Article

Risk Factors for Surgical Site Infection After Open Reduction and Internal Fixation in Overweight and Obese Patients With Tibial Plateau Fractures

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AIM: Overweight and obese patients present unique pathophysiological characteristics that may increase the risk of surgical site infection (SSI) following orthopedic surgery. However, the specific risk factors for SSI in overweight and obese patients with tibial plateau fractures remain unclear. This study aimed to identify the independent risk factors for SSI after open reduction and internal fixation (ORIF) in this high-risk population.
METHODS: A total of 300 patients with tibial plateau fractures who underwent ORIF were retrospectively analyzed. Patients were divided into three groups according to body mass index (BMI): control group (BMI $<$25 kg/m^2, n = 50), overweight group (25 $\leq$ BMI $<$ 30 kg/m^2, n = 194), and obese group (BMI $\geq$30 kg/m^2, n = 56). To evaluate the influencing factors of SSI in overweight and obese patients, those with BMI $\geq$25 kg/m^2 were further classified into an infection group (n = 30) and a non-infection group (n = 220) based on postoperative infection status. All patients were followed for one year to document the occurrence of SSI. Logistic regression analysis was performed to identify the independent factors associated with SSI after ORIF in overweight and obese patients.
RESULTS: A total of 31 patients developed postoperative SSI (10.33%), including 8 cases of deep SSI and 23 cases of superficial SSI. There was a significant difference in the incidence of SSI among the three groups (p = 0.042), with the overweight group exhibiting the highest incidence. Among overweight and obese patients, the proportions of open fracture, compartment syndrome, and operation time were significantly higher in the infection group than in the non-infection group (p = 0.022, 0.017, and $<$0.001, respectively). Multivariate logistic regression analysis showed that open fracture (odds ratio [OR] = 6.012, 95% confidence interval [CI]: 1.393–25.945, p = 0.016), compartment syndrome (OR = 3.276, 95% CI: 1.151–9.322, p = 0.026), and operation time $>$178 min (OR = 5.012, 95% CI: 1.907–13.172, p = 0.001) were independent risk factors for postoperative SSI after ORIF in overweight and obese patients.
CONCLUSIONS: Overweight and obese patients with tibial plateau fractures have a relatively high incidence of SSI. Open fracture, compartment syndrome, and operation time $>$178 min significantly increase the risks of postoperative SSI after ORIF in overweight and obese patients.

Keywords: tibial plateau fracture; open reduction and internal fixation; obese; overweight; surgical site infection

Introduction

Tibial plateau fracture, a common intra-articular fracture, is characterized by knee joint swelling, pain, and limited mobility, accounting for approximately 1% of all fractures [1,2]. Open reduction and internal fixation (ORIF) is a commonly used surgical method in clinical practice. It can effectively stabilize the fracture ends and promote fracture healing [3,4]. However, patients remain susceptible to postoperative surgical site infection (SSI). The reported incidence of SSI ranges from approximately 2.3% to 19.7% [5–7]. SSI may lead to multiple surgeries, delayed recovery, and temporary or permanent loss of function in the affected limb [8]. Moreover, SSI further increases the medical and economic burden on patients. Therefore, identifying the risk factors for SSI in patients with tibial plateau fractures is of considerable clinical significance.

Several studies have explored the independent risk factors for SSI after ORIF for tibial plateau fractures [5,9,10]. Multiple factors have been identified, including open fracture, operation time, compartment syndrome, and body mass index (BMI). Ma *et al.* [11] reported that BMI $>$26.0 kg/m^2 was an independent risk factor for deep SSI after ORIF in patients with closed tibial plateau fractures. Another multicenter study also demonstrated that high BMI (BMI $\geq$24.0) was associated with an increased risk of SSI in tib-

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ial plateau fractures [12]. These findings suggest that increased BMI may contribute to the occurrence of SSI in tibial plateau fractures. Potential mechanisms may involve metabolic disorders, tissue hypoxia, chronic inflammation, and increased skin tension [13]. In orthopedic surgery, the association between overweight/obesity and postoperative complications, including infection, has also been reported in other fracture types [14,15].

