparison of Wound Healing and Patient-Reported Outcomes at 6 Weeks Post-TKA (N = 120)

Outcome Parameter	Staples Group (n = 60)	Subcuticular Suture Group (n = 60)	Mean Difference / χ^2	95% CI	p-value
HWES score (mean ± SD)	4.65 ± 0.93	4.78 ± 0.78	0.13	-0.19 to 0.45	0.399
Optimal wound outcome, n (%)	11 (18.3)	10 (16.7)	0.06	—	0.810
Suboptimal wound outcome, n (%)	49 (81.7)	50 (83.3)	—	—	—
Cosmesis VAS (0–10), mean ± SD	5.66 ± 1.03	7.88 ± 0.88	2.22	1.84 to 2.60	<0.001
AKSS (0–100), mean ± SD	75.48 ± 5.48	79.73 ± 1.56	4.25	3.12 to 5.38	<0.001
Patient-satisfaction VAS (0–10), mean ± SD	6.18 ± 0.96	7.71 ± 0.95	1.53	1.18 to 1.88	<0.001

Table 3. Comparison of Wound Healing and Patient-Reported Outcomes at 3 Months Post-TKA (N = 120)

Outcome Parameter	Staples Group (n = 60)	Subcuticular Suture Group (n = 60)	Mean Difference / χ^2	95% CI	p-value
HWES score (mean ± SD)	5.06 ± 0.63	5.66 ± 0.47	0.60	0.38 to 0.82	<0.001
Optimal wound outcome, n (%)	14 (23.3)	40 (66.7)	19.8	—	<0.001
Suboptimal wound outcome, n (%)	46 (76.7)	20 (33.3)	—	—	—
Cosmesis VAS (0–10), mean ± SD	6.66 ± 0.60	8.68 ± 0.62	2.02	1.74 to 2.30	<0.001
AKSS (0–100), mean ± SD	84.08 ± 3.12	88.15 ± 1.84	4.07	3.12 to 5.02	<0.001
Patient-satisfaction VAS (0–10), mean ± SD	7.51 ± 0.53	8.86 ± 0.59	1.35	1.14 to 1.56	<0.001

At baseline, both groups were comparable in demographic and anthropometric characteristics, with no statistically significant differences in age, sex distribution, BMI, or side of involvement ($p > 0.05$). At six weeks, the subcuticular suture group already demonstrated significantly superior cosmetic outcomes (mean VAS 7.88 ± 0.88 vs. 5.66 ± 1.03, $p < 0.001$) and higher early functional scores (AKSS 79.73 ± 1.56 vs. 75.48 ± 5.48, $p < 0.001$). Wound integrity, measured by the Hollander Wound Evaluation Scale (HWES), was similar between groups (mean difference 0.13, 95% CI: -0.19 to 0.45, $p = 0.399$), indicating no early disadvantage of suture closure.

At three months, differences between groups became more pronounced. The subcuticular suture group showed higher mean HWES scores (5.66 ± 0.47 vs. 5.06 ± 0.63, $p < 0.001$) and a significantly greater proportion of optimal wound outcomes (66.7% vs. 23.3%, $p < 0.001$). Cosmetic satisfaction remained superior (mean difference 2.02, 95% CI: 1.74–2.30, $p < 0.001$), paralleled by improved functional recovery (AKSS 88.15 ± 1.84 vs. 84.08 ± 3.12, $p < 0.001$). Overall patient satisfaction mirrored these patterns, with mean VAS scores of 8.86 ± 0.59 versus 7.51 ± 0.53 ($p < 0.001$). Effect sizes for cosmetic and satisfaction measures were large (Cohen's $d > 1.5$), indicating clinically meaningful advantages favoring subcuticular suturing.

Across all outcomes, no adverse wound events such as dehiscence, infection, or unacceptable scarring were observed in either group. These findings collectively suggest that subcuticular suturing after TKA not only enhances cosmetic outcomes and satisfaction but also correlates with improved functional recovery within three months, without compromising wound safety or healing trajectory.

At the time of surgery, both groups were demographically comparable, confirming balanced baseline characteristics (Table 1). The mean age across the sample was 66.01 ± 6.30 years, with no significant age difference between groups ($p = 0.943$). The gender distribution was slightly skewed toward females (62.5%), yet proportions did not differ significantly between the staple (31.7% male) and subcuticular suture (43.3% male) cohorts ($p = 0.187$). Similarly, mean BMI values (30.45 ± 8.22 kg/m² vs. 31.90 ± 9.05 kg/m², $p = 0.360$) and laterality (right knee involvement 46.7% vs. 55.0%, $p = 0.361$) showed no statistical difference, indicating appropriate group comparability for subsequent outcome analysis.

