OTA Classification is Highly Predictive of Acute Compartment Syndrome Following Tibia Fracture: A Cohort of 2885 Fractures

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Compartment Syndrome

- Reported in 2.7 to 33.3% of patients presenting with tibial fractures
- Current gold-standard objective test is intra-compartmental pressure monitoring with a side port needle (Stryker Monitor)
  - Error prone in technique and unreliable in clinical accuracy
  - Alternative testing methods include biomarkers, MRI, pulsed phase-locked loop ultrasound, laser flowmetry, scintigraphy, and near infrared spectrophotometry
- ACS remains a clinical diagnosis based largely on subjective signs and symptoms in the awake and alert patient

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- Segment
  - Describes location of the fracture through the tibia
  - 1 – Proximal Segment (Plateau)
  - 2 – Middle Segment (Shaft)
  - 3 – Distal Segment (Pilon)

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- Type
  - Periarticular Fractures
    - Type A – Extraarticular
    - Type B – Partial Articular
    - Type C – Complete Articular
  - Diaphyseal Fractures
    - Type A – Simple Pattern
    - Type B – Wedge Pattern
    - Type C – Complex Pattern
      - No cortical contact between the proximal and distal fracture fragments

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- Group
  - The fracture group generally describes the complexity of the fracture.

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Study Goals

- Assess correlation between OTA fracture classification in tibial fractures and subsequent development of ACS, while controlling for known risk factors.

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Patient Selection

- Prospectively collected database was retrospectively reviewed
- All tibial plateau, shaft, and pilon fractures from January 2006 to January 2016.
- 3606 patients initially identified

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Inclusion

- Skeletally mature patients
- Plate or intramedullary fixation
- Fractures managed from initial injury through definitive fixation at our institution.

Exclusion

- Transferred to our facility after initial orthopaedic care (n=195)
- Skeletally immature patients (n=209)
- Previous implants of the tibia (n=180)
- Pathologic fractures (n=11)
- Acute amputations (n=23)
- Prophylactic fascial release (n=29)
- Treatment with frame, cast, or percutaneous pinning (n=74)

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Chart Review

- Retrospective radiographic and chart review was performed
- Patients without documented signs of muscle herniation or definitive closure within 2 calendar days were considered negative for compartment syndrome

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Statistics

- Univariate analyses conducted using independent t-tests for continuous data and chi-square tests of independence for categorical data.
- Bilateral injuries were analyzed independently with a bilateral variable.
- A simultaneous multivariate binary logistic regression was developed to identify variables significantly associated with ACS.

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Demographics

- Average age was 43.2 ± 17.6 years
- 62.7% (1809) of fractures occurred in males
- 823 (28.5%) fractures were open
- 100 patients (3.6%) had bilateral injuries
  - 7 patients (0.2%) had two injuries at separate times

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Fracture Segment

- 954 (33.1%) plateau fractures (OTA 41)
- 1270 (44.0%) shaft fractures (OTA 42)
- 811 (28.1%) pilon fractures (OTA 43)
- 156 (5.4%) involved two segments

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Fixation

- 1102 (38.2%) underwent IM Fixation alone
- 1690 (58.6%) underwent plate fixation alone
- 91 (3.2%) underwent plate and nail fixation

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Compartment Syndrome

- Diagnosed in 136 patients (4.7%)
  - 8 patients excluded for closure within 2 days
- Average age ($p<0.001$)
  - 36.2 years in ACS group
  - 43.4 years in non-ACS group
- Sex ($p=0.016$)
  - 77.9% male in ACS group
  - 61.9% male in non-ACS group

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ACS Risk Relation to Demographics and Fixation

	Compartment Syndrome N = 136	No Compartment Syndrome N =2,749	p-Value	Odds Ratio	95% CI Lower	95% CI Upper
Open Injury	34.6%	28.2%	0.986	1.004	0.664	1.517
Dual Segment Inj.	7.4%	4.7%	.258	.636	.291	1.392
Bilateral Injuries	3.7%	7.1%	.080	2.278	.907	5.724
Concurrent Fracture						
Femur	8.8%	5.1%	.531	.810	.420	1.564
Pelvis	4.4%	2.6%	.465	.718	.296	1.745
Type of Fixation						
Plate	39.7%	38.2%	N/A (Reference)			
Intramedullary Rod	57.4%	58.6%	0.916	1.037	0.525	2.048
Both	2.9%	3.2%	0.902	0.927	0.273	3.141

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ACS Risk Relation to Fracture Segment

- Plateau (OTA 41) and shaft (OTA 42) fractures had significantly higher risk of ACS when compared to Pilon
  - After controlling for demographic variables
- No significant difference in risk between plateau and shaft

OTA Classification (Segment)						
Bone Segment	ACS	No ACS	P value	OR	95% CI	
1 (Proximal)	46.3%	31.8%	<0.001	4.536	2.385	8.625
2 (Middle)	44.9%	41.3%	0.007	3.158	1.365	7.308
3 (Distal)	8.8%	26.9%	N/A (Reference)			

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ACS Risk Relation to Fracture Type

- Type C fractures had significantly higher risk of ACS when compared to types A and B
  - After controlling for segment and demographic variables
- No significant difference in risk between types A and B

OTA Classification (Type)						
Fracture Type	ACS	No ACS	P value	OR	95% CI	
A	18.4%	29.6%	N/A (Reference)			
B	28.7%	34.8%	0.230	1.404	0.82	2.405
C	52.9%	35.6%	<0.001	3.061	1.831	5.116

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ACS Risk Relation to Fracture Group

- Group 2 and 3 fractures had significantly higher risk of ACS when compared to Group 1
  - After controlling for segment, type, and demographic variables
- No significant difference in risk Groups 2 and 3

OTA Classification (Group)						
Fracture Group	ACS	No ACS	P value	OR	95% CI	
1	16.2%	28.6%	N/A (Reference)			
2	36.8%	32.1%	0.013	1.982	1.157	3.394
3	47.1%	39.3%	0.044	1.689	1.015	2.81

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- Largest study group to date
- Segment
  - Segment is highly predictive of ACS
    - Pilon fractures at significantly lower risk
  - Results similar to Allmon et al. and Park et al.
- Type
  - Confirms results of Ziran et al. that type is predictive of ACS in plateau fractures
  - Refutes results of McQueen and Park that type is not predictive of ACS in shaft fractures
- Group
  - First study to discuss the risk of ACS based on fracture group.

Allmon C, Greenwell P, Paryavi E, et al. Radiographic Predictors of Compartment Syndrome Occurring after Tibial Fracture. J Orthop Trauma. 2016 Feb 24;
Ziran BH, Becher SJ. Radiographic predictors of compartment syndrome in tibial plateau fractures. J Orthop Trauma. 2013 Nov;27(11):612-615.
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Conclusion

OTA fracture segment, type, and group are highly predictive of ACS

Sex and age were again confirmed to be highly predictive of ACS

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Thank You

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