

# Dual Mini-Fragment Plate Fixation of Midshaft Clavicle Fractures Reduces Risk of Reoperation Compared to Single Plate Fixation Techniques

Rajiv P Reddy, Shaquille Charles, Matthew Como, Stephen Chen, Peter Mittwede, Gele B Moloney, Soheil Sabzevari, Albert Lin

# Disclosures

- **Albert Lin has the following disclosures:**
  - Stryker/Tornier: Paid Consultant
  - Arthrex: Paid Consultant
  - American Academy of Orthopedic Surgeons: Committee or board member
  - American Shoulder and Elbow Surgeon: Committee or board member
  - American Orthopedic Society for Sports Medicine: Committee or board member
  - ISAKOS: Committee or board member
  - Knee Surgery, Sports Traumatology, Arthroscopy: Editorial or governing board
  - Annals in Joint: Editorial or governing board
  - Arthroscopy: Editorial or governing board
  - JISAKOS: Editorial or governing board
  - American Journal of Sports Medicine: Reviewer
  - Journal of American Academy of Orthopedic Surgeons: Reviewer
  - Knee Surgery, Sports Traumatology, Arthroscopy: Reviewer
  - Journal of Shoulder and Elbow Surgery: Reviewer
  - Journal of Bone and Joint Surgery: Reviewer
- **None of these disclosures are related to the content of this talk**

# Background

- Single-plate fixation of displaced midshaft clavicle fractures has been shown to have high rates of secondary surgery up to 27%<sup>1</sup>
- Recent studies have highlighted dual plating as a method to reduce post-operative complications following operative management of midshaft clavicle fractures<sup>2,3</sup>



# Study Objective

## Aim:

- To compare reoperation rates and risk among patients who have undergone superior, anterior, and dual plating of displaced midshaft clavicle fractures while adjusting for known risk factors

## Hypothesis:

- We hypothesized lower rates of reoperation among patients who underwent open ORIF via dual plating for displaced mid-shaft clavicle fractures compared to single anterior or superior plating

# Methods

- **Retrospective cohort study** of all patients who presented with a midshaft clavicle fracture and underwent ORIF from 2007-2021 at our level one trauma center
- **12-month minimum follow-up**
- **Three treatment cohorts**
  1. Orthogonal dual mini-fragment plate fixation
  2. Superior plate fixation
  3. Anterior plate fixation

# Methods

- **Preoperative data collection**
  - Demographics
  - Fracture pattern
  - Trauma mechanism
- **Outcomes**
  - All-cause reoperation rate and hazard ratio
  - Non-union
- **Multivariate multilevel mixed-effects parametric survival model**  
controlling for confounders with significance level set to  $p < 0.05$

# Study Cohort

256 patients - 101 superior plating, 92 anterior plating, 63 dual plating

Cohort Variable	Dual (n=94)	Superior (n=152)	Anterior (n=149)	p-value
Age	41.6 ± 14.6	37.9 ± 14.9	36.6 ± 13.2	<b>0.028</b>
Follow-up <sup>+</sup>	194.4 + 316.0	162.8 + 271.9	149.2 + 209.4	0.65
Male (%)	80 (84.2%)	124 (79.5%)	125 (82.8%)	0.60
BMI	25.6 + 5.6	25.8 + 4.8	26.7 + 4.9	0.29
Smoker (%)	30 (31.6%)	40 (25.6%)	61 (40.4%)	<b>0.02</b>
Diabetes (%)	3 (3.2%)	9 (5.8%)	6 (4.0%)	0.58
High-energy Trauma (%)	64 (67.4%)	83 (53.2%)	104 (68.9%)	0.009
<u>Fracture Morphology</u>				
Z-Type	42 (25.9%)	31 (39.2%)	26 (32.9%)	0.17
Transverse	31 (19.3%)	72 (44.7%)	58 (36.0%)	
Oblique	42 (25.9%)	53 (32.7%)	67 (41.4%)	

Dual plating cohort was older and had slightly lower mean follow-up ( $p < 0.05$ )

# Results

- **31 total reoperations among 22 patients (Table 1)**
  - 1 in dual plating (among 1 patient)
  - 18 in superior plating (among 12 patients)
  - 12 in anterior plating (among 9 patients)
- **8 total non-unions**
  - 0 in dual plating
  - 4 in superior plating
  - 4 in anterior plating
- **Superior plating revealed the highest reoperation rate (0.031 per person-years), followed by anterior plating (0.026 per person-years), and finally dual plating (0.005 per person-years)**



