

# 2D VERSUS 3D MEASUREMENT METHODS FOR TRICEPS INSERTION VIOLATION IN OLECRANON PLATE OSTEOSYNTHESIS

Kevin Nguyen<sup>1\*</sup>, Ahmed Habis<sup>2</sup>, Emad Anam<sup>2</sup>, Lacey Wice<sup>3</sup>, Julie Chan<sup>2</sup>, Ryan T. Bicknell<sup>1,2</sup>, Parham Daneshvar<sup>1,2</sup>, and Heidi-Lynn Ploeg<sup>1</sup>

<sup>1</sup>Department of Mechanical and Materials Engineering, Queen's University, Kingston, ON, Canada

<sup>2</sup>Department of Surgery, Queen's University, Kingston, ON, Canada

<sup>3</sup>Department of Biomedical and Molecular Sciences, Queen's University, Kingston, ON, Canada

Email: \*15cn24@queensu.ca

## Introduction

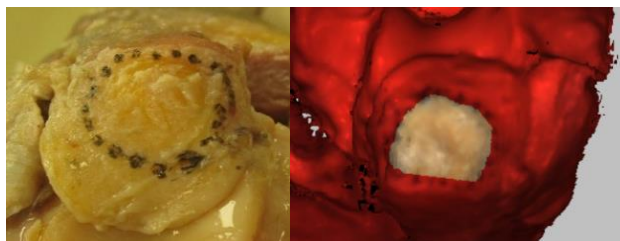
The triceps brachii muscle is the primary elbow extensor muscle. During olecranon fracture fixation, surgeons try to avoid compromising the tendon insertion as it can negatively impact tendon function or increase risk of rupture. However, it is common practice in olecranon fracture fixation to violate the triceps insertion by splitting and partially peeling off the triceps insertion to apply the olecranon plate directly on bone. Depending on the olecranon plate design and method of application, the amount of triceps violation can vary. However, the degree of triceps insertion violated has yet to be studied in literature. The purpose of this study was to compare two methods (2D vs. 3D) for measuring the degree of triceps insertion violation with commonly used olecranon plating systems.

## Methods

A total of six olecranon plating systems and twelve upper limbs (n = 12) were used throughout the study. This study was approved by the Health Sciences & Affiliated Teaching Hospitals Research Ethics Board (#6032061) in March 2021. The fresh-frozen donors were 73-, 88-, and 92-year old (1 woman and 2 men) whose cause of death were lung cancer, bladder cancer, and respiratory tract infection, respectively. The phenol-soft embalmed donors were 60-, 82-, and 93-year old (1 woman and 2 men) whose cause of death were lung cancer, dementia, and pneumonia, respectively.

To identify the triceps insertion surface area, the anatomical dissection of each sample consisted of the removal of the deep (muscular) and the superficial (tendinous) triceps insertion, followed by marking (**Figure 1**).

For the 2D method, the height and width were measured with a vernier caliper and the area was estimated assuming a rectangular shape for the triceps insertion surface areas. The 3D method measured surface area from a digitized surface model created from 3D data collected with a light scanner (Artec Eva Lite). (**Figure 1**).



**Figure 1:** The triceps insertion surface area (Left, 2D and Right, 3D).

Reverse moulds for the olecranon plating systems were laser scanned (SG100 ShapeGrabber) and the surface area of the olecranon plate in contact with the triceps insertion was determined. The percentage of triceps insertion violated was calculated using a percentage between the measured triceps insertion (2D and 3D method) and olecranon plate surface areas.

## Results and Discussion

The average triceps insertion violation by the six commonly used olecranon plating systems was 48.8%, where the smallest and largest triceps insertion violation were the Synthes – Extended and Synthes – Wide VA olecranon plates, respectively (**Table 1**).

**Table 1:** Percentage of triceps insertion violated by olecranon plates.

Olecranon Plates	Triceps Insertion Violation [%]	
	2D Method	3D Method
Acumed – Long	65.8	50.4
Smith-Nephew – Peri LOC	75.7	58.0
Synthes – Extended	51.9	39.8
Synthes – Narrow LCP	55.2	42.3
Synthes – Wide VA	81.4	62.4
Wright Medical - EPS	52.0	39.9

A mean percent difference of 30.4% was observed between the 2D and 3D measurement methods. In current literature, only the 2D measurement method has been reported [1][2]. Since the 2D measurement method assumed that the triceps insertions were rectangular, this method overestimated triceps insertion violation. Therefore, the 3D measurement method is a more accurate measurement of the triceps insertion violation.

A small sample size was a limitation for this study. With an increase in sample size, the degree of triceps insertion violation and the accuracy between the two measurement methods can be further investigated. Additional testing should be performed to assess how the triceps insertion violation correlates biomechanically and clinically in triceps dysfunction.

This study demonstrated that the commonly used olecranon plating systems significantly impact the triceps insertion during olecranon fracture fixation.

## Significance

By gaining knowledge about the degree of triceps insertion violation by olecranon plates, surgeons can be more aware of this violation and make informed decisions on the fixation methods that can decrease negative impacts on the triceps tendon. This information may help improve olecranon plate designs that provide patients with improved outcomes after this surgical procedure.

## Acknowledgments

We acknowledge the support of the Human Body Donor Program, Natural Sciences and Engineering Research Council of Canada (NSERC), Kingston Health Sciences Centre, and Centre for Health Innovation.

## References

- [1] Keener et al., 2010. JSES. 399-405.
- [2] Barco et al., 2017. JSES. 98-103.