"Notch" Involvement in Tibial Plateau Fractures: What is the Problem and Does it Matter?

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INTRODUCTION:
Intercondylar eminence ("notch") involvement is frequently observed in tibial plateau fractures. Given its role as the attachment site for the ACL and meniscal roots, injuries to this region may have important clinical implications. However, its clinical significance remains unclear and existing classification systems offer limited guidance for management. This study aims to evaluate whether notch involvement and degree of displacement are independently associated with increased rates of secondary procedures and worse patient-reported outcomes following surgical fixation of tibial plateau fractures.
METHODS:
A retrospective review of skeletally mature patients who underwent surgical treatment for AO/OTA 41B and 41C tibial plateau fractures at a Level I trauma center between 2011–2021 was conducted. Preoperative CT scans were evaluated to assess notch involvement and quantify displacement, which was rounded to the nearest 5 mm and stratified into three groups: 0 mm, 5 mm, and ≥10 mm. Inclusion criteria consisted of patients aged 18 years or older with isolated tibial plateau fractures (AO/OTA 41B or C), no prior knee injuries, and a minimum of 3 months follow up or the occurrence of a primary outcome prior to 3 months. The primary outcome was all cause return to the OR, including manipulation under anesthesia, irrigation and debridement, repair of nonunion or malunion, hardware removal or revision, amputation, fasciotomy wound management with or without split-thickness skin grafting, treatment of osteomyelitis, total knee arthroplasty, arthroscopy or lysis of adhesions, free flap coverage, ligament reconstruction, and external fixator removal. Secondary outcomes included PROMIS Physical Function, PROMIS Pain Interference, and VAS pain scores recorded at last clinic follow up. Multivariate analyses controlled for AO/OTA fracture classification.
RESULTS: A total of 557 patients met inclusion criteria, with a mean age of 49.3 years (range 16–98). The overall cohort was 47.2% female and 52.8% male. Patients with notch involvement were significantly older than those without (50.7 vs. 45.4 years, $p = 0.0006$). BMI, medical comorbidities, tobacco or substance use, and the rate of open fracture did not differ between groups. Mean follow up was 13.25 months (range 3.00–93.24 months). Notch involvement was present in 411 patients (73.8%). 263 patients (47.2%) sustained 41B fractures, while 294 patients (52.8%) sustained 41C fractures. Among those with notch involvement, displacement was categorized as 0 mm in 122 patients (29.7%), 5 mm in 125 patients (30.4%), and ≥10 mm in 164 patients (39.9%). On univariate analysis, notch involvement was associated with a higher rate of secondary procedures compared to those without involvement (41.6% vs. 30.1%, $p = 0.0150$, OR 1.65, 95% CI [1.10–2.47]). Stiffness-related reoperations, including manipulation under anesthesia, arthroscopy, or lysis of adhesions, occurred in 10.0% of patients with notch involvement versus 6.2% without ($p = 0.1726$, OR 1.67, 95% CI [0.79–3.53]). PROMIS Physical Function, PROMIS Pain Interference, and VAS pain scores were not significantly different between groups (all $p > 0.16$) at final clinic follow up. After adjusting for AO/OTA classification, the association between notch involvement and secondary procedures was no longer significant ($p = 0.2959$, OR 1.27, 95% CI [0.81–1.97]). Similarly, stiffness-related reoperations remained non-significant ($p = 0.3582$, OR 1.46, 95% CI [0.65–3.28]). When stratified by displacement, rates of stiffness-related reoperation increased with greater displacement: 5.7% for 0 mm ($p = 0.0059$), 9.6% for 5 mm ($p = 0.9183$), and 16.5% for ≥10 mm. Compared to the ≥10 mm group, the 0 mm group had significantly lower odds of requiring a stiffness procedure ($p = 0.0059$, OR 0.31, 95% CI [0.15–0.63]), which remained significant after AO/OTA adjustment ($p = 0.0175$, OR 0.34, 95% CI [0.16–0.72]). PROMIS and VAS scores did not significantly differ across displacement groups (all $p > 0.13$).
DISCUSSION AND CONCLUSION: After adjusting for AO/OTA classification, notch involvement was not independently associated with increased rates of secondary procedures or worse patient reported outcomes. This suggests notch involvement likely reflects underlying fracture complexity rather than serving as an independent predictor of outcomes. However, when notch involvement was further stratified by degree of displacement, fragments displaced by ≥10 mm were independently associated with increased rates of stiffness-related reoperations, even after controlling AO/OTA classification, perhaps indicating notch displacement may be a secondary marker of fracture severity. Despite this, patient-reported outcomes did not significantly differ based on displacement. These findings suggest the clinical relevance of notch involvement is displacement dependent, with more substantial displacement reaching a threshold that leads to further surgical intervention. While non-displaced fragments may not require intervention, further study is needed to clarify the optimal management of displaced notch fragments. Future investigations aim to evaluate if surgical reduction of notch displacement or if residual displacement after fixation impact outcomes.