



## RESIDUAL DORSAL TILT PART 1: IMPORTANCE OF VOLAR TILT RESTORATION

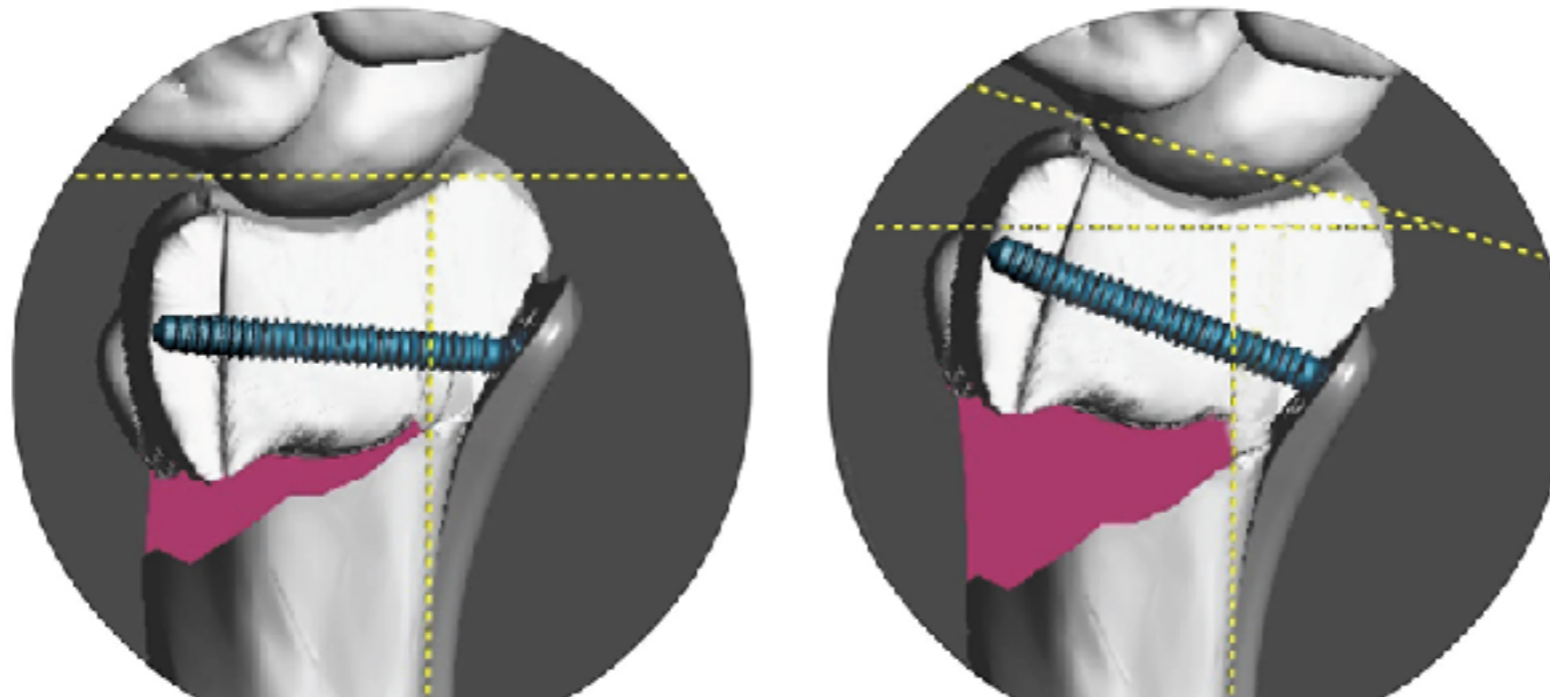
*\*Nicolas Galli, Federico Bertone, Rodrigo Sastre, Hugo Nuñez, A. Fernández, J. Jupiter*

Is it worthwhile to struggle to restore Volar Tilt?

May restored volar tilt increase dorsal bone defect and late collapse risk?

Does volar tilt restoration decrease flexor tendon impingement risk?

Which should the goal be: neutral tilt or volar tilt?



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# BACKGROUND

“Restoration of volar tilt is critical.”

Mc Lawhorn 2013

“The final volar tilt averaged 5°”

Orbay 2002

“Accept no more than 0° dorsal tilt”

Weiland (OKU-Trauma, AAOS / 1996

“Accept no more than 0° dorsal tilt”

ASSH Regional Review Course / 1994

“Accept no more than 10° dorsal tilt”

Trumble (ASSH Specialty Day at AAOS / 1999

“Correction to a volar tilt of 11° (+/-) 5° has been shown to restore biomechanical function of the wrist.”

Bernstein 2016

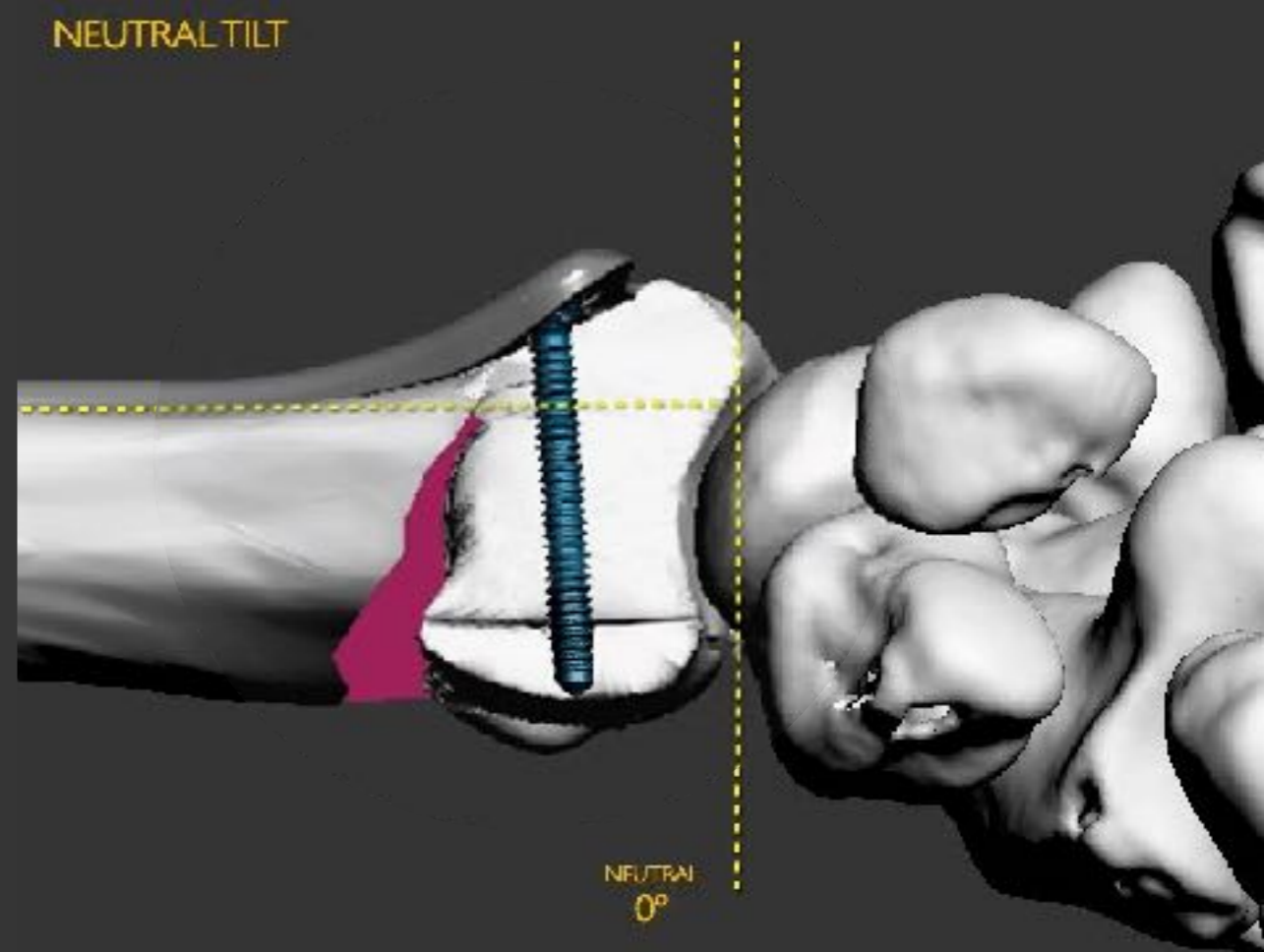
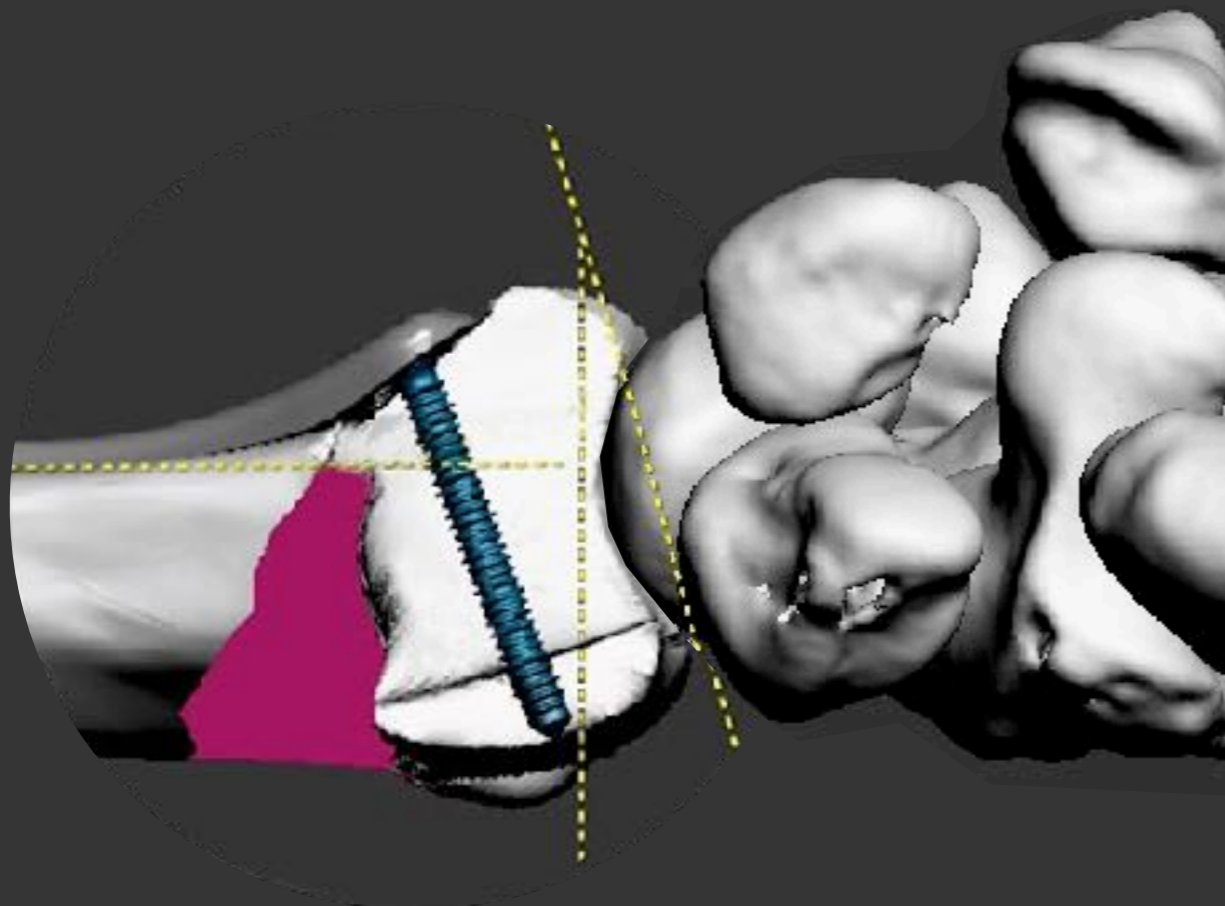
“...in our experience, the volar tilt was restored to neutral at most by manipulation of the fragments”

