EVALUATION OF THE POSITION OF SUBCHONDRAL SCREWS USED IN DISTAL RADIUS FRACTURE PLATES

DANIELLE TIEMI SIMÃO[1], FERNANDA DO CARMO IWASE[1], FERNANDO MUNHOZ MOYA[1], MARCOS HIDEYO SAKAKI[2], ARNALDO VALDIR ZUMIOTTI[3]

SUMMARY

The distal radius fractures are the most common fractures on upper limbs. They are classified as stable and unstable. The unstable ones require surgical treatment. However, literature does not define the best fixation method, but, today, a trend is seen towards using the locked screw plate. An important technical aspect is the distal screws positioning in the subchondral bone, with an adequate support. Fluoroscopy and radiographs are used to evaluate screws position, but there are usually doubts about the accurate positioning. The objectives of this study are to evaluate if it is possible to determine precisely the screw positioning by means of radiographs and if the previous experience of the investigator may improve the results. Cadavers' fists were used in this study. Three screws were introduced to each radius next to the distal joint surface. Specialized hand surgeons and not specialized physicians evaluated the X-ray images, at classic and angled planes, to provide the accurate positioning of each screw, intra or extra joint. The accuracy rate was submitted to statistical analysis. The X-ray images were proven to be a good evaluation method. The X-ray images captured at angled plane resulted in no improvements in the analysis of the screws positioning. Neither did the evaluator experience influence the results.

Keywords: *Radius fractures; Fracture fixation internal; Bone plates*.

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INTRODUCTION

Distal radius fractures are the most common ones on upper limbs (74.5% of forearm fractures) in adults[1]. They occur in younger populations, being associated to high-energy trauma such as motorcycle and car accidents, high falls, and sports-related accidents. However, the older population is the one most commonly affected due to bone weakening process resulting mainly from osteoporosis, where fractures result from low-energy trauma, usually in falls at home.

Distal radius fractures may be categorized as stable and unstable, being characterized by: early dorsal comminution > 50% from the dorsal to palmar region. palmar metaphyseal comminution, early dorsal bent > 20°, fragment translation > 1.0 cm, early shortening > 0.5 cm, intra-joint rupture, ulnar fracture associated to severe osteoporosis[2]. Stable fractures are easier to treat and usually evolve well with non-surgical methods. As for unstable fractures, these require surgical treatment, with the methods most commonly employed in clinical practice being fixation with Kirschner's wires, external fixators and plates and screws, either the traditional kind or the blocked ones (threaded to the plate).

Although there is no definition in literature about what fixation method is the best one for distal radius fractures, today, an increasing trend exists towards using plates with blocked nails, either volar or octagonal[3,4] (dorsal and radial), because these provide better stability to osteoporotic bones[5-13]. One important technical aspect for avoiding secondary reduction loss is the appropriate positioning of distal screws on these plates, which should be maintained next to the subchondral bone, where bone density is increased, providing a more appropriate support[14]. A disadvantage found with blocked screws is that they have a pre-determined direction by the thread present on the plate, which often makes its correct positioning difficult, in addition to its potential to wrongly penetrate into joint space. These screws position assessment is made with the aid of radioscopy and ordinary X-ray imaging, but we observe that its right position is frequently questioned.

Some recent studies propose the use of tangential planes to the distal radius joint surface, so as to neutralize radial and volar bending, making the visualization of joint surface boundaries easier and helping on identifying the right position of subchondral screws.

On the study published on *Injury* journal, in December/2001[15], two new X-ray planes have been proposed: an anteroposterior (AP) tangential, and a lateral tangential one.

At tangential AP plane, wrist was positioned at maximum pronation and lifted to form a 10 to 15-degree angle with the surgical table. At lateral tangential plane, the wrist was positioned at medium-pronation and lifted to form a 20 to 25-degree angle with the surgical table.

These angles were based on natural volar and radial joint bends (respectively) of the distal radius surface in adults.

Thus, joint surfaces could be in parallel to the X-ray beam and, according to the results of the mentioned study, even enabled a more distal and safe positioning of the plate and screws.

The objectives of this study are described below:

- To check the possibility of accurately determining by means of X-ray images, the appropriate position of subchondral screws, either intra or extra-jointly.
- To determine the contribution of angled planes (tangential) for the appropriate positioning of subchondral screws.
- To check the existence of any orthopaedic surgeon experience's bias on the assessment of screws positioning at X-ray images captured in this study.