Although previous studies have identified several risk factors for SSI in the general population of patients with tibial plateau fractures [5,9,10], the specific risk factors in overweight and obese patients remain unclear. With the increasing global prevalence of obesity and the unique pathophysiological characteristics of overweight and obese individuals, such as chronic low-grade inflammation, impaired tissue perfusion, and increased soft-tissue tension, it is crucial to identify specific risk factors for SSI in this high-risk population. A previous study reported that BMI did not significantly affect SSI after ORIF for tibial plateau fractures [16], suggesting that the association between BMI and SSI remains controversial and warrants further investigation. However, the influencing factors of SSI specifically in overweight and obese patients are still not well defined. Therefore, this study aimed to explore the independent risk factors for SSI after ORIF in overweight and obese patients with tibial plateau fractures, which may help develop targeted preventive strategies and improve surgical outcomes in this vulnerable population.

Methods

Patients

This study was a retrospective analysis. A total of 300 patients with tibial plateau fractures who visited the Zhejiang Rongjun Hospital between January 2022 and October 2024 were selected as the research subjects. The inclusion criteria were as follows: (1) age >18 years; (2) diagnosed with tibial plateau fractures, confirmed by imaging and clinical examination; (3) meeting surgical indications and undergoing ORIF; and (4) complete clinical data available. Patients were excluded if they met any of the following criteria: (1) pathological fracture; (2) periprosthetic fracture; (3) old fractures (>21 days from initial injury); or (4) a history of ipsilateral knee trauma or surgery.

All patients were divided into three groups according to BMI: control group (BMI <25 kg/m^2, n = 50), overweight group (25 $\leq$ BMI < 30 kg/m^2, n = 194), and obese group (BMI $\geq$30 kg/m^2, n = 56). To explore the influencing factors of SSI in overweight and obese patients, those with BMI $\geq$25 kg/m^2 were further classified into an infection group (n = 30) and a non-infection group (n = 220) based on postoperative infection status. This study was approved by the Ethics Committee of Zhejiang Rongjun Hospital (No. 2025-104). All procedures complied with the Declaration of Helsinki. All patients signed informed consent forms.

Open Reduction and Internal Fixation (ORIF)

All surgeries were performed by an orthopedic surgical team. The patients received general anesthesia. All patients underwent ORIF. Relatively stable split and split-depression fractures were treated with screws alone. For Schatzker II and III fractures, single plate fixation was used. A single medial plate fixation was used for Schatzker IV fractures. Complex fractures were treated with double plating. Antibiotics were administered during the perioperative period to prevent infection. After surgery, all patients received standardized nursing care, including wound drainage, regular dressing changes, rehabilitation training, and nutritional support. All procedures were performed by a team of orthopedic surgeons with at least five years of experience in fracture fixation. The surgical approach and fixation method were selected for each fracture type according to standardized institutional protocols to minimize inter-surgeon variability. To control for potential confounding effects of fracture type and surgical method, Schatzker classification and fixation type were included as covariates in the multivariate logistic regression analysis.

Follow-up

All patients were followed for 1 year after surgery through outpatient visits and telephone contact. SSI was recorded during follow-up. SSI was determined according to the fracture-related infection criteria [17]. Specifically, infection was confirmed if a fistulous tract was observed or if persistent purulent drainage occurred at the wound or fracture site. If the infection involved deep soft tissue, muscle, or fascia, presented with persistent wound drainage or dehiscence, or showed visible abscess or gangrene requiring debridement and secondary surgery, it was diagnosed as deep SSI.

Collection of Clinical Information

Patient information was collected from case records and follow-up documentation. These variables included age, sex, BMI, smoking status, chronic disease, cause of fracture, Schatzker type, involved side, open fracture, compartment syndrome, polytrauma, operation time, length of hospital stay, fixation type, and SSI. Chronic diseases included diagnosed diabetes, hyperlipidemia, and hypertension. Polytrauma was defined as an injury severity score (ISS) >16 [18].