Sreedharan 2014

**Which should our goal be?**  
**Neutral tilt?**  
**Volar tilt?**

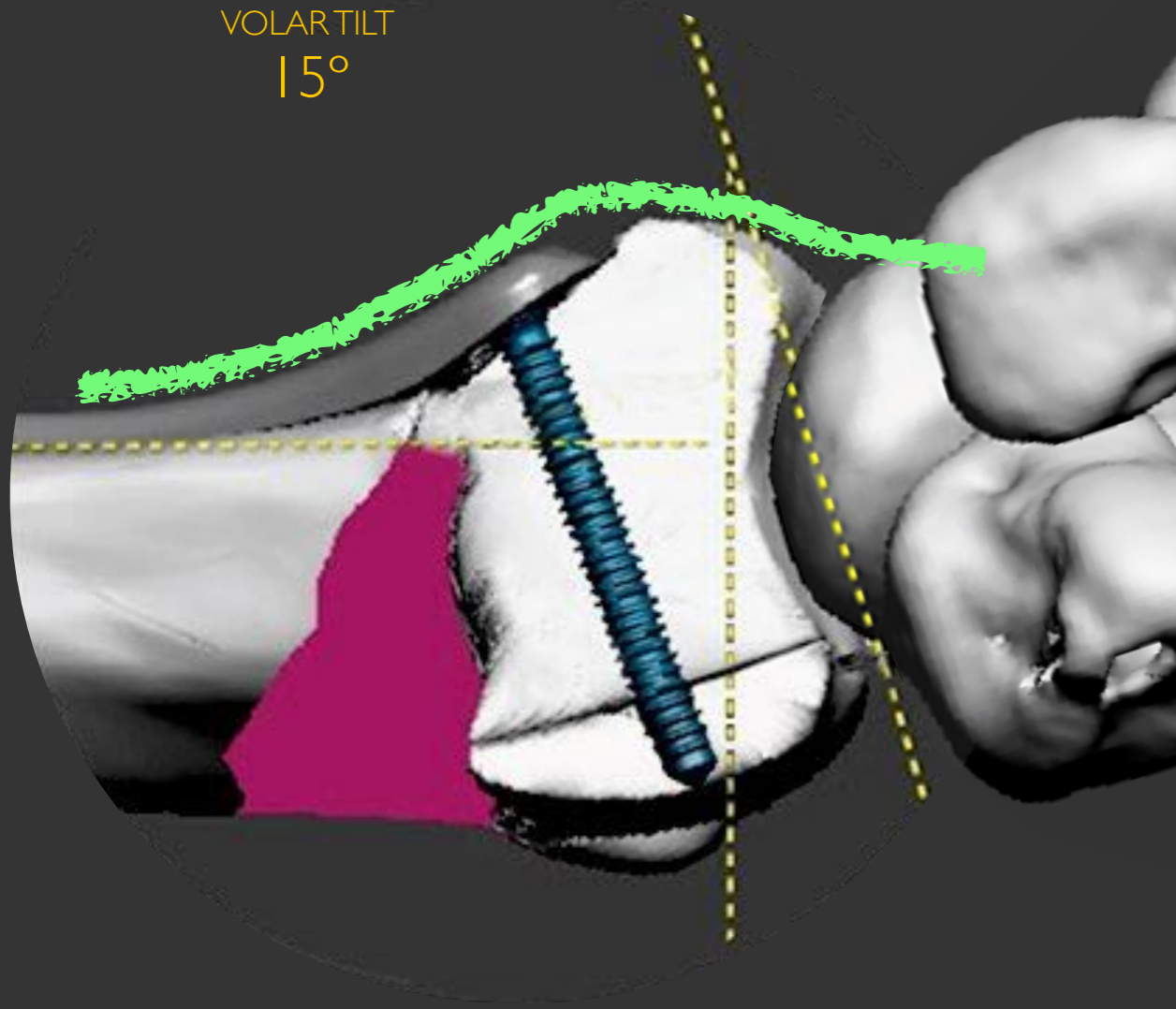
Should we really strive to get volar tilt or is neutral tilt acceptable?

**Can volar tilt be restored by volar locked plating?**

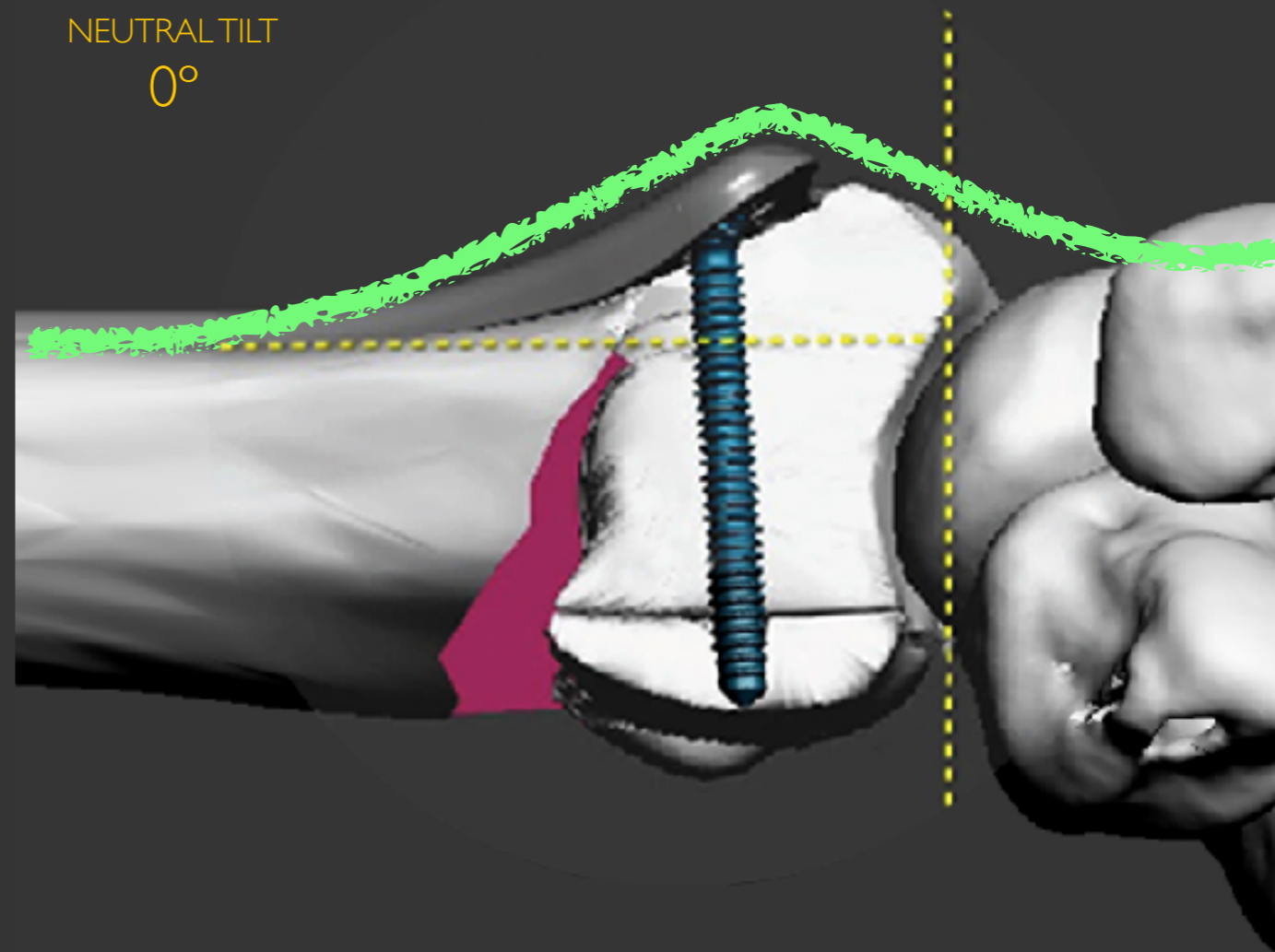


The question comes up if you have a large metaphyseal defect by virtue of reducing the displacement of the fracture, in an osteoporotic patient particularly, will there be a bone defect that ultimately leads to later collapse? Look what happens with a large metaphyseal loss: this volar tilt may collapse and so the risk increases with the metaphyseal defect, and that means particularly with very osteoporotic patients.

