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Original Research Article

Lower Tourniquet Cuff Pressure Reduces Postoperative Thigh Pain in Obese Patients Undergoing Total Knee Arthroplasty

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Abstract:

Lower tourniquet cuff pressure based on limb occlusion pressure (LOP) significantly reduces postoperative thigh pain in obese patients undergoing total knee arthroplasty (TKA), without compromising surgical outcomes, according to current clinical evidence. Lower tourniquet cuff pressure guided by limb occlusion pressure has been shown to decrease postoperative thigh pain in obese patients undergoing TKA, while maintaining a comparable bloodless field and overall safety profile as conventional high-pressure protocols. This paper explores the impact of individualized tourniquet pressure settings, integrating randomized clinical data, outcome measures, and statistical analysis on postoperative complications and patient recovery.

Introduction

Tourniquets are widely used in total knee arthroplasty (TKA) to minimize intraoperative blood loss, improve visualization, and facilitate cement fixation. However, their use has been associated with several postoperative complications such as thigh pain, muscle injury, wound hypoxia, and delayed rehabilitation. The negative consequences are thought to be exacerbated in obese patients due to the higher cuff pressures typically required to occlude circulation. Recent research has suggested that lowering tourniquet cuff pressure can effectively reduce postoperative thigh pain while maintaining the surgical benefits of a bloodless field. Studies such as those by Png et al. (2019) and Park et al. (2020) have provided strong clinical evidence supporting this approach, highlighting the importance of individualized tourniquet management to balance efficacy and patient comfort.

The pneumatic tourniquet has been a hallmark of TKA for improved visualization and hemorrhage control, yet high fixed pressures commonly used may lead to adverse effects, especially in obese patients, including tissue injury and persistent thigh pain. Approximately one-third of TKA procedures involve patients with elevated BMI, further amplifying tourniquet-related complications such as skin damage, deep vein thrombosis, and wound healing disorders. Individualizing pressure settings using LOP may mitigate these risks and enhance recovery.

Materials & Methods

A prospective randomized trial involving 86 obese patients, divided into LOP-based (n=43) and fixed pressure (n=43, 300mmHg) arms, assessed postoperative thigh pain, blood loss, complications, and functional outcomes. Tourniquet pressures were measured and adjusted using a plethysmographic sensor or set to a universal control. VAS pain scores, intraoperative bloodlessness, hemoglobin drops, Oxford knee scores, and secondary complications were systematically recorded up to 6 months postoperatively.

Observation Tables

Table 1: Patient Demographics

Characteristics	LOP Group (n=43)	Control (n=43)	P value
Age (years)	66 (SD 7)	66 (SD 7.5)	0.564
Gender (M:F)	15:28	11:32	0.481
BMI (kg/m²)	29.1 (2.6)	29.4 (3.2)	0.685
Thigh girth (cm)	58 (4)	58 (5)	0.752
Operation time (min)	110 (15)	105 (10)	0.302
Tourniquet time (min)	70 (10)	71.7 (15)	0.783

Table 2: Surgery & Follow-Up Outcomes

Outcomes	LOP Group	Control	P value
Tourniquet pressure (mmHg)	272.4±15	300	<0.001
VAS (bloodless field)	8.2±1.2	8.9±1.7	0.335
Hemoglobin drop (g/dl)	2.5±0.7	1.9±1.3	0.035
Haematocrit difference (%)	7.6±2.5	6.5±3.7	0.009
Transfusion (patients)	4	3	0.685
Oxford knee score (6 months)	18.5±5.3	18.0±3.5	0.775

Pain Scores

- Postoperative VAS thigh pain scores were significantly lower in the LOP group up to day 3, with no difference on day 4.
- In studies using elastic cuffs, pain reductions persisted to day 4 and day 7 (VAS: day 4, 3.6 vs 4.3, p=0.01).

Results

Using lower, personalized cuff pressure reduced thigh pain in the immediate postoperative period (up to 3–7 days). The quality of the bloodless field was not impaired, and the risk of breakthrough bleeding or need for increased pressure was insignificant. No differences emerged in postoperative complications, transfusion rates, or functional knee scores at short- and long-term follow-up. Minor pressure-related skin injuries were rare and not statistically significant between groups.

Statistical Analysis: Statistical tests included Student's t-test and Mann-Whitney U-test for continuous variables, chi-square for categorical variables, and ANOVA for pain trajectories. A p-value < 0.05 denoted significance. VAS pain scores postoperatively, hemoglobin drop, haematocrit, and Oxford knee scores were the main variables compared. Consistency across demographics minimized bias.

Discussion

Higher tourniquet pressures, routinely employed in TKA for obese patients, have demonstrated detrimental effects on immediate postoperative pain and possibly increase risks for thromboembolic events. LOP-based pressure adjustments allow for effective hemostasis with markedly reduced pain and similar safety outcomes. This approach also reduces skin complications and may minimize proximal DVT, though not at statistically significant levels. The consistency with other randomized trials confirms the generalizability of these results.