Statistical Analysis

Continuous variables were tested for normality using the Shapiro-Wilk test. Normally distributed data were expressed as mean $\pm$ standard deviation (SD) and compared using an independent *t*-test or one-way analysis of variance (ANOVA). Non-normally distributed data were expressed as median (25th percentile, 75th percentile) and compared using the Mann-Whitney U test or Kruskal-Wallis H test. Categorical variables were expressed as frequency (per-

Table 1. Baseline clinical characteristics of all patients.

Clinical characteristics	Total (n = 300)	Control group (n = 50)	Overweight group (n = 194)	Obese group (n = 56)	F/H/χ^2	*p*-value
Age, years	51.70 ± 10.09	50.94 ± 10.59	51.77 ± 9.86	52.14 ± 10.56	0.199	0.820
BMI, kg/m^2	27.03 (25.68, 29.09)	21.64 (20.35, 23.28)	26.97 (26.25, 28.15)	31.52 (30.70, 33.98)	214.819	<0.001
Sex, n (%)					0.822	0.663
Male	190 (63.33%)	29 (58.00%)	124 (63.92%)	37 (66.07%)		
Female	110 (36.67%)	21 (42.00%)	70 (36.08%)	19 (33.93%)		
Smoking status, n (%)	50 (16.67%)	7 (14.00%)	32 (16.49%)	11 (19.64%)	0.617	0.734
Diabetes, n (%)	56 (18.67%)	8 (16.00%)	35 (18.04%)	13 (23.21%)	1.047	0.592
Hypertension, n (%)	87 (29.00%)	16 (32.00%)	57 (29.38%)	14 (25.00%)	0.667	0.716
Hyperlipidemia, n (%)	37 (12.33%)	3 (6.00%)	27 (13.92%)	7 (12.50%)	2.307	0.316
Cause of fracture, n (%)					1.472	0.479
High-energy injury	161 (53.67%)	27 (54.00%)	100 (51.55%)	34 (60.71%)		
Low-energy injury	139 (46.33%)	23 (46.00%)	94 (48.45%)	22 (39.29%)		
Schatzker type, n (%)					0.722	0.697
I–III	133 (44.33%)	20 (40.00%)	86 (44.33%)	27 (48.21%)		
IV–V	167 (55.67%)	30 (60.00%)	108 (55.67%)	29 (51.79%)		
Involved side, n (%)					1.002	0.606
Left	173 (57.67%)	32 (64.00%)	109 (56.19%)	32 (57.14%)		
Right	127 (42.33%)	18 (36.00%)	85 (43.81%)	24 (42.86%)		
Open fracture, n (%)	11 (3.67%)	1 (2.00%)	6 (3.09%)	4 (7.14%)	2.490	0.288
Compartment syndrome, n (%)	28 (9.33%)	4 (8.00%)	18 (9.28%)	6 (10.71%)	0.232	0.891
Polytrauma, n (%)	14 (4.67%)	1 (2.00%)	8 (4.12%)	5 (8.93%)	3.214	0.200
Operation time, minutes	177 (146, 202)	170 (145, 208)	179 (150, 201)	173 (140, 202)	0.811	0.667
Length of hospital stay, days	29 (20, 37)	30 (20, 37)	29 (20, 36)	29 (20, 37)	0.043	0.979
Fixation type, n (%)					–	0.606
Plate and screws	279 (93.00%)	45 (90.00%)	181 (93.30%)	53 (94.64%)		
Screws	21 (7.00%)	5 (10.00%)	13 (6.70%)	3 (5.36%)		

Note: –, indicates Fisher's exact test. BMI, body mass index.

Table 2. Comparison of SSI among the three groups.

Indicator	Total (n = 300)	Control group (n = 50)	Overweight group (n = 194)	Obese group (n = 56)	χ^2	*p*-value
SSI, n (%)	31 (10.33%)	1 (2.00%)	26 (13.40%)	4 (7.14%)	6.334	0.042

Note: SSI, surgical site infection.

centage) and compared using the chi-square test or Fisher's exact test when the expected cell count was <5.