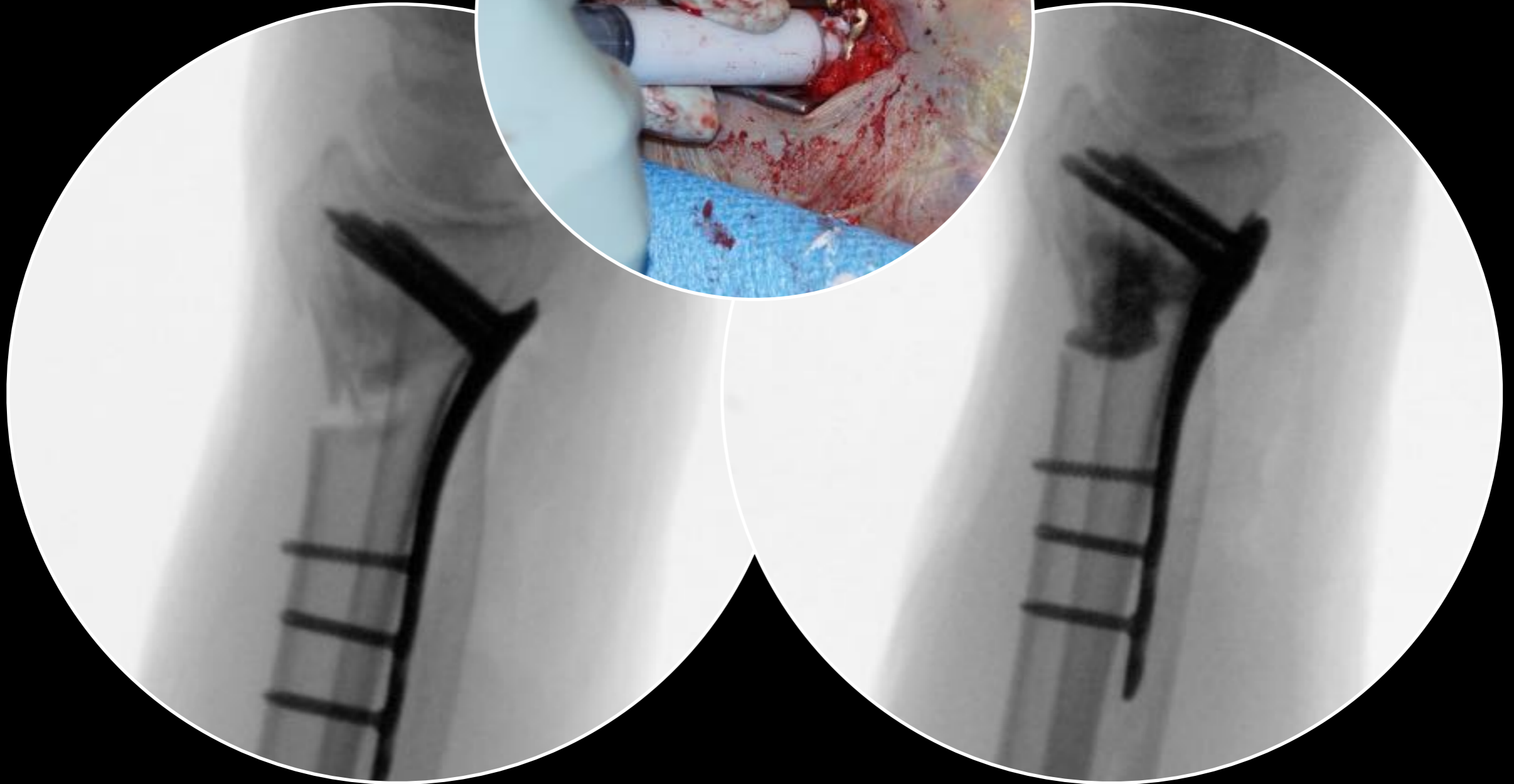
VOLAR TILT  
15°



NEUTRAL TILT  
0°



We know that the flexor tendons extend over so called watershed zone and then drop off closer to the end of the radius. So, if we have a large defect and we loose that position that situation may be more precarious.



This means that with a large defect like this it may be an indication for bone substitute to bone cements, to prevent this loss of volar tilt and then becoming a problem?.

“The volar locking plate fixation without bone grafting and early mobilization is a safe and effective treatment for dorsally displaced, unstable fractures of the distal radius.”

*J Hand Surg Am.* 2008 May-Jun;33(5):691-700. doi: 10.1016/j.jhsa.2008.01.024.

### **Prospective study of distal radius fractures treated with a volar locking plate system.**

Osada D<sup>1</sup>, Karnei S, Masuzaki K, Takai M, Karneda M, Tamai K.

#### **⊕ Author information**

#### **Abstract**

**PURPOSE:** To prospectively determine the results of treatment of distal radius fractures with a graft and early mobilization.

**METHODS:** Internal fixation and early mobilization of dorsally displaced, unstable fractures of the distal radius with a locking plate system without bone grafting was investigated in a prospective series of 49 fractures in 49 patients. Patients were allowed to move the wrist joint immediately after surgery. Physical examination at 5 weeks, 1 year, and 2 years after operation were performed. Radiographic parameters on preoperative, postoperative, and 1-year follow-up were compared. At 1-year review, the final clinical functions were evaluated with the Gartland and O'Brien system, a modified Green and O'Brien system, and the Disabilities of the Arm, Shoulder, and Hand questionnaire.

**RESULTS:** The average radiographic results at 1 year were 9 degrees of volar tilt; 22 degrees of ulnar variance, and 0 mm of articular incongruity. At 1-year review, an excellent or good result was found in 47 of 49 patients with the Gartland and O'Brien system and Werley and a modified Green and O'Brien system with scores of 100% and 98%, respectively. The Disabilities of the Arm, Shoulder, and Hand score averaged 6, indicating a high degree of patient satisfaction. There were no cases of infection, ulnar pain syndrome, tendon rupture, tendon irritation, nerve injury, or implant failure.

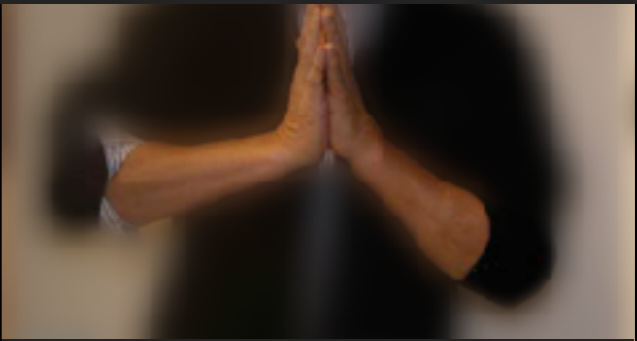
**CONCLUSIONS:** The volar locking plate fixation without bone grafting and early mobilization is a safe and effective treatment for dorsally displaced, unstable fractures of the distal radius.

**CONCLUSIONS:**  
The volar locking plate fixation without bone grafting and early mobilization is a safe and effective treatment for dorsally displaced, unstable fractures of the distal radius.

So the question then is whether or not bone graft is necessary or bone substitutes for these situations.