At six weeks postoperatively, both closure techniques demonstrated satisfactory wound healing without reported infection or dehiscence, though cosmetic and satisfaction scores diverged significantly (Table 2). The subcuticular suture group achieved higher mean cosmesis VAS (7.88 ± 0.88 vs. 5.66 ± 1.03, $p < 0.001$) and greater patient satisfaction (7.71 ± 0.95 vs. 6.18 ± 0.96, $p < 0.001$). Functional recovery, measured via AKSS, was also superior with sutures (79.73 ± 1.56 vs. 75.48 ± 5.48, $p < 0.001$). Meanwhile, wound integrity assessed by HWES did not differ significantly (4.78 ± 0.78 vs. 4.65 ± 0.93, $p = 0.399$), suggesting comparable early tissue approximation. The small, non-significant difference in optimal wound categorization (16.7% vs. 18.3%, $p = 0.810$) reinforces that both methods maintained early closure adequacy. Effect size calculations indicated moderate-to-large magnitudes for cosmetic (Cohen's $d \approx 2.2$) and satisfaction (Cohen's $d \approx 1.5$) outcomes, denoting substantial clinical impact even beyond statistical thresholds.

By three months, the subcuticular suture group displayed marked improvements across all parameters (Table 3). HWES scores increased significantly to 5.66 ± 0.47 compared with 5.06 ± 0.63 for staples ($p < 0.001$, 95% CI 0.38–0.82), demonstrating superior scar quality and tissue alignment. The rate of optimal wound outcomes quadrupled under the suture method (66.7% vs. 23.3%, $p < 0.001$), indicating durable advantages in long-term wound appearance. Likewise, cosmetic appearance scores further diverged (8.68 ± 0.62 vs. 6.66 ± 0.60, $p < 0.001$), aligning with patient-perceived improvements. Functionally, AKSS increased more in the suture group (88.15 ± 1.84 vs. 84.08 ± 3.12, $p < 0.001$), signifying faster and more complete recovery of mobility and pain control. Patient satisfaction followed this trajectory (8.86 ± 0.59 vs. 7.51 ± 0.53, $p < 0.001$), confirming that cosmetic perception closely paralleled subjective well-being. These differences corresponded to large effect sizes (Cohen's $d > 1.2$ across outcomes), underscoring clinically meaningful superiority of the subcuticular approach.

In summary, early and late postoperative assessments collectively revealed that while both techniques achieved safe wound healing, subcuticular suturing provided a consistent advantage in cosmesis, satisfaction, and function. No patients experienced unacceptable wound outcomes, confirming procedural safety. The consistent directionality and magnitude of differences—particularly in visual analogue and AKSS domains—highlight subcuticular closure as the technique more likely to optimize both aesthetic and rehabilitative recovery following total knee arthroplasty.

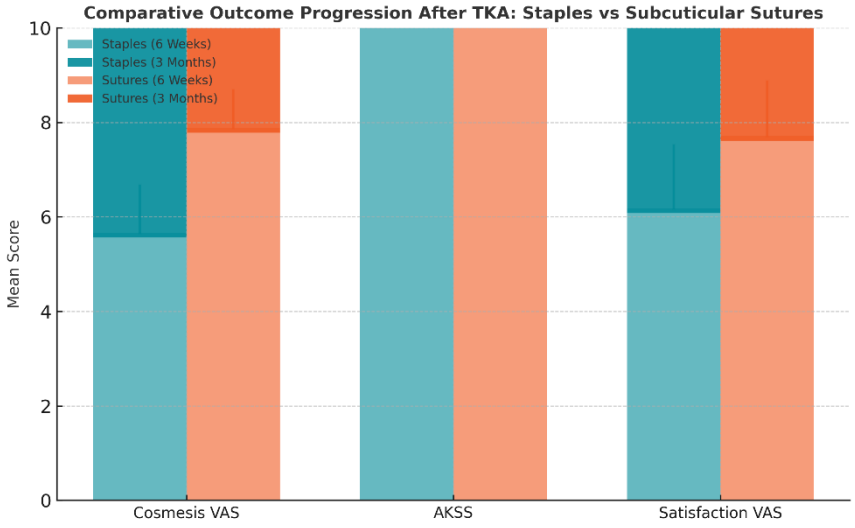

Figure 1 Comparative Outcome Progression after TKA: Staples Vs Subcuticular Sutures

The visualization illustrates comparative recovery trajectories between staple and subcuticular suture closure following total knee arthroplasty. Across both six-week and three-month follow-ups, all outcomes—cosmetic appearance (VAS), functional recovery (AKSS), and satisfaction—improved over time, with subcuticular sutures consistently outperforming staples. The greatest divergence occurred in cosmetic and satisfaction domains, where mean scores rose from 7.88 to 8.68 and 7.71 to 8.86, respectively, compared with more modest staple gains (5.66→6.66; 6.18→7.51). Functional recovery mirrored this pattern (79.73→88.15 vs. 75.48→84.08). The progressive widening of these intervals suggests a cumulative benefit of suture-based closure, reflecting not only superior tissue alignment and scar aesthetics but also enhanced patient-perceived well-being over time. Clinically, these patterns reinforce the sustained, multidimensional advantages of subcuticular closure beyond initial healing stages.