Univariate analyses were performed to compare baseline characteristics between groups. Variables with $p < 0.05$ in the univariate analysis were entered into the multivariate logistic regression model (enter method) to identify independent risk factors for surgical site infection, while adjusting for potential confounders, including age, sex, BMI category, diabetes, hypertension, hyperlipidemia, Schatzker type, open fracture, compartment syndrome, and operation time. Results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs).

Results

Clinical Information of Patients

No significant differences were observed among the three groups in age, sex, smoking status, diabetes, hypertension, hyperlipidemia, cause of fracture, Schatzker type, involved side, open fracture, compartment syndrome, polytrauma, operation time, length of hospital stay, and fixation type ($p > 0.05$). However, there were significant differences in BMI among the three groups ($p < 0.001$) (Table 1).

Comparison of SSI Among the Three Groups

To investigate the impact of BMI on SSI rates, the incidence of SSI was compared among patients with normal BMI, overweight, and obesity. The overall SSI rate was 10.33% (31/300) among all patients, including 8 cases of deep SSI (2.6%) and 23 cases (7.7%) of superficial SSI. There was a significant difference in the incidence of SSI among the three groups ($p = 0.042$), with the highest incidence of SSI in the overweight group (Table 2).

Comparison of Clinical Information Between the Non-Infection Group and Infection Group in Overweight and Obese Patients

Among overweight and obese patients, compared with the non-infection group, the proportions of open fracture and compartment syndrome, as well as operation time, were sig-

Table 3. Comparison of clinical information between the infection and non-infection groups in overweight and obese patients.

Clinical characteristics	Non-infection group (n = 220)	Infection group (n = 30)	$t/Z/\chi^2$	p-value
Age, years	51.60 ± 10.02	53.73 ± 9.85	1.094	0.275
BMI, kg/m^2	27.45 (26.42, 29.49)	28.82 (27.10, 29.64)	1.924	0.054
Sex, n (%)			0.076	0.782
Male	141 (64.09%)	20 (66.67%)		
Female	79 (35.91%)	10 (33.33%)		
Smoking status, n (%)	39 (17.73%)	4 (13.33%)	0.358	0.550
Diabetes, n (%)	39 (17.73%)	9 (30.00%)	2.563	0.109
Hypertension, n (%)	59 (26.82%)	12 (40.00%)	2.256	0.133
Hyperlipidemia, n (%)	28 (12.73%)	6 (20.00%)	1.188	0.276
Cause of fracture, n (%)			2.340	0.126
High-energy injury	114 (51.82%)	20 (66.67%)		
Low-energy injury	106 (48.18%)	10 (33.33%)		
Schatzker type, n (%)			0.372	0.542
I–III	101 (45.91%)	12 (40.00%)		
IV–V	119 (54.09%)	18 (60.00%)		
Involved side, n (%)			0.130	0.718
Left	125 (56.82%)	16 (53.33%)		
Right	95 (43.18%)	14 (46.67%)		
Open fracture, n (%)	6 (2.73%)	4 (13.33%)	5.218	0.022
Compartment syndrome, n (%)	17 (7.73%)	7 (23.33%)	5.720	0.017
Polytrauma, n (%)	10 (4.55%)	3 (10.00%)	0.679	0.410
Operation time, minutes	175 (142, 199)	198 (182, 232)	4.344	<0.001
Length of hospital stay, days	29 (20, 37)	32 (22, 37)	0.490	0.624
Fixation type, n (%)			–	1.000
Plate and screws	206 (93.64%)	28 (93.33%)		
Screws	14 (6.36%)	2 (6.67%)		

Note: –, indicates Fisher's exact test.

nificantly higher in the infection group (p = 0.022, 0.017, and <0.001, respectively) (Table 3).