CASE STUDY 1



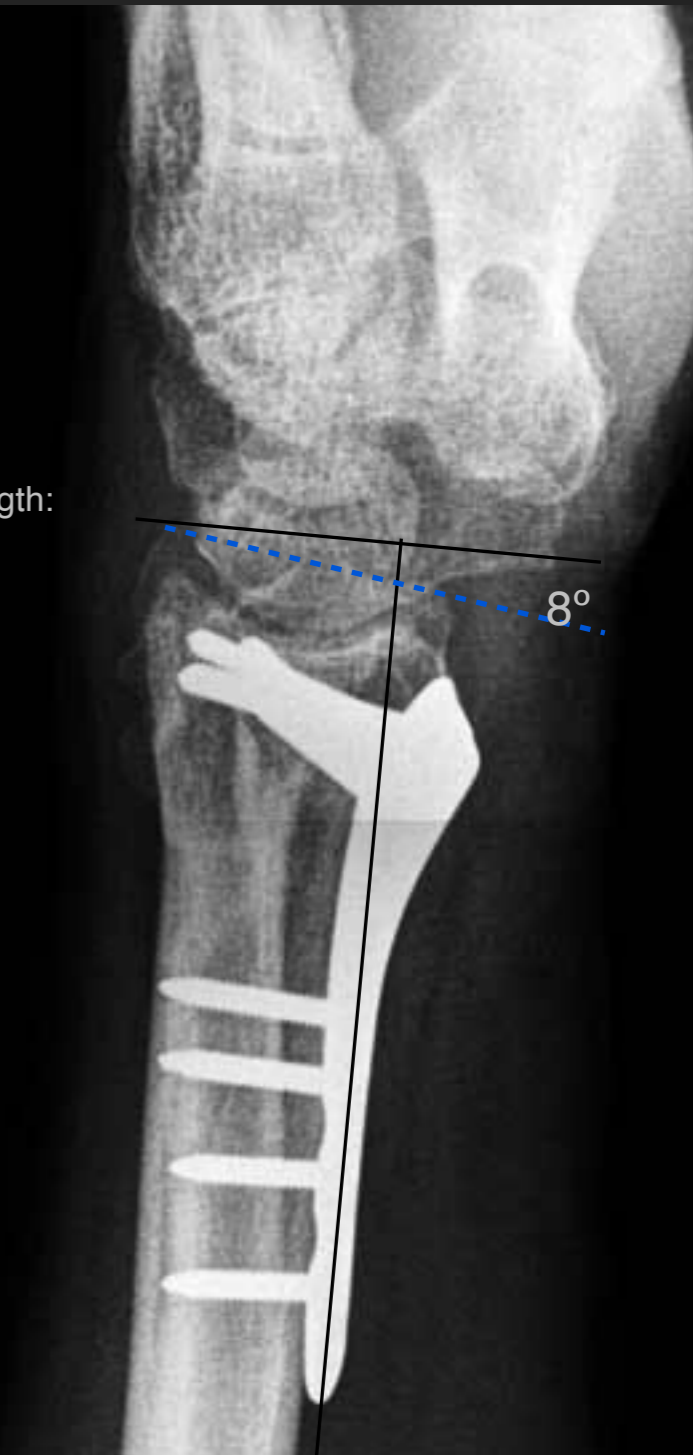
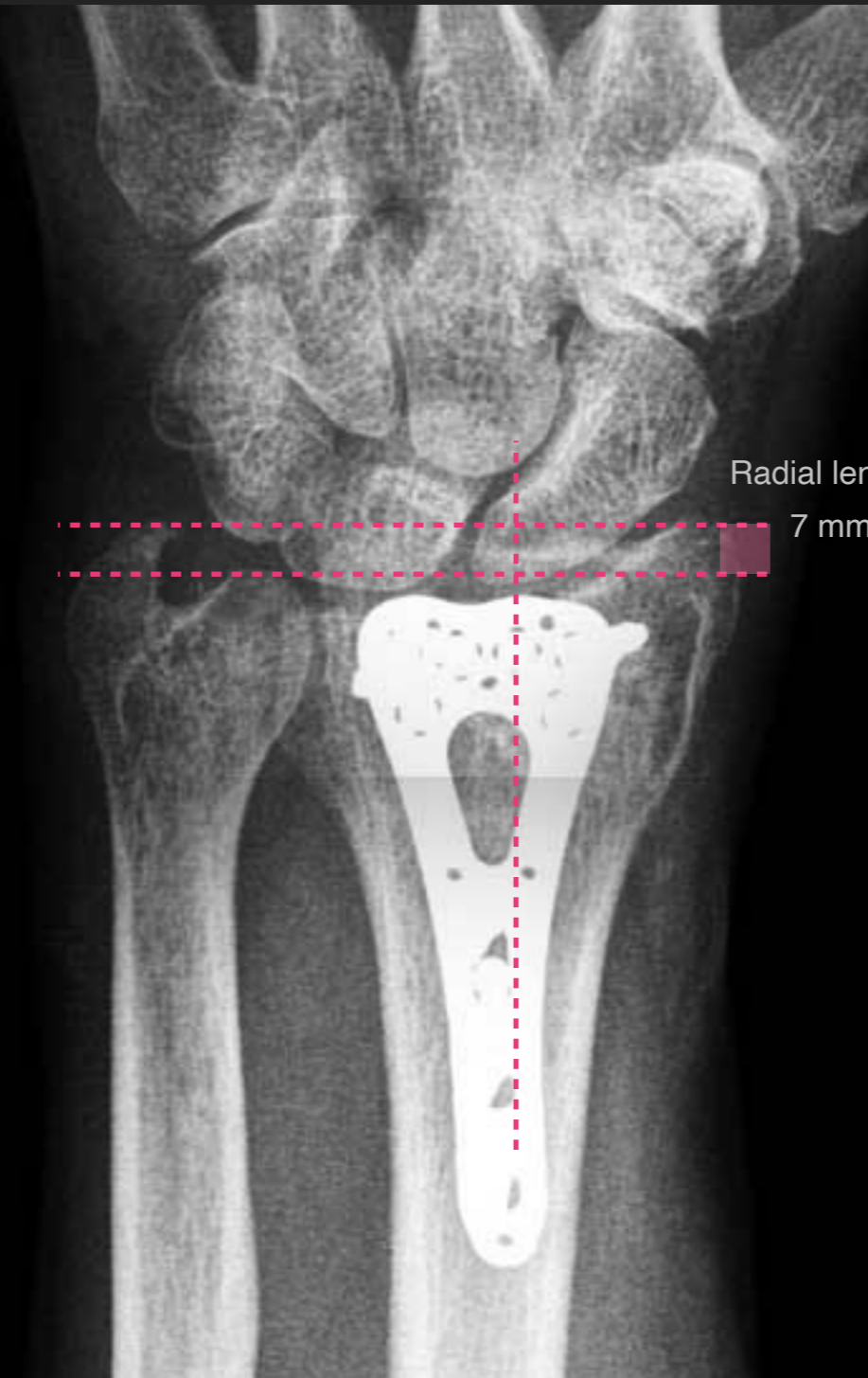
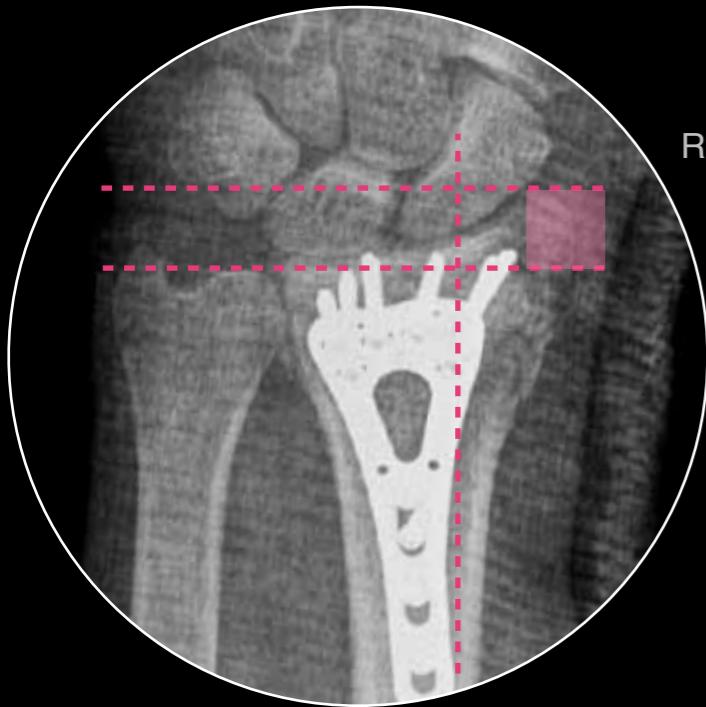
2w



0w

Here's a case where we see a nice restoration of volar tilt but note we have a defect here and we have a good function without tendon problems.

13w



Here it went on to healing. And notice we've lost length and we've lost the volar tilt. Notice the plate, the plate now becomes a little bit more prominent, and it is potentially a risk.

67w | Soong 2



251w | Flexor Tendon Rupture



21w after Implant removal | 32w after 2nd surgery | 283w after 1st surgery



We've lost length and we've lost the volar tilt. The plate now becomes a little bit more prominent. Flexor tendon rupture at 251 w.

**Which should our goal be?**  
**Neutral tilt?**  
**Volar tilt?**

Should this be the goal of whether or not we get a volar tilt or not?

# DISTAL RADIUS TILT AFTER VOLAR LOCKING PLATE MAKING USE OF THE RADIOLUCENT BONE CLAMP

\* Nicolas Galli, Federico Bertone, Rodrigo Sastre, Hugo Nuñez

(From 78 cases in the ICUC® App in October 2016)

The ICUC app has a collection of cases that starts from pre-op all the way to follow up with documentation: pre-op X-ray, CT scan and similarly post-op, immediate post op and then sequential X-rays and the operative technique is illustrated from start to finish.

ICUC Library

Reference Cases

Expert Opinions

Proximal Humerus



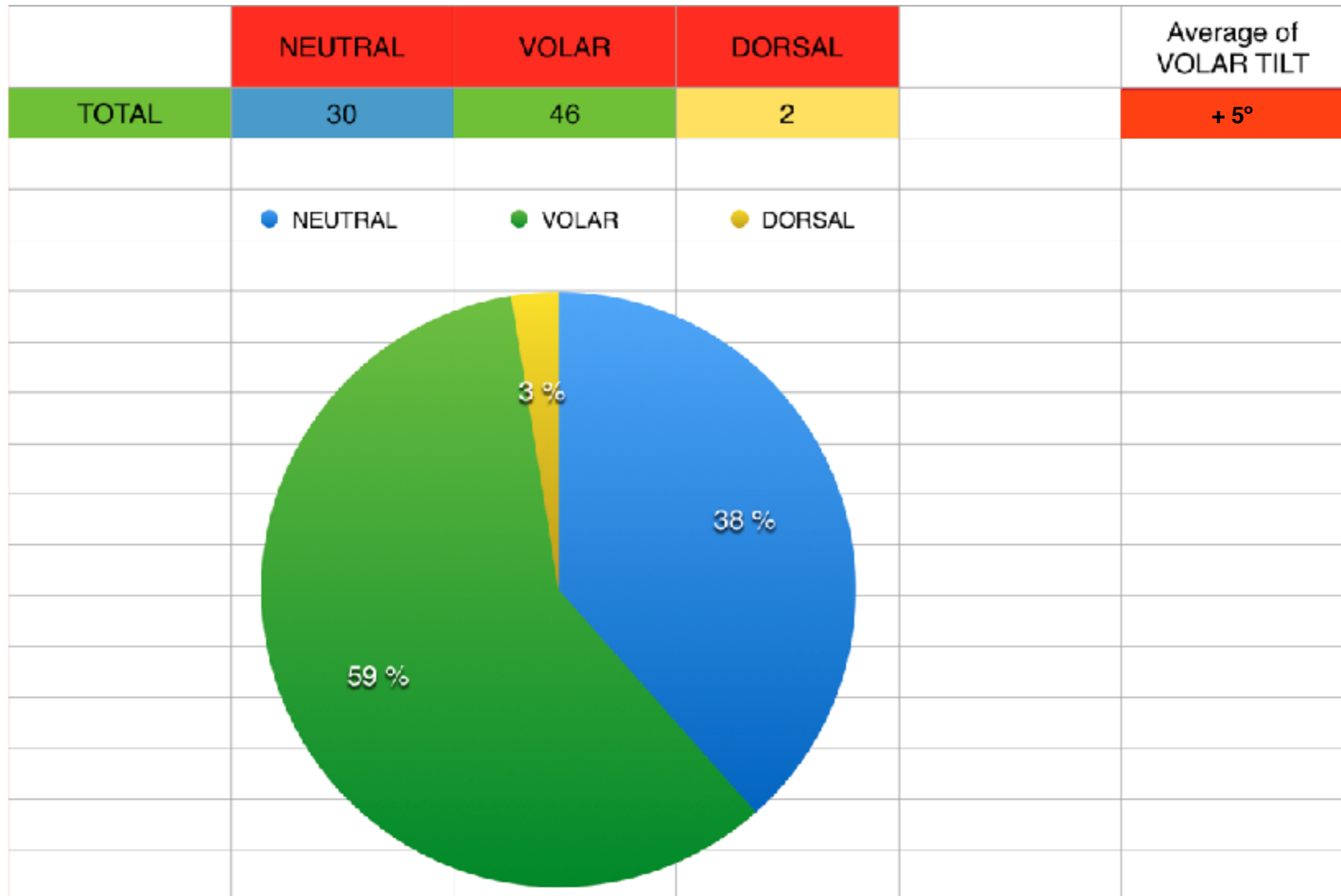
Humeral Shaft



Dorsal Displacement

Volar Displacement

Hand



In essence about 40% had a neutral a situation.  
About 60% restored some degree of volar tilt and very few dorsal tilt.



