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The Quest for Accurate Patient-Specific Guides for Distal Radius Osteotomy Surgery

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INTRODUCTION

The Distal Radius Osteotomy is a very common procedure for correcting malunions. In order to improve correction accuracy, patient specific surgical guides were manufactured using 3D printing and 3D surgical planning (Figure 1). The accuracy of patient-specific guides was evaluated by a comparison between 3D planned correction, correction., correction made using the patient-specific guide and the correction using the traditional technique.

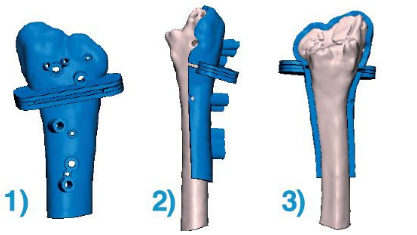

Figure 1: Patient-specific cutting guide. 1) Front view patient-specific cutting guide; 2) Lateral view, patient-specific guide positioned on bone; 3) posterior view, patient-specific guide positioned on bone.

MATERIALS AND METHODS

CT images of both upper limbs of a female patient, with a malunion in her left radis, were obtained and 3D recontructed with Minics Medical software. The 3D model was used for planning the correction osteotomy and posteriorly a patient-specific guide was created using 3-matic Medical .

Figure 2: Polyurethane model of the wrist with malunion

3D printing in ABS was used to obtain a physical model of the malunited distal radius and ulna. This was then used as a mold for 24 polyurethane bones as shown in the Figure 2. A protocol for evaluating the accuracy of the guides was designed, where the 24 polyurethane models were corrected, 12 of them using patient-specific guide and the remaining 12 using the traditional technique (Figure 3). After correcting, all samples were 3D scanned for virtual measurements. For a significant comparison three anatomic values were measured on each sample and comapred to the planned correction, those were: radial angle, radial shortening, radial displacement (Figure 4).

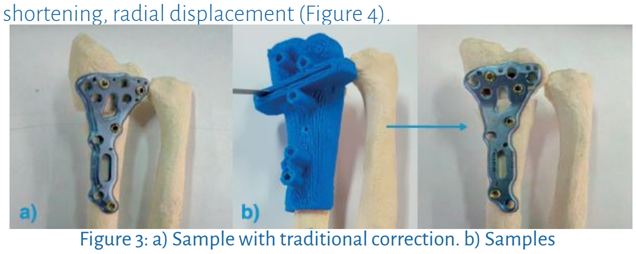

Figure 3: a) Sample with traditional correction. b) Samples with correction using the patient-specific guides

In order to reduce results bias, samples were measured by two blind observers. The resulting measurements were statistically analyzed by averages and standard deviations, which were compared between the planned correction and the correction obtained by both traditional and patient-specific guide techniques. (Figure 5)

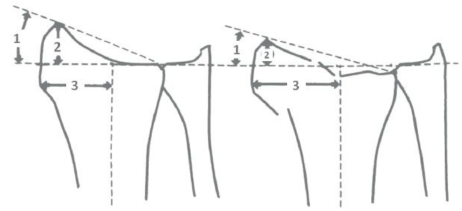

Figure 4: AP view, 1) Radial angle, 2) Radial shortening, 3) Radial displacement. Taken from De la Cruz Fernandez, M.J.S. Fracturas distales de radio: clasificacion, tratamiento conservador. Rev. Esp. Cir. Orthop. Traumatol. 46, 141-154 (2008).

RESULTS

Table 1. Measurements for traditional and patient-specific guide techniques.

	Radial Angle		Radial Shortening		Radial Displacement	
Technique	Guide	Traditional	Guide	Traditional	Guide	Traditional
Average	29,52	38,36	11,80	13,64	12,69	11,72
Standard deviation	3,16	4,62	1,33	1,76	1,049	1,56
Planned Correction	29,48		11,91		12,8	
Deviation from Planned	0,04	8,88	0,11	1,73	0,11	1,08
Percentage of planned	100%	70%	99%	85%	99%	92%

Table 1 shows the final results for each technique, compared to the planned correction. The most representative values are the "Precentage of Planned", the highest accuracy was found for the radial angle with the guided method. The highest variability across all dimensions studied was the radial angle. Similar accuracies were observed for the other dimensions, where the highest accuracy was obtained with the guided technique.

Figure 5: Front view from the comparison between planned correction, traditional technique and patient-specific guide use.

CONCLUSIONS

A good anatomic correction is critical in obtaining good patient outcomes for distal radius malunions, The use of 3D planning, and comparison to mirror of the healthy contralateral limb is a very good way to obtain the patient's basic dimensions. Measuring these dimensions before and after a correction is a good means of assessing the degree of correction obtained. The higher standard deviations found using the standard porcedure suggests that the use of the patient-specific guides allows for more repeatable results. The higher "Percentage of Planned" values founs in the use of the guides suggest a more accurate surgery. An in vivo study to corroborate the findings is recommended to show that the increased precision and accuracy will translate to shorter surgical times, faster learning curves and better patient outcomes.