Univariate and Multivariate Logistic Regression Analyses of Influencing Factors for SSI After ORIF in Overweight and Obese Patients

The range of surgical time was 41–246 minutes. Considering its clinical relevance, the operation time was converted into a categorical variable based on the median value (178 minutes). Multivariate logistic regression analysis showed that open fracture (odds ratio [OR] = 6.012, 95% confidence interval [CI]: 1.393–25.945, p = 0.016), compartment syndrome (OR = 3.276, 95% CI: 1.151–9.322, p = 0.026) and operation time >178 minutes (OR = 5.012, 95% CI: 1.907–13.172, p = 0.001) were independent risk factors for postoperative SSI after ORIF in overweight and obese patients (Table 4).

Discussion

SSI remains a severe complication following ORIF of tibial plateau fractures, often necessitating multiple reoperations, prolonged antibiotic therapy, and potentially compromising functional outcomes [1,8]. In the present study, the overall SSI rate was 10.33%, with overweight patients demonstrating the highest infection rate (13.40%), followed by obese (7.14%) and normal-weight (2.00%) groups. Multivariate analysis further revealed that open fracture, compartment syndrome, and operative time exceeding 178 minutes were independent risk factors for SSI among overweight and obese patients.

The observation that overweight patients exhibited higher SSI rates than obese patients appears paradoxical but may reflect the complex interplay between metabolic dysfunction and surgical technical factors. Obesity is characterized by chronic low-grade inflammation, in which adipose tissue secretes increased levels of proinflammatory cytokines such as TNF-α and IL-6, thereby impairing immune function and wound healing [13,19]. Additionally, the poor vascularization of adipose tissue leads to hypoperfusion at the incision margins, compromising the oxygen delivery required for bacterial clearance and collagen synthesis [13,20]. However, the higher SSI rate in overweight compared with obese patients may suggest that moderate adiposity creates conditions favorable for infection, sufficient to impair tissue repair yet insufficient to provide the metabolic reserves that may partially buffer severe postoperative complications. This finding aligns with the systematic review by Kinder *et al.* [13], which reported that

Table 4. Univariate and multivariate logistic regression analyses of influencing factors for SSI after ORIF in overweight and obese patients.

Variable	Univariate analysis					Multivariate analysis				
	β	SE	Wald	OR (95% CI)	*p*-value	*β*	SE	Wald	OR (95% CI)	*p*-value
Age	0.022	0.020	1.199	1.022 (0.983–1.063)	0.273					
BMI	0.090	0.059	2.299	1.094 (0.974–1.228)	0.129					
Male	0.114	0.412	0.076	1.121 (0.500–1.513)	0.782					
Smoking status	–0.337	0.565	0.355	0.714 (0.236–2.162)	0.551					
Diabetes	0.688	0.436	2.490	1.989 (0.847–4.673)	0.115					
Hypertension	0.598	0.403	2.210	1.819 (0.826–4.004)	0.137					
Hyperlipidemia	0.539	0.499	1.166	1.714 (0.644–4.561)	0.280					
High-energy injury	0.620	0.410	2.288	1.860 (0.832–4.155)	0.130					
Schatzker type IV–V	0.241	0.396	0.371	1.273 (0.585–2.769)	0.543					
Left side involved	–0.141	0.390	0.130	0.869 (0.404–1.867)	0.718					
Open fracture	1.702	0.678	6.303	5.487 (1.453–20.727)	0.012	1.794	0.746	5.780	6.012 (1.393–25.945)	0.016
Compartment syndrome	1.290	0.500	6.658	3.634 (1.364–9.685)	0.010	1.187	0.534	4.948	3.276 (1.151–9.322)	0.026
Polytrauma	0.847	0.689	1.511	2.333 (0.604–9.010)	0.219					
Operation time >178 minutes	1.569	0.476	10.855	4.800 (1.888–12.204)	<0.001	1.612	0.493	10.690	5.012 (1.907–13.172)	0.001
Length of hospital stay	0.008	0.017	0.228	1.088 (0.975–1.043)	0.633					
Plate-and-screw fixation	–0.050	0.782	0.004	0.951 (0.205–4.408)	0.949					

Note: ORIF, open reduction and internal fixation; OR, odds ratio.

abnormal BMI, including both high and low values, adversely influences orthopedic trauma outcomes through distinct pathophysiological mechanisms.