Dorsal Ulnar Corner

ULNAR CORNER					
	CASES ID	NEUTRAL	VOLAR TILT	DORSAL	DEGREES
	23-DU-113	1			0
	23-DU-204		1		12
	23-DU-272	1			0
	23-DU-351		1		10
	23-DU-557		1		6
	23-DU-595		1		8
	23-DU-619	1			0
	23-DU-745		1		9
	23-DU-764		1		7
	23-DU-958		1		13
	23-DU-126		1		6
	23-DU-212		1		9
	23-DU-318	1			0
	23-DU-328		1		7
	23-DU-417		1		8
	23-DU-668		1		7
	23-DU-720		1		7
	23-DU-779		1		9
	23-DU-968		1		7
<b>TOTAL</b>	<b>19</b>	<b>4</b>	<b>15</b>	<b>0</b>	
<b>AVERAGE DEGREE</b>					<b>7</b>

And this is the data set.





Dorsal Simple

SIMPLE					
	CASES ID	NEUTRAL	VOLAR TILT	DORSAL	DEGREES
	23-DS-087		1		9
	23-DS-143		1		8
	23-DS-223		1		5
	23-DS-372		1		9
	23-DS-481		1		11
	23-DS-700	1			0
	23-DS-832	1			0
	23-DS-481		1		9
<b>TOTAL</b>	<b>8</b>	<b>2</b>	<b>6</b>	<b>0</b>	
<b>AVERAGE DEGREE</b>					<b>6</b>



Dorsal Extra Articular

EXTRA ARTICULAR					
	CASES ID	NEUTRAL	VOLAR TILT	DORSAL	DEGREES
	23-DE-042		1		10
	23-DE-111	1			0
	23-DE-294		1		7
	23-DE-436	1			0
	23-DE-692		1		10
	23-DE-729		1		11
	23-DE-740	1			0
	23-DE-747	1			0
	23-DE-857	1			0
	23-DE-955		1		9
	23-DE-024		1		8
	23-DE-036	1			0
	23-DE-052		1		10
	23-DE-119			1	-9
	23-DE-229	1			0
	23-DE-333		1		8
	23-DE-485		1		14
	23-DE-486	1			0
	23-DE-524	1			0
	23-DE-538	1			0
	23-DE-754		1		8
	23-DE-956	1			0
	23-DE-985		1		7
<b>TOTAL</b>	<b>23</b>	<b>11</b>	<b>11</b>	<b>1</b>	
<b>AVERAGE DEGREE</b>					<b>4</b>



Dorsal Complex

COMPLEX					
	CASES ID	NEUTRAL	VOLAR TILT	DORSAL	DEGREES
	23-DC-006		1		12
	23-DC-025	1			0
	23-DC-221	1			0
	23-DC-256		1		15
	23-DC-550		1		21
	23-DC-613		1		15
	23-DC-654	1			0
	23-DC-679		1		8
	23-DC-689		1		14
	23-DC-707		1		10
	23-DC-850		1		10
	23-DC-904		1		9
	23-DC-019		1		13
	23-DC-236			1	-7
	23-DC-250		1		9
	23-DC-284		1		8
	23-DC-410	1			0
	23-DC-425	1			0
	23-DC-449	1			0
	23-DC-456	1			0
	23-DC-475	1			0
	23-DC-580		1		6
	23-DC-775		1		8
	23-DC-826	1			0
	23-DC-889	1			0
	23-DC-954	1			0
<b>TOTAL</b>	<b>26</b>	11	14	1	
<b>AVERAGE DEGREE</b>					<b>6</b>

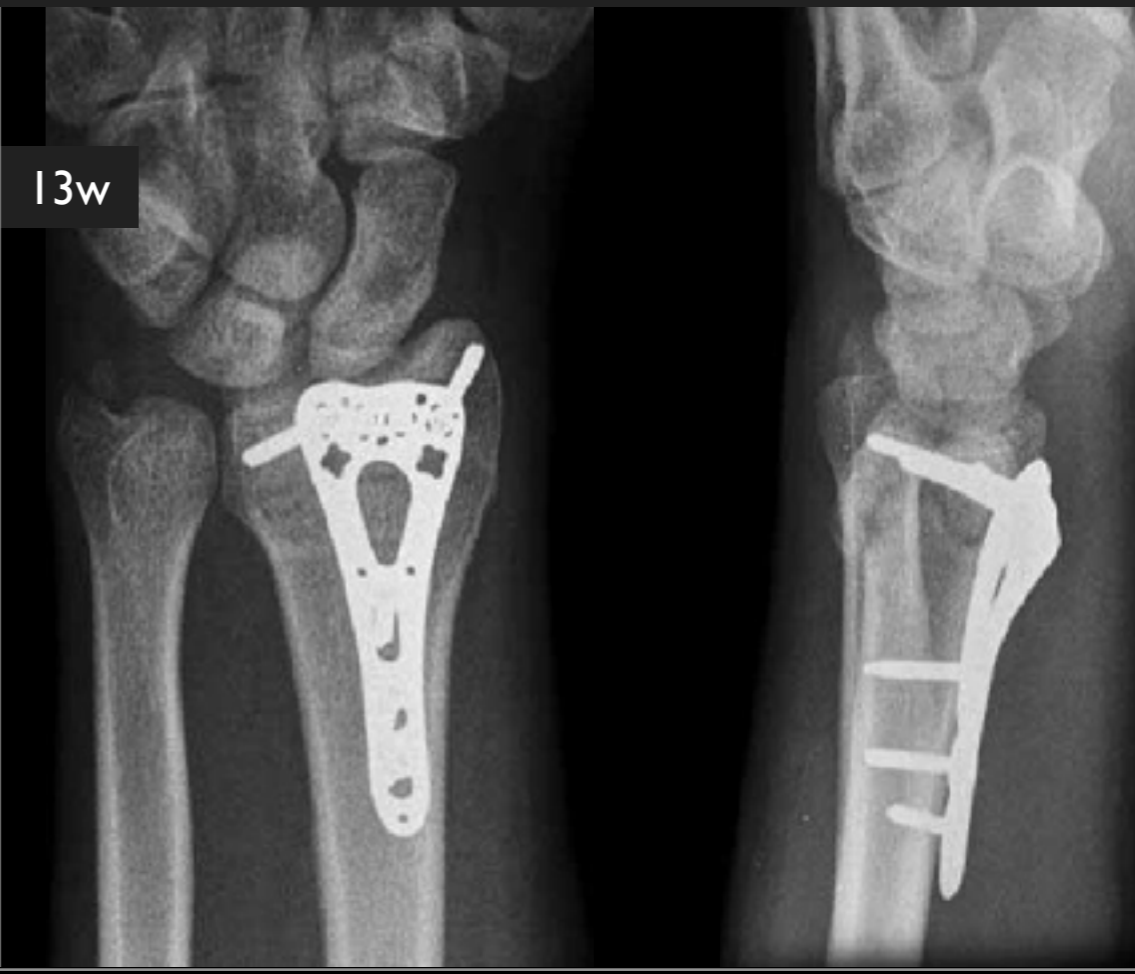
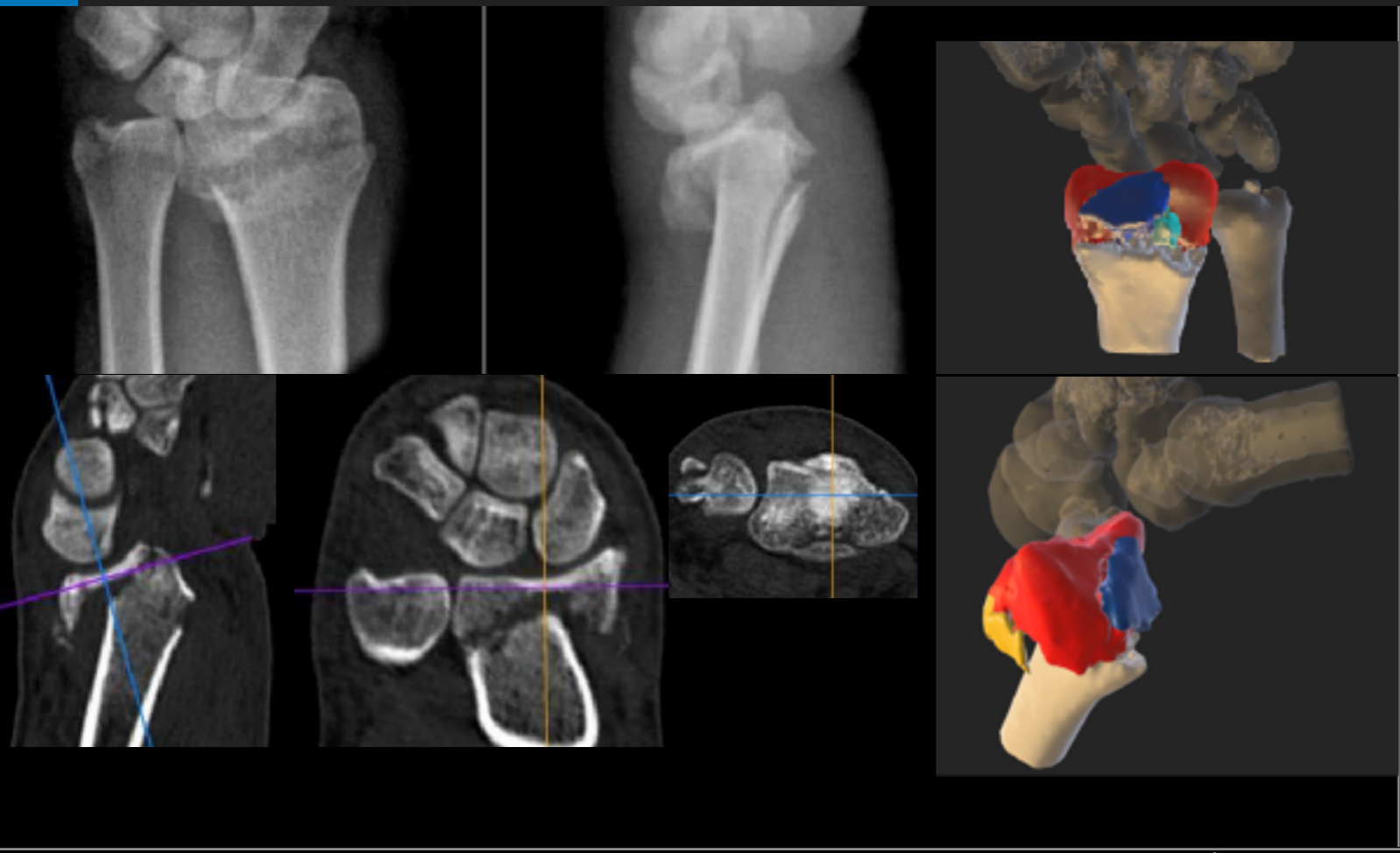