Study developed at the Institute of Orthopaedics and Traumatology, HC-FMUSP – Discipline of Trauma / Discipline of Hand and Microsurgery
Correspondences to: Rua Manoel da Nóbrega, 803 – Diadema – Centro – SP - Brasil – CEP: 09910-720 – E-mail: danielletiemi@yahoo.com.br

1. Resident Doctor, Institute of Orthopaedics and Traumatology, HC-FMUSP
2. Assistant Doctor, Institute of Orthopaedics and Traumatology, HC-FMUSP
3. Chairman of the Department of Orthopaedics and Traumatology – FMUSP

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MATERIALS AND METHODS

Seven anatomical pieces of human wrists were used, which were removed from cadavers sourced by SVO-HCFMUSP, upon previously regulated authorization (and complied with when taking the pieces, activity performed by the laboratory of arthroscopy – IOT-FMUSP). The pieces were identified with random numbers ranging from 1 to 7.

For screws introduction, each piece was dissected according to Henry's volar path for reaching distal radius, and a small volar incision was provided cross-sectionally to radiocarpal joint, in order to visualize the joint surface appropriately.

Each radius received three screws, which were inserted next to the distal joint surface, similarly to screws used on locked screw plates. The distribution of the screws on each piece was provided by sorting, following the specifications below:

- all screws should be positioned at the subchondral bone: 4 pieces
- one screw entering into the joint: 2 pieces
- two screws entering into the joint: 1 piece

Each piece was subsequently sutured intending to hide screws' position.

We submitted each piece to traditional and angled (tangential) AP and lateral planes.

For tangential planes, supports made of radio transparent material were used, with fixed angles to the X-ray instrument table: 15° for tangential AP planes and 25° for tangential lateral plane.

X-ray images were captured on only one X-ray instrument, under the supervision of the same technician and the same orthopaedic doctor.

On X-ray images, the pieces were identified according to numbers and a numeric ID was assigned to each screw at AP planes, from 1 to 3 (radial to ulnar).

X-ray images were assessed by 21 individuals: 7 resident doctors (3rd grade) in orthopaedics, 7 assistant doctors of trauma discipline, and 7 assistant doctors of the hand and microsurgery discipline, all of them working at the Institute of Orthopaedics and Traumatology, HC- FMUSP.

The individuals filled in a previously established protocol (Annex 1), assigning a number to each piece corresponding to the screw(s) they believed was (were) at an intra-joint position, if existent.

ANNEX 1

Participant Nr.:_____

Group: ( ) Assist. Hand ( ) Assist Trauma ( ) R3

Planes: ( )T ( )A

Check on the number of the screw(s) at intra-joint position, if existent, in each anatomical piece.

Piece 01 ( )11 ( )12 ( )13
Piece 02 ( )21 ( )22 ( )23
Piece 03 ( )31 ( )32 ( )33
Piece 04 ( )41 ( )42 ( )43
Piece 05 ( )51 ( )52 ( )53
Piece 06 ( )61 ( )62 ( )63
Piece 07 ( )71 ( )72 ( )73

Date:__/__/__

Author responsible for Test application:

_____

Each participant doctor assessed a total of 28 X-ray images: 7 pieces submitted to traditional AP and L planes, and 7 pieces submitted to angled AP and L planes.

All doctors were blinded to the correct position of the screws and to colleagues' opinions. They also were blinded to the fact that those were the same 7 pieces submitted to non-conventional (angled) X-ray imaging.

The statistical analysis was provided to studied samples, presenting the following parameters: mean, median, standard deviation, mean standard error, minimum value, maximum value, and number of findings.

The following outcomes were assessed:

- Percentage of right answers of each participant (traditional and angled planes)
- Percentage of right answers (average) for each group of professionals (traditional and angled planes)
- Comparisons between right answers percentage and traditional vs. angled planes for each participant and each group of professionals (in order to check if angled planes helped to achieve a certain level of right answers)
- Comparison between right answers percentage among the groups for traditional and angled planes (in order to check if the investigator experience influenced the level of right answers)

For the comparison between traditional vs. angled planes for each participant, the two-tailed Wilcoxon's test was employed. In the comparison of the three groups, for each plane assessed, the Kruskall-Wallis' test was employed, and supplemented by Dunn's post-test for differentiation of professional groups, pair by pair.