Prolonged operative time was identified as a significant predictor of SSI (OR = 5.012), which is consistent with previous studies reporting operative time ≥3 hours as an important risk factor for SSI after tibial plateau fracture surgery [16,21]. In overweight and obese patients, this relationship may be further amplified by technical challenges during surgical exposure. Excess subcutaneous tissue requires deeper dissection and stronger retraction, which can lead to prolonged tissue compression and impairment of local microcirculation [22]. Because adipose tissue is particularly susceptible to ischemia due to its relatively poor vascularity, sustained retraction during prolonged surgery may exacerbate tissue hypoxia and increase the likelihood of bacterial colonization [20,22]. Therefore, the 178-minute threshold identified in this study may represent a critical duration beyond which cumulative tissue hypoperfusion and bacterial contamination significantly elevate the risk of postoperative infection.

Open fractures demonstrated the strongest association with SSI (OR = 6.012), reflecting the well-established pathophysiology of bacterial contamination and soft tissue devitalization associated with high-energy trauma [12,23]. In overweight and obese patients, reduced tensile strength of adipose tissue and its susceptibility to shear injury may further exacerbate soft-tissue damage, while increased wound tension from inelastic subcutaneous tissue may compromise wound closure and healing [13,20].

Compartment syndrome (OR = 3.276) likely serves as a marker of severe soft-tissue injury rather than a direct causal factor. Elevated intracompartmental pressure compromises capillary perfusion and leads to muscle ischemia and necrosis. The resulting edematous and poorly perfused tissues exhibit impaired immune responses and reduced antibiotic penetration, thereby increasing susceptibility to infection [12,24]. These mechanisms may be particularly relevant in obese patients, where increased compartment volume and pressure may further compromise tissue viability and local perfusion [13].

Our findings underscore the need for tailored preventive strategies in overweight and obese patients. Preoperative optimization should address modifiable risk factors, including glycemic control, as diabetes and hyperglycemia are known to impair neutrophil function and delay wound healing [5,13]. Surgical planning should prioritize adequate exposure and procedural efficiency to minimize operative time and utilize extensile approaches when necessary to reduce soft-tissue trauma [22]. In addition, enhanced antibiotic prophylaxis strategies, including weight-based dosing and intraoperative redosing, may be warranted given the altered pharmacokinetics associated with obesity and the potential for prolonged operative times [12,25].

Several limitations of this study should be acknowledged. First, the retrospective design inherently introduces potential selection bias and limits the ability to infer causal relationships. Second, different surgical approaches were utilized according to Schatzker fracture types, which may introduce potential confounding. However, we adjusted for Schatzker type and fixation method in the multivariate analysis to partially control for these factors. Third, although multiple surgeons performed the procedures, all followed standardized surgical protocols at our institution, which likely minimized intersurgeon variability. Fourth, the unequal sample sizes across BMI groups (control: n = 50; overweight: n = 194; obese: n = 56) may influence the robustness of the findings. Although potential confounders were adjusted for in the multivariate analysis, the relatively small sample size in the control and obese groups may reduce the statistical power and limit the generalizability of the results. Fifth, other chronic diseases, such as chronic obstructive pulmonary disease (COPD) and chronic kidney disease (CKD), were not included in this analysis due to their low prevalence in our cohort (<5%). Future studies should comprehensively evaluate the impact of a broader range of comorbidities on the risk of SSI. Finally, the relatively small sample size of obese patients (n = 56) may have further limited the statistical power to detect significant differences among BMI categories.

Conclusions

Overweight and obese patients undergoing ORIF for tibial plateau fractures appear to face an increased risk of SSI. Open fracture, compartment syndrome, and operative time >178 minutes were identified as independent risk factors in this population. These findings highlight the importance of meticulous surgical planning and efficient operative management to mitigate the risk of infection in patients with elevated BMI.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

QFL contributed to study design, data collection, statistical analysis, and manuscript drafting. XJS, MY, QYY, and LHZ contributed to data collection. QYL contributed to study conception, study design, and supervision. All authors have been involved in revising the manuscript critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Zhejiang Rongjun Hospital (No. 2025-104). All procedures complied with the Declaration of Helsinki. All patients signed informed consent forms.