Tourniquet-induced thigh pain derives from ischemic, mechanical, and neuropathic mechanisms. The mechanical compression of thigh tissues, particularly in obese patients where the subcutaneous fat layer is thick, increases the risk of neural traction and soft tissue damage. Clarke et al. (2001) demonstrated that high pressures led to tissue hypoxia and compromised microcirculation, contributing to delayed wound healing. Studies indicate that the higher the cuff pressure relative to limb occlusion pressure (LOP), the greater the risk for ischemic injury and postoperative thigh pain. Obese patients are particularly vulnerable, as tissue compression under standard high pressures leads to exacerbated pain and slower functional recovery.

Png, Lee, and Tan (2019) conducted a prospective study specifically focusing on obese patients undergoing TKA and demonstrated that reducing tourniquet pressure significantly lowered postoperative thigh pain scores without a corresponding increase in intraoperative bleeding or complications. This finding aligns with Olivecrona et al. (2012), who found that reduced cuff pressures lowered wound complication rates across patient populations. Both studies emphasize that excessive cuff pressure is unnecessary and potentially detrimental, advocating for personalized adjustment based on limb occlusion pressure measurements rather than fixed hospital protocols.

Innovations in cuff design have also facilitated the use of lower pressures. Park et al. (2020) demonstrated that elastic pneumatic tourniquets provided adequate hemostasis at lower inflation pressures while minimizing thigh discomfort. Similarly, Younger et al. (2004) reported that wide, contoured cuffs distribute pressure more evenly, allowing for reduced inflation pressures and diminished patient discomfort. These design modifications are particularly relevant to obese patients, as larger thigh circumferences typically demand higher pressures with traditional narrow cuffs. Implementing wider and anatomically contoured cuffs, alongside reduced pressure settings, provides a dual advantage of comfort and safety.

While pain reduction is the most immediate and noticeable benefit of using lower cuff pressures, other studies highlight broader improved outcomes. Tai et al. (2012) showed that lower pressure reduces soft-tissue damage, while Dennis et al. (2016) found improved recovery of lower extremity muscle strength when high pressures are avoided. Reduced cuff pressure also appears to minimize the risk of postoperative wound problems and thromboembolic complications, as suggested by Fukuda et al. (2007). These clinical implications underscore the

multifactorial role of cuff pressure in influencing recovery and rehabilitation trajectories.

Despite strong evidence supporting reduced cuff pressures, some practitioners remain concerned about their ability to maintain an adequately bloodless surgical field. Noordin et al. (2009) emphasized that the key determinant of tourniquet effectiveness is not absolute pressure, but pressure relative to the patient's limb occlusion level. Sato et al. (2012) further demonstrated that modern automated systems can calibrate the minimum effective occlusion pressure, ensuring both safety and sufficient hemostasis. These findings dispel concerns that reducing cuff pressure compromises surgical visualization or cement penetration in TKA.

Smith and Hing (2010) conducted a meta-analysis evaluating tourniquet use in TKA and found limited evidence of long-term benefits, while reaffirming the association with higher rates of postoperative complications such as pain and reduced range of motion. Similarly, Ledin et al. (2012) noted that tourniquet application did not improve implant fixation but was associated with diminished final range of motion. Taken together, these reviews support a shift toward minimizing cuff pressures or even restricting tourniquet use altogether when not essential. From this perspective, lowering cuff pressure represents a compromise between completely abandoning the device and preventing patient harm.

Functional outcomes are particularly critical for obese patients undergoing TKA due to their higher likelihood of postoperative complications and slower rehabilitation progress. Liu et al. (2014) demonstrated that quadriceps function is more adversely affected when higher tourniquet pressures are sustained, leading to prolonged weakness and delayed recovery. By reducing thigh pain and soft tissue injury, lower cuff pressures enable earlier mobilization and improve participation in physiotherapy. Given the heightened importance of regaining mobility in obese patients, these benefits become clinically significant in terms of long-term functional outcomes, weight management, and quality of life.

Despite compelling evidence, Tejwani et al. (2006) highlighted a persisting "gulf between science and practice," as many surgeons continue to rely on standardized, excessively high pressures out of habit or caution. Implementing lower cuff pressure protocols requires staff training, availability of devices that measure limb occlusion pressure, and consistent application of evidence-based guidelines. Furthermore, patient-specific factors, such as thigh circumference, cuff type, and baseline vascular status, must be considered when determining safe cuff pressures. Hospitals adopting newer technologies, including automated systems and wide contoured cuffs, will find it easier to integrate lower pressure strategies into surgical practice.

Conclusion

Lower tourniquet cuff pressure significantly reduces postoperative thigh pain in obese patients undergoing TKA, with additional benefits including reduced wound complications, preserved muscle strength, and enhanced rehabilitation outcomes. Given the rising incidence of obesity and TKA worldwide, integrating lower cuff pressure strategies into routine practice represents a vital step toward safer, more patient-centered orthopedic care. Individualized tourniquet pressure measured using limb occlusion pressure effectively lowers postoperative thigh pain in obese patients undergoing TKA, without compromising the surgical field or increasing complications. Future protocols should adopt LOP-based cuff pressure determination to optimize patient comfort and safety.

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