Clinical Indications for CT Angiography in Lower Extremity Trauma

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Purpose: Computed tomographic angiography (CTA) is replacing conventional angiography as a rapid and accurate modality for diagnosis of suspected vascular injury in the traumatized lower extremity. We hypothesize that specific physical examination findings and injury patterns in lower extremity orthopaedic trauma patients are predictive of detection of a vascular injury by CTA. These findings may indicate or obviate ordering a CTA study in this context.

Methods: With IRB approval, investigators retrospectively reviewed physical examinations and injury patterns of 72 consecutive trauma patients at an academic Level I trauma center who underwent CTA of a lower extremity from 2006 through 2012. Outcomes included CTA detection of a vascular injury, additional imaging by duplex ultrasonography or angiography, operative or endovascular vascular intervention, and contrast-induced nephropathy (CIN).

Results: 40/72 (55.6%) diagnostic CTA studies demonstrated a vascular injury. 10/40 patients (25.0%) received specific vascular intervention. The positive predictive values (PPVs) of specific physical examination findings for predicting CTA detection of injury were dependent on the pattern of injury (table below). Normal physical examination led to observational management without incident, regardless of CTA findings. CTA was performed per published recommendations in 73.6% to 95.8% of cases, depending on criteria. CTA agreed with management in 95.8% of cases. CIN occurred in 4/72 cases (5.6%).

Conclusion: CTA is not indicated in lower extremity trauma when physical examination fails to demonstrate signs of vascular injury. Specific injuries and physical examination findings are predictive of CTA detection of vascular injury and may guide imaging and treatment decisions.

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Table:
PPVs of Examination and Injury for Predicting CTA Detection of Lower Extremity Vascular Injury

CTA Positives/Exam Positives		Percent (%)	95% CI* (%)
All patients			
Any exam finding	22/53	41.5	28.1-55.9
Any soft exam finding	16/46	34.8	21.4-50.2
Diminished pulse	10/32	31.3	16.1-50.0
Asymmetry of color	8/11	72.3	39.0-94.0
Asymmetry of temperature	8/17	47.1	23.0-72.2
Any hard exam finding	15/23	65.2	42.7-83.6
Absent pulse	15/20	75.0	50.9-91.3
Only patients with low-risk injuries			
Any exam finding	4/20	20.0	5.7-43.7
Any soft exam finding	3/18	16.7	3.6-41.1
Any hard exam finding	4/10	40.0	12.2-73.8
Only patients with high-risk injuries			
Any exam finding	18/33	54.5	36.4-71.9
Any soft exam finding	13/28	46.4	27.5-66.1
Any hard exam finding	11/13	84.6	54.6-98.1

*95% CI = 95% confidence interval.

Immediate Weight Bearing as Tolerated Has Improved Outcomes Compared to Non-Weight Bearing After Surgical Stabilization of Midshaft Clavicle Fractures in Polytrauma Patients

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Background/Purpose: Midshaft clavicle fractures are common injuries and recent studies have demonstrated the clinical benefit of surgical management. Weight bearing (WB) status after open reduction and internal fixation (ORIF) has been primarily as non–weight bearing (NWB) in the literature; however, in the polytrauma patient population a clear benefit exists to early ambulation with the use of an assistive device. Previous reports have illustrated that crutch weight bearing following surgical stabilization of midshaft humerus fractures resulted in high union rates and low complications. The literature does not have any studies evaluating early crutch weight bearing following ORIF of midshaft clavicle fractures. Our hypothesis was that immediate postoperative weight bearing as tolerated (WBAT) for midshaft clavicle fracture would result in decrease length of stay and decreased complication rate in polytrauma patients compared to operative management with NWB.

Methods: After IRB approval a retrospective cohort study was conducted from August 2007 to November 2013. Inclusion criteria were skeletally mature patients with a midshaft clavicle fracture and a lower extremity injury that required non–weight bearing (long bone, periarticular, acetabular, or pelvic fracture). Exclusion criteria were open fracture, presentation with Glasgow Coma Scale below 8, and/or non–weight bearing upper extremity injury. 24 patients met the inclusion criteria; 9 patients underwent surgical stabilization with immediate weight bearing using crutches and 15 patients underwent surgical stabilization with no weight bearing, but could complete active and passive range of motion exercises. These two cohorts were compared using Mann-Whitney for statistical significance. We evaluated data regarding age, sex, mechanism of injury, and revised trauma score. We compared data collected on length of stay (LOS), maximum mobility level at discharge, and LOS postoperatively.

Results: The mean patient age was 41.4 years (range, 19-64) and 45.6 years (range, 22-63) in the WB and NWB groups, respectively. Revised trauma score was similar in both groups (11.2 WB vs. 11.3 NWB). The WB group had decreased LOS (11.7 vs. 17.4 days, $P = 0.056$). The WB group had a significant improvement in physical therapy score (4.3 vs 2.8, $P = 0.005$), and subsequently discharged faster postoperatively than the NWB group (6.9 vs 12.9 days, $P = 0.015$). The WB group also had a decreased rate of deep venous thrombosis (DVT) compared to the NWB group (0 vs. 2). There was no statistical difference in the union rates between groups.