Dorsal Central Impaction

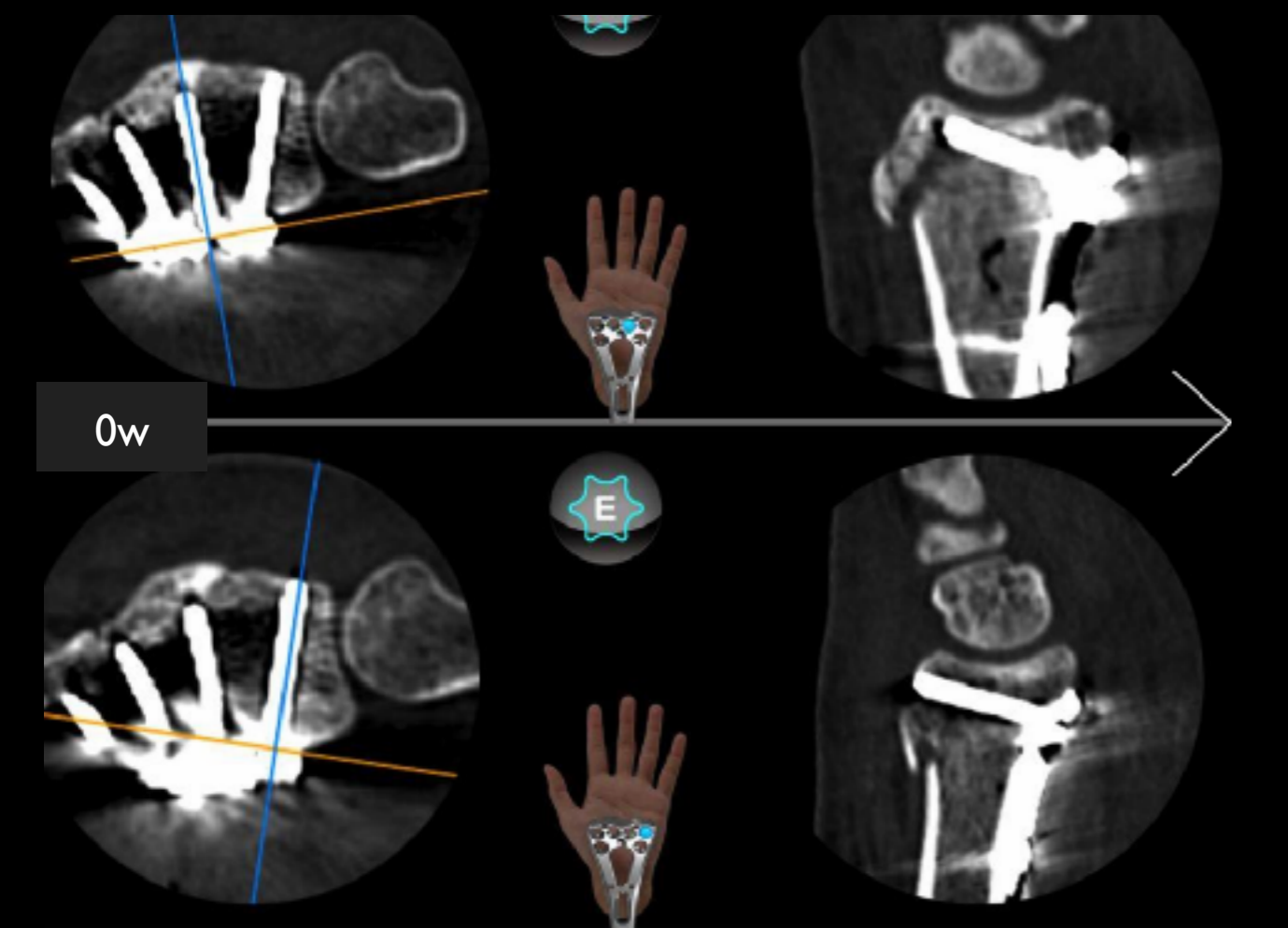
CENTRAL IMPACTATION					
	CASES ID	NEUTRAL	VOLAR TILT	DORSAL	DEGREES
	23-DI-634	1			0
	23-DI-682	1			0
<b>TOTAL</b>	<b>2</b>	<b>2</b>	<b>0</b>	<b>0</b>	
<b>AVERAGE DEGREE</b>					<b>0</b>

Every case was documented, is accesible at ICUC App (for iPad) or icuc.net.

**The 2 cases (out of 78) found with residual dorsal tilt are shown:**



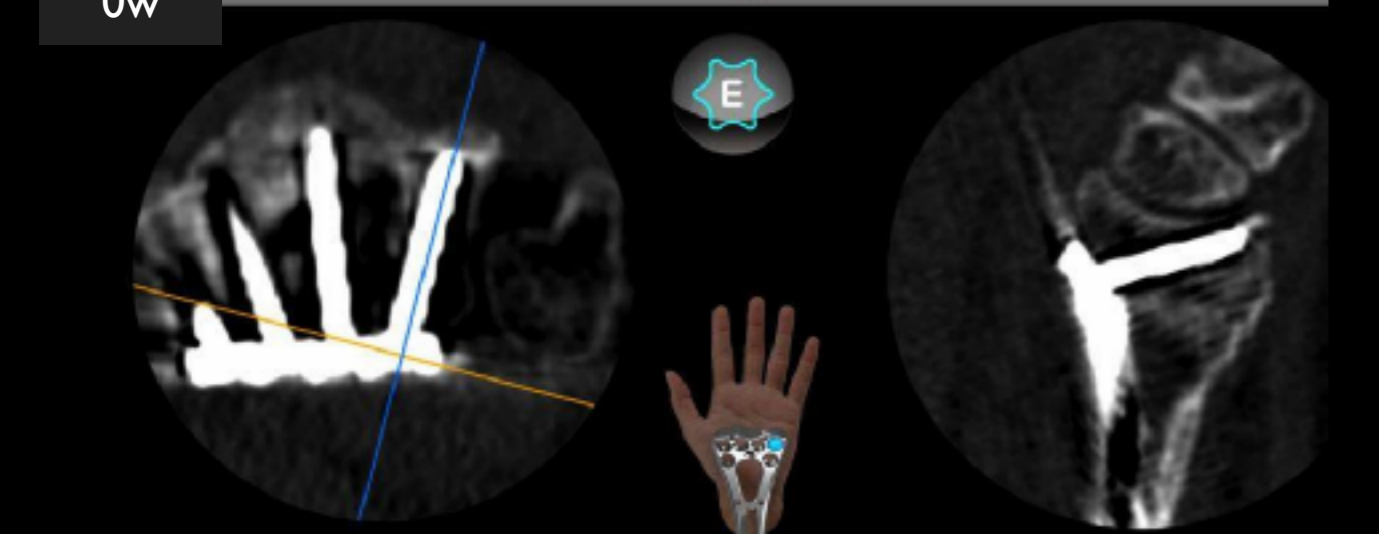
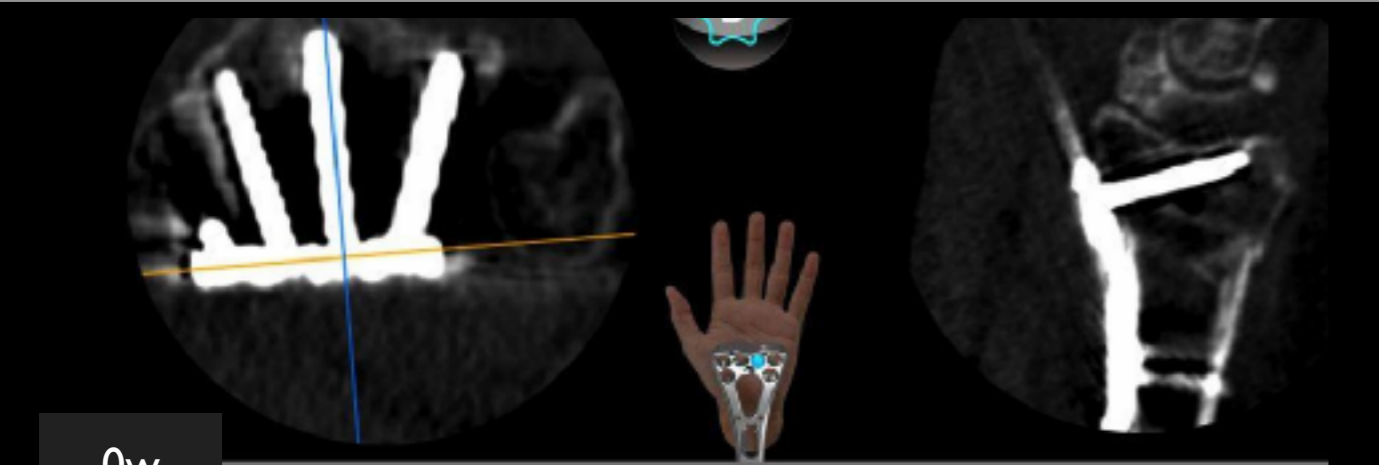
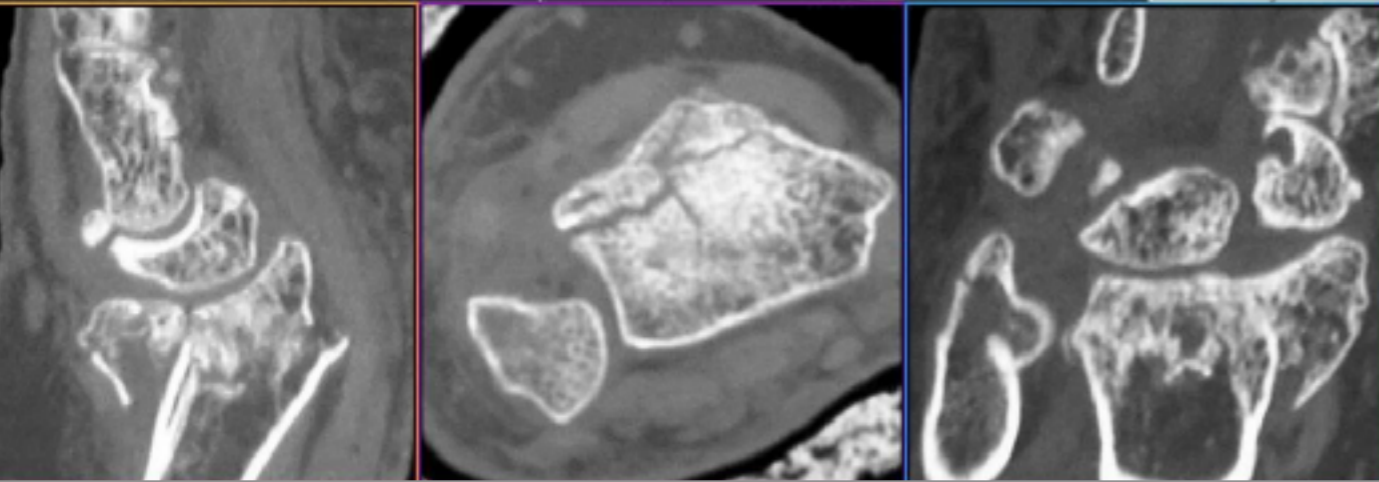
13w