# Indications for Reoperation

Technique	Patients Requiring Reoperation	Number of Reoperations	Indications
Dual Plating (n= 63)	1 (1.6%)	1	<b>1 patient with one reoperation:</b> <ul style="list-style-type: none"> <li>1 for symptomatic implant</li> </ul>
Superior Plating (n= 101)	12 (11.9%)	18	<b>8 patients with one reoperation:</b> <ul style="list-style-type: none"> <li>3 for symptomatic implants</li> <li>2 for non-union</li> <li>2 for irrigation and debridement of deep wound infection</li> <li>1 for re-fracture</li> </ul> <b>3 patients with two reoperations:</b> <ul style="list-style-type: none"> <li>1 for non-union (twice)</li> <li>1 for symptomatic implant followed by re-fracture</li> <li>1 for irrigation and debridement of deep wound infection (twice)</li> </ul> <b>1 patient with four reoperations:</b> <ul style="list-style-type: none"> <li>1 for non-union followed by symptomatic implant followed by re-fracture followed by deep wound infection</li> </ul>
Anterior Plating (n=92)	9 (9.8%)	12	<b>7 patients with one reoperation:</b> <ul style="list-style-type: none"> <li>4 for symptomatic implant</li> <li>2 for non-union</li> <li>1 for irrigation and debridement of deep wound infection</li> </ul> <b>1 patient with two reoperations:</b> <ul style="list-style-type: none"> <li>1 for symptomatic implant (twice)</li> </ul> <b>1 patient with three reoperations:</b> <ul style="list-style-type: none"> <li>1 for irrigation and debridement of deep wound infection followed by wound dehiscence (three times)</li> </ul>

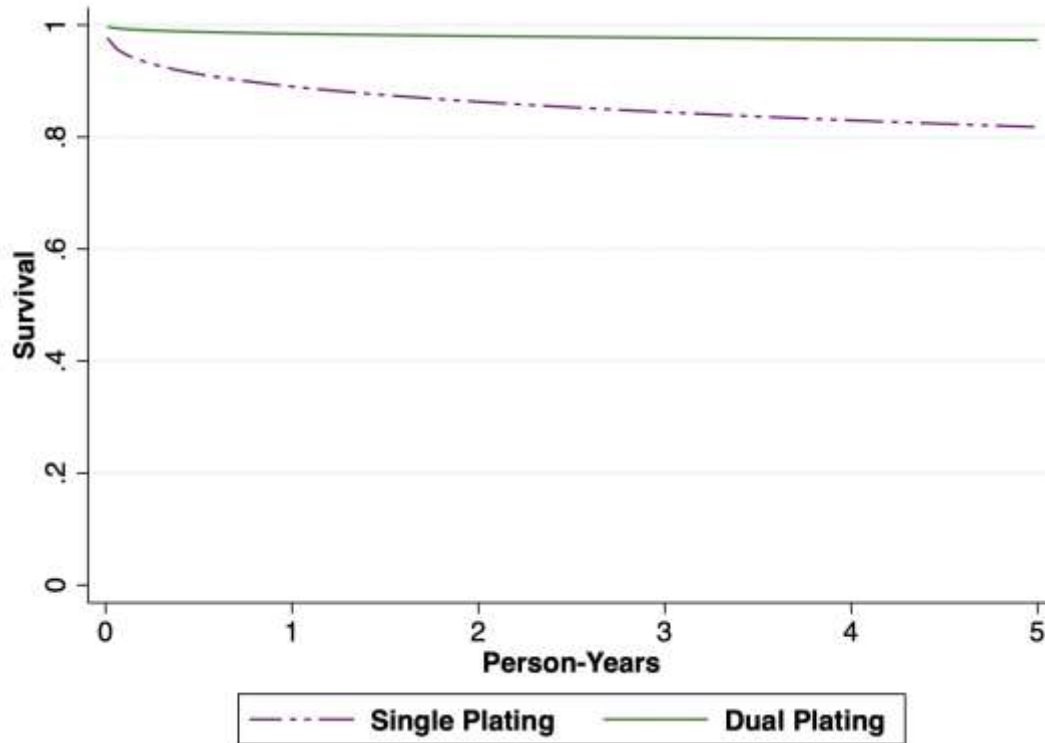
# Results

- Patients who underwent single plating (either anterior or superior placement) revealed a greater rate of reoperation when compared to patients who underwent dual plating (HR: 8.3,  $p=0.045$ ).
- Patients who underwent single plating with superior placement had a rate of reoperation ten-times greater than patients who underwent dual plating (HR:10.1,  $p=0.03$ )
- Patients who underwent single plating with anterior placement had a rate of reoperation six-times greater than patients who underwent dual plating (HR: 6.4,  $p=0.09$ ), although not statistically significant.