In all cases, a significance level of 5% ($\alpha = 0.05$) was adopted.

RESULTS

All results are exhibited on the tables (Tables 1 to 4).

According to the results shown on the tables, in none of the data assessed (comparative) statistically significant results were achieved.

Table 1 – *Samples and descriptive statistics parameters for coincidence rates (average of three measurements) data on X-ray evaluations, in both kinds of planes, by the individuals of each group (right answers rate for each participant).*

	ATC	AMC	R3C	ATA	AMA	R3A
	80.95	85.71	90.48	71.43	80.95	80.95
	61.90	95.24	71.43	71.43	80.95	76.19
	80.95	80.95	90.48	61.90	85.71	85.71
	76.19	90.48	90.48	90.48	80.95	71.43
	61.90	85.71	76.19	80.95	80.95	76.19
	90.48	80.95	61.90	76.19	80.95	80.95
	90.48	76.19	76.19	80.95	71.42	80.95
Mean	77.550	85.033	79.593	76.190	80.269	78.910
Median	80.950	85.710	76.190	76.190	80.950	80.950
SD	11.897	6.407	11.243	9.120	4.286	4.645
MSE	4.497	2.422	4.249	3.447	1.620	1.756
Minimum	61.90	76.19	61.90	61.90	71.42	71.43
Maximum	90.48	95.24	90.48	90.48	85.71	85.71
n	7	7	7	7	7	7

SD – standard deviation – MSE – mean standard error – n – number of observations in the sample
ATC – Assistant doctors of the traumatology group – traditional planes.
ATA – Assistant doctors of the traumatology group – angled planes.
AMC – Assistant doctors of the hand-specialized group – traditional planes
AMA – Assistant doctors of the hand-specialized group – angled planes.
R3C – Resident doctors on the 3rd grade of orthopaedics course – traditional planes.
R3A – Resident doctors on the 3rd grade of orthopaedics course – angled planes.

Table 2 – Comparison of kinds of planes for each group of investigators.

comparison	p =
ATCxATA	0.9375
AMCxAMA	0.0938
R3CxR3A	0.6875

Wilcoxon's two-tailed test.

Table 3 – Comparison of the investigators groups for traditional planes.

comparison	p
ATCxAMCxR3C	p = 0.4651
ATCxAMC	p > 0.05
ATCxR3C	p > 0.05
AMCxR3C	p > 0.05

Kruskall-Wallis' test with Dunn's post-test

Table 4 – Comparison of investigators groups for angled planes.

comparison	p
ATAxAMAxR3A	p = 0.5185
ATAxAMA	p > 0.05
ATAxR3A	p > 0.05
AMAxR3A	p > 0.05

Kruskall-Wallis' test with Dunn's post-test

DISCUSSION

As oppositely to expected, based on previous studies mentioned on the introduction herein (15), angled planes (tangential to the distal radial joint surface) did not make the identification of subchondral screws on distal radius easier, not improving nor worsening the percentage of right answers.

By analyzing the individual results of each participant and for each piece, we found that, in general, most of the investigators tended to assign a higher number of screws (as intra-joint) to angled planes than to traditional planes, for the same pieces. Therefore, the number of right answers was reduced, because the investigators tended to overestimate the number of intra-joint screws with angled planes.

These results suggest that angled incidences could contribute to a larger safety margin for the correct positioning of subchondral screws.

Sensitivity and specificity were compared on traditional and angled planes, and we found that traditional planes show better sensitivity and specificity, again oppositely to what was expected (sensitivity was expected to increase with angled planes).

In this study, we intended to assess a data not found in previous studies, which is the influence of the orthopaedic doctor's experience on the result of X-ray images assessment.

We expected that the more experienced and/ or expert an investigator was, the higher would be the number of right answers, since the right assessment of X-ray images supposedly is something acquired with continuous professional practice.

This study has proven that an investigator's experience does not statistically change the results.

CONCLUSION

Upon results analysis, we can conclude that:

X-ray imaging is still a good test to assess subchondral screws' per operative and postoperative positioning (average number of right answers above 76% for the three groups of professionals).

Angled planes (tangential to radial joint surface) did not improve or worsen the rate of right answers.

Investigator's experience did not influence the results.

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