0w



8w



“Correction to a volar tilt of  $11^\circ$  **(+/-)  $5^\circ$**  has been shown to restore biomechanical function of the wrist.”

Bernstein 2016

## VOLAR TILT ANGLE INDEFINITION. **(+/- $5^\circ$ )**

**A.** DIFFERENT INTRA-OPERATIVE C-ARM  
IMAGES OF THE SAME 3D SITUATION.  
(DIFFERENT X-RAY BEAM POSITIONS)

**B.** INTER-OBSERVER VARIATION ON THE  
SAME X-RAY IMAGE

It turns out, however, that it's not always so perfect because it's not always so easy to demonstrate the true radiographic measurement.



**A.** DIFFERENT INTRA-OPERATIVE C-ARM  
IMAGES OF THE SAME 3D SITUATION.  
(DIFFERENT X-RAY BEAM POSITIONS)



If we look at image here's a what is recorded as a 13°, but you twist the forearm a little bit and now it's 7°, turn it back 2°, etc.

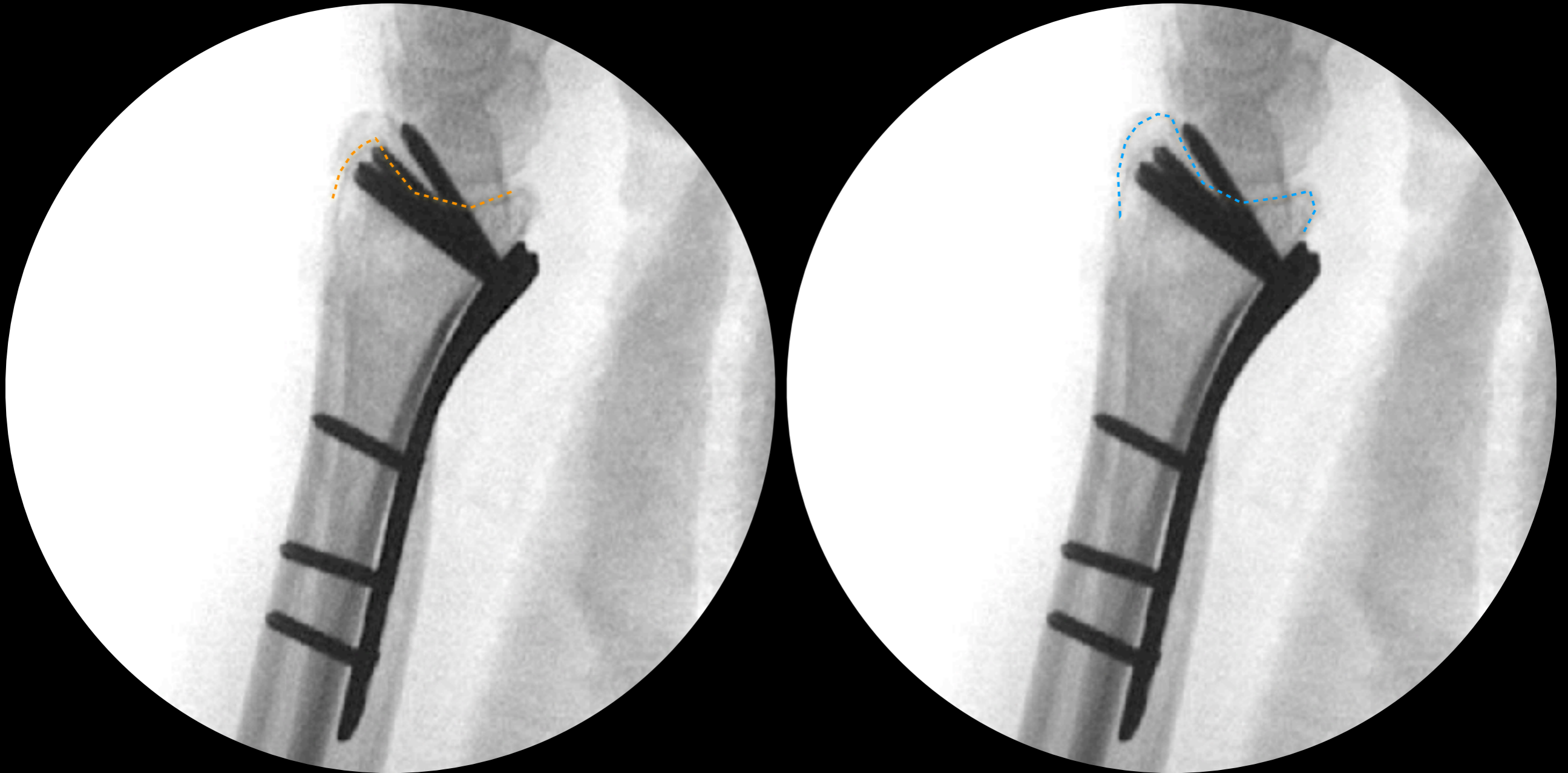
**A.** DIFFERENT INTRA-OPERATIVE C-ARM  
IMAGES OF THE SAME 3D SITUATION.  
(DIFFERENT X-RAY BEAM POSITIONS)



## VOLAR TILT ANGLE INDEFINITION

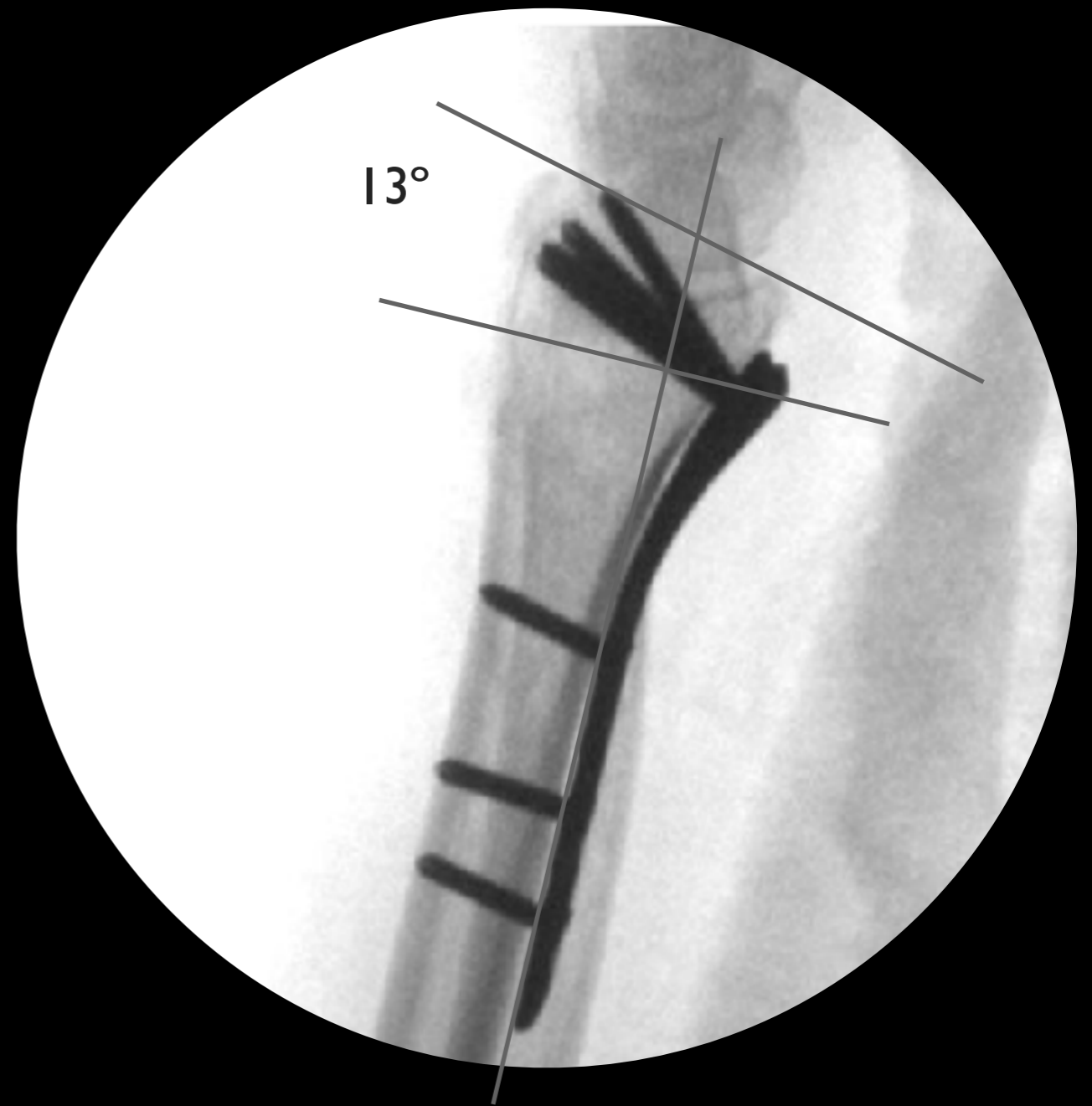
- A.** DIFFERENT INTRA-OPERATIVE C-ARM IMAGES OF THE SAME 3D SITUATION.  
(DIFFERENT X-RAY BEAM POSITIONS)
  