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Conflict of Interest

The authors declare no conflict of interest.

References

[1] Reátiga Aguilar J, Rios X, González Edery E, De La Rosa A, Arzuza Ortega L. Epidemiological characterization of tibial plateau fractures. Journal of Orthopaedic Surgery and Research. 2022; 17: 106. https://doi.org/10.1186/s13018-022-02988-8.

[2] Traerup J, Larsen P, Elsøe R. The Knee injury and Osteoarthritis Outcome Score (KOOS) for lateral tibial plateau fractures- relevance, reliability and responsiveness. European Journal of Trauma and Emergency Surgery. 2024; 50: 2551–2557. https://doi.org/10.1007/s00068-024-02607-7.

[3] Naja AS, Bouji N, Eddine MN, Alfarii H, Reindl R, Tfayli Y, *et al*. A Meta-analysis Comparing External Fixation against Open Reduction and Internal Fixation for the Management of Tibial Plateau Fractures. Strategies in Trauma and Limb Reconstruction. 2022; 17: 105–116. https://doi.org/10.5005/jp-journals-10080-1557.

[4] Tay ST, Chen MZ, Chan YS, Kuo LT. The efficacy of arthroscopy-assisted versus stand-alone open reduction and internal fixation for treating tibial plateau fracture: a systematic review and meta-analysis. BMC Musculoskeletal Disorders. 2024; 25: 865. https://doi.org/10.1186/s12891-024-07958-1.

[5] Li J, Zhu Y, Zhao K, Zhang J, Meng H, Jin Z, *et al*. Incidence and risks for surgical site infection after closed tibial plateau fractures in adults treated by open reduction and internal fixation: a prospective study. Journal of Orthopaedic Surgery and Research. 2020; 15: 349. https://doi.org/10.1186/s13018-020-01885-2.

[6] Shao J, Chang H, Zhu Y, Chen W, Zheng Z, Zhang H, *et al*. Incidence and risk factors for surgical site infection after open reduction and internal fixation of tibial plateau fracture: A systematic review and meta-analysis. International Journal of Surgery. 2017; 41: 176–182. https://doi.org/10.1016/j.ijsu.2017.03.085.

[7] Forni JEN, Rabesquine CHN, Jalikj W. Risk Factors for Surgical Site Infection following External Fixation and Osteosynthesis of Patients with Tibial Plateau Fracture. The Journal of Knee Surgery. 2026; 39: 44–49. https://doi.org/10.1055/a-2664-7448.

[8] Rezaei AR, Zienkiewicz D, Rezaei AR. Surgical site infections: a comprehensive review. Journal of Trauma and Injury. 2025; 38: 71–81. https://doi.org/10.20408/jti.2025.0019.

[9] Franulic N, Muñoz JT, Pineda T, Laso J, Olivieri R, Schröter S. Fixation of tibial plateau fracture - risk factors for developing infection: a narrative review. EFORT Open Reviews. 2024; 9: 1170–1178. https://doi.org/10.1530/EOR-24-0058.

[10] Zhu Y, Qin S, Jia Y, Li J, Chen W, Zhang Q, *et al*. Surgeon volume and the risk of deep surgical site infection following open reduction and internal fixation of closed tibial plateau fracture. International Orthopaedics. 2022; 46: 605–614. https://doi.org/10.1007/s00264-021-05221-z.

[11] Ma Q, Aierxiding A, Wang G, Wang C, Yu L, Shen Z. Incidence and risk factors for deep surgical site infection after open reduction and internal fixation of closed tibial plateau fractures in adults. International Wound Journal. 2018; 15: 237–242. https://doi.org/10.1111/iwj.12856.

[12] Henkelmann R, Frosch KH, Mende M, Gensior TJ, Ull C, Braun PJ, *et al*. Risk Factors for Deep Surgical Site Infection in Patients With Operatively Treated Tibial Plateau Fractures: A Retrospective Multicenter Study. Journal of Orthopaedic Trauma. 2021; 35: 371–377. https://doi.org/10.1097/BOT.0000000000002011.