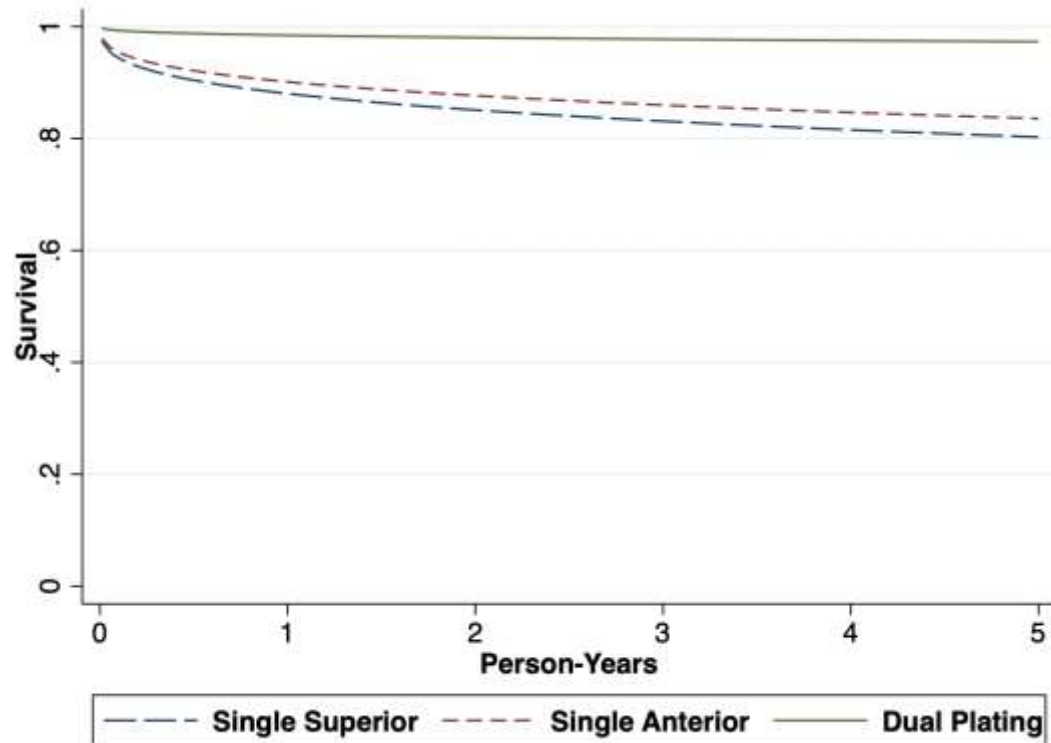
# Mixed-effects Weibull regression model comparing risks of reoperation between techniques

Variable	Hazard Ratio	95% CI	P Value
<b>Plate Technique (compared to Dual)</b>			
Single Overall	7.62	1.02 – 56.82	<b>0.048</b>
Superior	8.36	1.10 – 63.86	<b>0.041</b>
Anterior	6.79	0.87 – 52.90	ns
<b>Smoking</b>	2.98	1.45 – 6.15	<b>0.003</b>
<b>Fracture Morphology (compared to oblique fracture)</b>			
Transverse	5.69	1.28 – 25.25	<b>0.022</b>
Z-Type	11.36	2.50 – 51.62	<b>0.002</b>

## Single and dual plating survival per person-years



## Superior, anterior, and dual plating survival per person-years



# Discussion

- Dual plate fixation of midshaft clavicle fractures may be an excellent alternative to single plate fixation.
- When compared to single pre-contoured locked superior or anterior plate fixation, dual mini-fragment plate fixation has a nearly eight-fold lower risk of reoperation, potentially mitigating the concern that operative treatment of clavicle fractures is associated with a prohibitively high risk of implant removal.

# References

1. Nourian A, Dhaliwal S, Vangala S, Vezeridis PS. Midshaft Fractures of the Clavicle: A Meta-analysis Comparing Surgical Fixation Using Anteroinferior Plating Versus Superior Plating. *J Orthop Trauma*. 2017;31(9):461-467. doi:10.1097/BOT.0000000000000936
2. Chen X, Shannon SF, Torchia M, Schoch B. Radiographic outcomes of single versus dual plate fixation of acute midshaft clavicle fractures. *Arch Orthop Trauma Surg*. 2017;137(6):749-754. doi:10.1007/S00402-017-2676-0
3. Czajka CM, Kay A, Gary JL, et al. Symptomatic Implant Removal Following Dual Mini-Fragment Plating for Clavicular Shaft Fractures. *J Orthop Trauma*. 2017;31(4):236-240. doi:10.1097/BOT.0000000000000760

# Thank You