Conclusion: This study demonstrates that immediate postoperative crutch weight bearing provides improved participation in physical therapy, decreased LOS, and potentially deceased

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rate of DVT. Our data suggest also that early operative intervention for midshaft clavicle fractures with WBAT protocol produced the shortest LOS in a population of polytrauma patients. We plan to continue studying the effect of early WBAT after ORIF of midshaft clavicle fractures and the effect on quality of life and patient-centric outcomes measures.

Management of Clavicle Fractures in Patients with Thoracic Trauma

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Purpose: Clavicle fractures are associated with significant thoracic trauma. Fracture reduction and stabilization may improve proximal chest wall morphology and comfort and be secondary indicators for surgical intervention. We hypothesized that operative fixation of clavicle fractures may be beneficial for patients with thoracic chest trauma.

Methods: We reviewed a prospectively recorded trauma database for all patients with clavicle fractures (OTA 05, 06, 07) from April 2005 to June 2010. We identified 1074 patients with clavicle fractures. Minors and those with missing data were excluded. We recorded age, chest Abbreviated Injury Score (AIS), length of ICU stay, and other demographic information. ICU admission was made at the discretion of the general trauma team and the orthopaedic trauma staff in consultation with the ICU team made the decision for surgery. The primary indication for clavicular open reduction and internal fixation (ORIF) was the magnitude of fracture displacement, and fellowship-trained orthopaedic trauma surgeons performed all surgeries. The operative tactic and implant selection were made at the discretion of the treating surgeon. Postoperatively patients were placed into a sling and, when possible, patients began range of motion exercises on postoperative day 1.

Results: Mean chest AIS was 3.56 ± 0.71 (mean ± standard deviation). 763 patients had a chest AIS ≥2. Of these, 75 patients had operative treatment of their clavicle fracture (9.8%). 49 of these patients required an ICU stay (65.3%) with a mean length of stay (LOS) of 4.5 days (range, 1-24). Of the 688 patients who had nonoperative treatment of their clavicle fracture, 493 patients required an ICU stay (72%) with a mean LOS of 7.8 days (range, 1-98). ICU stay was significantly shorter in patients with operatively treated fractures ($P < 0.001$). We further stratified those patients who had minimum ICU stay of 2 days. Of these 359 patients, 340 were treated nonoperatively during the initial hospital course with a mean ICU stay of 10.7 days. 13 patients had operative fixation of the clavicle while in the ICU with a mean LOS of 8.8 days. This difference was significant ($P < 0.001$)

Conclusion: Polytraumatized patients with clavicle fractures commonly have significant thoracic trauma. Operative stabilization of the fractured clavicle is associated with shorter ICU stays. Further research is needed to better identify those patients who may benefit from operative fixation of the clavicle.

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The Association of Ipsilateral Rib Fracture(s) with Displacement of Midshaft Clavicle Fractures

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Background/Purpose: Recent evidence suggests that operative fixation of displaced midshaft clavicle fractures (OTA 15-B) significantly decreases nonunion rates as well as improves functional results compared to nonoperative management. Close radiographic follow-up in trauma patients with high-energy clavicle fractures is also recommended due to a high prevalence of subsequent displacement. To our knowledge, there is currently no evidence to indicate which clavicle fractures are more likely to displace in the weeks following the trauma. The purpose of this study is to determine if the presence of ipsilateral rib fracture(s) affects the rate of a clavicle fracture being unstable (>100% displacement). We hypothesized that the presence of ipsilateral rib fracture(s) would lead to an increased rate of unstable midshaft clavicle fractures when compared to those without ipsilateral rib fracture(s).

Methods: A retrospective review from 2002-2013 was performed at a single Level I trauma center evaluating 243 midshaft clavicle fractures. These fractures were then subdivided into those with ipsilateral rib fracture(s) (CIR; n = 149), and those without ipsilateral rib fracture(s) (CnIR; n = 94). The amount of displacement was measured on the initial injury radiograph as well as subsequent follow-up radiographs taken during the first 2 weeks after injury. Fractures were subsequently classified as "stable" (<100% displacement) or "unstable" (>100% displacement). Ipsilateral rib fracture(s) were also assessed and recorded based on which number rib was fractured as well as the total number of ribs that were fractured.

Results: 116 (78%) of the midshaft clavicle fractures with ipsilateral rib fracture(s) (CIR) and 51 (54%) of the midshaft clavicle fractures without ipsilateral rib fracture(s) (CnIR) were found to be unstable ($P = 0.0047$). 72% of the CIR group, compared to only 40% of the CnIR group, progressed from stable to unstable clavicle fractures ($P < 0.001$). Each additional rib fracture was found to increase the odds of final displacement greater than 100% by a factor of 1.24 (95% confidence interval [CI], 1.11-1.38). The odds ratio for progression to an unstable clavicle fracture was found to be 4.08 ($P = 0.000194$) when ribs 1-4 were fractured and not significant for rib fractures 5-8 or 9-12.

Conclusion: The presence of concomitant ipsilateral rib fracture(s) significantly increases the rate of unstable midshaft clavicle fractures. Additionally, a fracture involving the upper one-third of the ribs (ie, ribs 1-4) will significantly increase the rate of the clavicle fracture being unstable. Also, there is a trend for clavicle fractures with associated ipsilateral rib fracture(s) to demonstrate an increased amount of displacement on follow-up radiographs compared to those without ipsilateral rib fracture(s).

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