[13] Kinder F, Giannoudis PV, Boddice T, Howard A. The Effect of an Abnormal BMI on Orthopaedic Trauma Patients: A Systematic

Review and Meta-Analysis. Journal of Clinical Medicine. 2020; 9: 1302. https://doi.org/10.3390/jcm9051302.

[14] Zhang J, Lu V, Zhou AK, Stevenson A, Thahir A, Krkovic M. Predictors for infection severity for open tibial fractures: major trauma centre perspective. Archives of Orthopaedic and Trauma Surgery. 2023; 143: 6579–6587. https://doi.org/10.1007/s00402-023-04956-1.

[15] Mittwede PN, Gibbs CM, Ahn J, Bergin PF, Tarkin IS. Is Obesity Associated With an Increased Risk of Complications After Surgical Management of Acetabulum and Pelvis Fractures? A Systematic Review. Journal of the American Academy of Orthopaedic Surgeons. Global Research & Reviews. 2021; 5: e21.00058. https://doi.org/10.5435/JAAOSGlobal-D-21-00058.

[16] Chan G, Iliopoulos E, Jain A, Turki M, Trompeter A. Infection after operative fixation of tibia plateau fractures. A risk factor analysis. Injury. 2019; 50: 2089–2092. https://doi.org/10.1016/j.injury.2019.06.022.

[17] Metsemakers WJ, Morgenstern M, McNally MA, Moriarty TF, McFadyen I, Scarborough M, *et al*. Fracture-related infection: A consensus on definition from an international expert group. Injury. 2018; 49: 505–510. https://doi.org/10.1016/j.injury.2017.08.040.

[18] Baker SP, O'Neill B, Haddon W, Jr, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. The Journal of Trauma. 1974; 14: 187–196.

[19] Taylor EB. The complex role of adipokines in obesity, inflammation, and autoimmunity. Clinical Science. 2021; 135: 731–752. https://doi.org/10.1042/CS20200895.

[20] Cotterell A, Griffin M, Downer MA, Parker JB, Wan D, Longaker MT. Understanding wound healing in obesity. World Journal of Experimental Medicine. 2024; 14: 86898. https://doi.org/10.5493/wjem.v14.i1.86898.

[21] Peng W, Chen S, Chen X, Ma Y, Wang T, Sun X, *et al*. Trends in major non-communicable diseases and related risk factors in China 2002-2019: an analysis of nationally representative survey data. The Lancet Regional Health. Western Pacific. 2023; 43: 100809. https://doi.org/10.1016/j.lanwpc.2023.100809.

[22] Tripathy SK, Varghese P, Panigrahi S, Panda BB, Srinivasan A, Sen RK. External fixation versus open reduction and internal fixation in the treatment of Complex Tibial Plateau Fractures: A systematic review and meta-analysis. Acta Orthopaedica et Traumatologica Turcica. 2021; 55: 444–456. https://doi.org/10.5152/j.aott.2021.20350.

[23] Coombs J, Billow D, Cereijo C, Patterson B, Pinney S. Current Concept Review: Risk Factors for Infection Following Open Fractures. Orthopedic Research and Reviews. 2022; 14: 383–391. https://doi.org/10.2147/ORR.S384845.

[24] Merchan N, Ingalls B, Garcia J, Wixted J, Rozental TD, Harper CM, *et al*. Factors Associated With Surgical Site Infections After Fasciotomy in Patients With Compartment Syndrome. Journal of the American Academy of Orthopaedic Surgeons. Global Research & Reviews. 2022; 6: e22.00002. https://doi.org/10.5435/JAAOSGlobal-D-22-00002.

[25] Montoya-delaTorre C, Muñoz-Mahamud E, Zumbado JA, Morata L, Martínez-Peñas J, Ares O. Comparison of Three Antibiotic Prophylaxis Protocols for Preventing Postoperative Infection in Tibial Plateau Fractures. Applied Sciences. 2024; 14: 4192. https://doi.org/10.3390/app14104192.