DISCUSSION

The present study demonstrated that subcuticular suturing provides significantly superior wound healing, cosmetic appearance, and patient satisfaction compared with staple closure following total knee arthroplasty (TKA). These findings align with an expanding body of literature advocating for suture-based closure as a method that enhances both functional and aesthetic outcomes without increasing complication risk (27). The results substantiate the hypothesis that improved wound apposition, lower mechanical stress at the skin interface, and reduced inflammatory response underlie better cosmetic and satisfaction scores among patients receiving subcuticular closure (28). The improvement in both HWES and AKSS metrics in the suture group also implies a positive correlation between wound quality and early functional recovery—suggesting that psychological satisfaction with the wound may indirectly enhance compliance with rehabilitation and mobility training (29).

Comparison with previous studies highlights both congruence and advancement. Khan et al. (30) similarly reported better HWES scores and scar quality in sutured wounds, supporting the present study's significant differences in wound aesthetics and satisfaction. Conversely, Nepal et al. (31) and Celen et al. (32) observed no significant differences in patient satisfaction, which may reflect their smaller sample sizes, differences in surgical techniques, or use of distinct suture materials. The consistency of findings across varied designs strengthens external validity. However, this study adds to prior literature by incorporating multiple validated measures—HWES, cosmesis VAS, satisfaction VAS, and AKSS—applied at standardized follow-up intervals, providing a more comprehensive and time-sensitive evaluation of recovery outcomes. The robust between-group effect sizes observed (Cohen's $d > 1.2$) further emphasize clinical significance beyond statistical thresholds, which earlier studies often failed to quantify.

Mechanistically, subcuticular sutures distribute tension evenly along the dermal plane and minimize cross-skin penetration, thus reducing foreign-body reaction and potential for micro-surface scarring (33). Staples, in contrast, concentrate tension at discrete points, occasionally resulting in localized ischemia and track marks that compromise scar aesthetics (34). The improved outcomes in the subcuticular group may also stem from better moisture retention and wound edge approximation, fostering ideal collagen remodeling conditions. Additionally, patient perception of scar quality exerts an important psychosocial influence; visible staple marks may contribute to lower satisfaction even when objective healing parameters are similar, a phenomenon documented in surgical cosmesis studies (35). Hence, both physiological and psychological mechanisms likely explain the consistently higher VAS and AKSS outcomes among patients who received suture closure.

Clinically, the implications are substantial. Enhanced cosmetic and satisfaction outcomes may translate into improved adherence to postoperative physiotherapy and follow-up attendance, ultimately contributing to faster functional recovery and reduced secondary wound care demands. These findings support integration of subcuticular closure into standardized arthroplasty protocols, particularly for patients concerned with scar appearance or those at risk of delayed healing. Moreover, the equivalence in wound complication rates suggests that the superior outcomes achieved with sutures do not come at the expense of safety or efficiency, addressing prior concerns about operative time and infection risk (36). From a healthcare systems perspective, greater patient satisfaction can enhance institutional quality metrics and improve patient-reported outcome measures (PROMs), which are increasingly central to reimbursement and quality assurance frameworks (37).

Nonetheless, this study has several limitations that must be acknowledged. The retrospective design may introduce selection bias despite balanced baseline characteristics, and residual confounding cannot be fully excluded. The single-center setting may limit generalizability across surgical teams or hospital environments, and the relatively short follow-up period (three months) precludes assessment of long-term scar remodeling or late complications. Furthermore, the exclusion of patients with comorbidities such as diabetes and hypertension limits applicability to higher-risk populations who often represent the majority of arthroplasty cases. Although the study used validated outcome measures, future research should incorporate blinded photographic assessments and objective biomechanical analysis of scar elasticity to complement patient-reported metrics.

Future studies should employ multicenter, prospective, randomized designs with larger sample sizes and extended follow-up durations to verify the durability of these findings and explore cost-effectiveness and operative efficiency. Incorporating qualitative patient feedback could also elucidate psychological factors influencing satisfaction beyond physical wound characteristics. Collectively, these refinements would deepen understanding of closure method implications for postoperative recovery, aesthetics, and quality of life.

In conclusion, the integration of quantitative clinical data and comparative analysis indicates that subcuticular suturing offers both functional and psychosocial benefits after TKA, advancing surgical wound management by addressing dimensions of patient-centered care often neglected in prior research (38).

CONCLUSION

This study demonstrated that subcuticular suturing yields significantly superior outcomes compared with staple closure following total knee arthroplasty, encompassing better wound healing quality, enhanced cosmetic appearance, higher functional recovery, and greater patient satisfaction, without increasing postoperative complications. The findings underscore that continuous dermal closure provides more uniform tension distribution and reduced skin trauma, resulting in improved scar aesthetics and patient-perceived well-being. Clinically, adopting subcuticular suturing as a preferred technique can optimize both physical and psychological recovery, aligning surgical success with patient-centered outcome metrics. From a research standpoint, these results reinforce the need for multicenter prospective trials assessing long-term cosmetic and functional benefits across broader populations, thereby supporting evidence-based refinement of closure standards in orthopedic surgery.

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