Outcomes in acute vs. delayed definitive fixation of bicondylar tibial plateau fractures

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INTRODUCTION: Bicondylar tibial plateau fractures typically arise from high-energy mechanisms, leading to considerable soft tissue trauma. The optimal timing for definitive fixation is primarily dependent on the condition of the surrounding skin and soft tissue of the proposed surgical site[1]. Historically, early definitive fixation has been linked to heightened incidences of wound complications and infections. Infection rates in the management of bicondylar tibial plateau fractures have been reported as high as 88%, while more recent literature indicates a range of 5-21% of cases[2]. Consequently, a staged approach, with initial external fixation followed by a subsequent open-reduction internal fixation (ORIF) is often used to decrease wound complication risk associated with a single stage early definitive fixation. This study aims to determine efficacy of a more nuanced approach, comparing surgical outcomes of patients stratified by definitive fixation within 24 or 72 hours of initial injury, using either single definitive fixation or staged approach.

METHODS: A retrospective chart review was performed with adult patients treated for bicondylar tibial plateau fracture from May 2016-Dec 2020, identified by OTA classification 41C from a single American College of Surgeons (ACS) Level 1 Trauma Center Fracture Registry. All patients were initially temporized in the emergency department with a knee immobilizer. Patients were divided into 4 groups, (1) acute primary ORIF within 24 hours, (2) primary ORIF between 24 and 72 hours, (3) subacute primary ORIF > 72 hours, (4) staged fixation with temporizing external fixator followed by ORIF. Data collected included fracture classification of injury, hospital length of stay (LOS), time from injury to initial and/or definitive surgery, surgical approach, , method of surgical fixation, wound closure at definitive surgery, surgical time, and complications requiring unplanned return to the operating room within 12 months of definitive fixation. ANOVA and post hoc analysis with Tukey's HSD were used to stratify the dependent variable based on the outlined divisions.

RESULTS SECTION: 142 records were screened from the Trauma Registry. 10 patients were excluded as their injuries did not classify as OTA classification 41C; 1 patient was excluded as he was treated with external fixation and then lost to follow up. 124 patients with bicondylar tibial plateau fractures were identified and assigned to 4 groups: 16 patients were treated definitively with acute ORIF within 24 hours (1), 61 patients were treated definitively with ORIF within 24-72 hours (2), 11 patients were treated with ORIF >72 hours from initial injury (3), and 36 patients were treated with initial external fixations followed by definitive ORIF (4). Table 1 describes the sample groups. Average from presentation to external fixation was 0.9 days (SD 1.5); average time from external fixation to definitive fixation was 6.3 days (SD 6.1). There were three cases with complications including blood loss anemia (Group 2), aspiration at time of intubation (Group 2), and preoperative compartment syndrome treated with fasciotomies (Group 4). This patient was eventually treated with skin grafting; there were no other patients in this cohort treated with skin grafting. One patient in Group 1 included wound vac application at time of definitive surgery. Post-hoc analysis on cumulative operative time showed significantly increased time comparing Group 4 and all other groups: Group 1 ($p=0.0012$), Group 2 ($p=0.000006$), and Group 3 ($p=0.0025$). Group 3 had the only subject with an unplanned return to the OR within 12 months (hardware removal); this data is statistically significant ($p=0.015$). A one-way ANOVA revealed a significant difference in initial LOS between the groups ($p=0.047$). However, post-hoc pairwise comparisons using Tukey's HSD did not reveal any significant differences between specific group pairs. ANOVA testing revealed no significant difference in age, complications, sex, BMI, total comorbidities, and polytrauma between the 4 groups.

DISCUSSION: In the management of bicondylar tibial plateau fractures, time to definitive fixation and the type of fixation strategy have been areas of clinical interest, primarily driven by improving outcomes while reducing complications. Patterns emerged when comparing the efficacy of common practices by evaluating complications, surgical, and radiographic outcomes based on definitive fixation timing and method. Though the operative time for Group 4 significantly varied from all other groups, this included two surgeries for each patient. While Group 3 showed significant increase in rate of return to the OR within a year post-operatively, only one patient met these criteria in the entire study; consequently, this cannot be evaluated as a meaningful data point. The data showed no significant variance between groups concerning age, sex, BMI, total comorbidities, polytrauma, complications, nor length of stay. Given the lack of significance in all factors except cumulative operative time, our cohort appears to highlight appropriate stratification of patients into treatment groups including primary ORIF and staged surgery with external fixation, and shows that with appropriate stratification based on clinical assessment of soft tissue condition and swelling, there was no additional risk in return to the OR with knee immobilizer temporization in those patients whose surgeries were delayed >24hrs in Group 2 and 3.

SIGNIFICANCE/CLINICAL RELEVANCE: Recent literature has challenged the concept of bicondylar tibial plateau fractures requiring staged fixation due to wound complications. The surrounding skin and soft tissue often dictate the surgical timing of bicondylar tibial plateau fractures, however, no single objective measure exists to determine appropriate timing. Our study demonstrates that wound complications requiring return to the operating room may be avoided with careful selection of patients to be treated with definitive ORIF >24h from time of injury. Alternatively, if soft tissues are not amenable to acute ORIF, a subset of patients may be safely immobilized in a knee immobilizer and not require external fixation. A subset of patients (29%) still required a staged approach of external fixation with delayed ORIF. The goal of future studies will be to better describe the specific patient characteristics that allow for accurate stratification of patients into the appropriate successful treatment groups.

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IMAGES AND TABLES:

Table 1. Demographic Characteristics

	N=124	Age [years]	Sex [F]	Body Mass Index (BMI) [kg/m²]	Current Smoker	Total Comorbidities* [Range]	Substance use**	Polytrauma	Length of Hospital Stay	Operative Time-Cumulative
Group 1	16 (13%)	45 (17)	50%	31.6 (6.0)	50%	0.19 [0-2]	12.5%	7 (44%)	5 (5)	2.00
Group 2	61 (49%)	52 (18)	59%	29.2 (5.9)	44%	0.57 [0-4]	13%	22 (36%)	6 (7)	2.08
Group 3	11 (9%)	56 (13)	55%	32.3 (5.9)	27%	0.81 [0-3]	18%	4 (36%)	16 (27)	1.88
Group 4	36 (29%	48 (15)	42%	29.9 (6.8)	44%	0.28 [0-3]	8%	19 (53%)	10 (14)	3.42

*Comorbidities reported: cerebrovascular disease, asthma, cancer, coronary artery disease, depression, diabetes, end stage renal disease, hypercholesterolemia, and hypertension

**Substance use includes: alcohol and drug abuse