- B.** INTER-OBSERVER VARIATION ON THE SAME X-RAY IMAGE

## B. INTER-OBSERVER VARIATION ON THE SAME X-RAY IMAGE



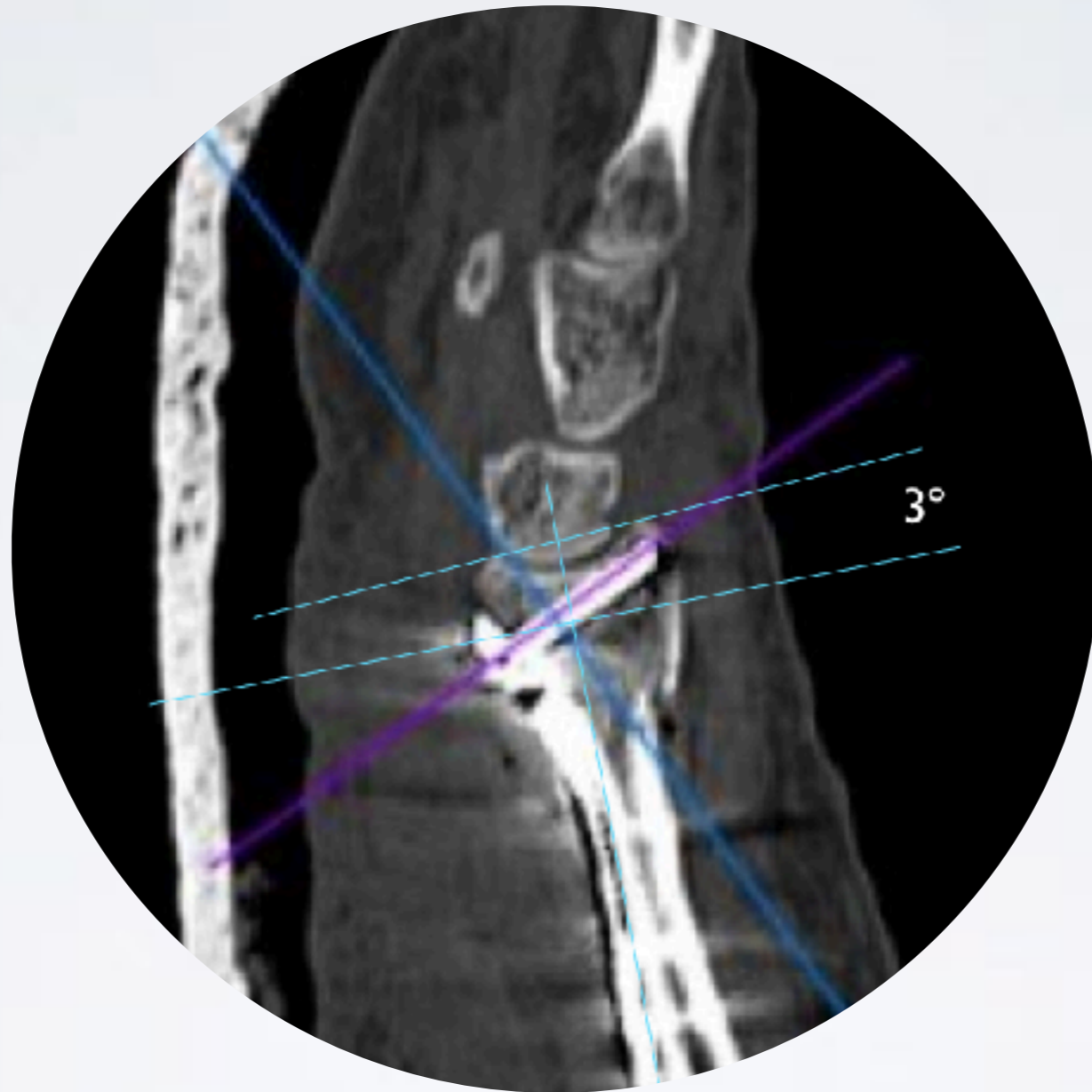
Any study looking at two different individuals or three, may come up with different measurements.

## B. INTER-OBSERVER VARIATION ON THE SAME X-RAY IMAGE



Any study looking at two different individuals or three, may come up with different measurements.

## VOLAR TILT ANGLE AS MEASURED IN ONE CT IMAGE.



VOLAR TILT  
ANGLE  
INDEFINITION.  
**(+/- 5°)**

Can we get a better sense with a CT scan? Perhaps.

One aspect I think is beautifully shown in this series is that the interpretation of the X-ray or even the CT is crucial. And a few standard marks have to be defined in order to avoid inter-observer discrepancies.

So, is it worthwhile to restore the volar tilt? We believe it is or at least to neutral. We believe that it's more preferable to make certain that you have a better wrist function, better radio-ulnar joint function.

If you restore the volar tilt with a large defect, do you have a risk of late collapse? If you have a major defect one has to consider that. So even if you place the screws in a nice subchondral bone in an osteoporotic patient over the large metaphyseal defender this may settle.

If you do restore and maintain the volar tilt you certainly minimize risk of tendon problems with the plate being too prominent.

However loss of position can put the implant in a more prominent position.

So, our goal we believe to go at least the neutral but preferably the volar tilt.

Having reviewed a large number of cases in the **ICUC** data bank looking specifically at the relevance of reduction in normal anatomic volar tilt, we were able to see that patients ideally had enhanced function if the end of the radius articular surface was at least neutral but no in further dorsal position.

We can't say for sure whether or not the reduction would improve the function if the volar tilt was restored to the normal 10 to 14 degrees on the basis of evaluation of patients outcome function pain and overall patient satisfaction, however it's clear that once you increase the extension of the articular surface that affects the way the carpal interaction goes with the capitate and lunate axis and therefore I think the ability with the volar plate is to reduce this volar tilt at least to neutral and one should strive for that and not accept anything less than neutral.



## Further readings

Orthopedics. 2013 Dec;36(12):918-21.

### **Leveraging the plate: reliably restoring volar tilt of distal radius fractures.**

McLawhorn AS, Cody EA, Kitay A, Goldwyn EM, Golant A, Quach T.

### **Indications for Reduction in Distal Radius Fractures**

David L. Nelson, MD

eRADIUS 12/1999



### **Operative Technique: Use of a Volar Plate for Restoration of Volar Tilt Intra-operatively**

Bernstein j, Gray B. June 2016

Original Communications

### **Volar fixation for dorsally displaced fractures of the distal radius: A preliminary report \* \*\***

Jorge L. Orbay, MD, Diego L. Fernandez, MD

## INTRA-OPERATIVE CORRECTION OF VOLAR TILT OF DISTAL RADIUS FRACTURES USING VOLAR LOCKING PLATE AS REDUCTION TOOL: REVIEW OF 24 CASES

Sechachalam Sreedharan

2018 Jun;43(6):523-528. doi: 10.1016/j.jhsa.2018.02.011. Epub 2018 Mar 17.

### Lift-Off Screw Results in Accurate Sagittal Tilt Correction in a Distal Radius Fracture Model

[Austin J Roebke](#) <sup>1</sup>, [Adam S Martin](#) <sup>1</sup>, [Zubair Sarmast](#) <sup>1</sup>, [Erica Fisk](#) <sup>1</sup>, [Kanu S Goyal](#) <sup>2</sup>

Affiliations expand PMID: 29559327 DOI: [10.1016/j.jhsa.2018.02.011](https://doi.org/10.1016/j.jhsa.2018.02.011)

[J Wrist Surg.](#) 2019 Apr; 8(2): 118–123.

Published online 2018 Oct 3. doi: [10.1055/s-0038-1673407](https://doi.org/10.1055/s-0038-1673407)

PMCID: PMC6443535

PMID: [30941251](https://pubmed.ncbi.nlm.nih.gov/30941251/)

### Dorsal Lunate Facet Fracture Reduction Using a Bone Reduction Forceps

[Jonathan Lans](#), MD,<sup>1</sup> [Josefina Alvarez](#), MD,<sup>2</sup> [Amir R. Kachooei](#), MD,<sup>3</sup> [Sezai Ozkan](#), MD,<sup>1</sup> and [Jesse B. Jupiter](#), MD<sup>1</sup>



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meaning the full set of data used by the authors is accessible through our platform.