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Beatriz Gonçalves da Silva

Fratura Distal do Rádio: é mesmo necessário restaurar a anatomia? /

Distal radius fractures – how important is it to restore anatomy?

Março, 2022

FMUP

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Eu, Beatriz Gonçalves da Silva, abaixo assinado, nº mecanográfico 201502959, estudante do 6º ano do Ciclo de Estudos Integrado em Medicina, na Faculdade de Medicina da Universidade do Porto, declaro ter atuado com absoluta integridade na elaboração deste projeto de opção.

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DESIGNAÇÃO DA ÁREA DO PROJECTO

Medicina Clínica

TÍTULO DISSERTAÇÃO/MONOGRAFIA (riscar o que não interessa)

Distal radius fractures – how important is it to restore anatomy?

ORIENTADOR

João Manuel da Costa Ferreira Torres

COORDINADOR (se aplicável)

ASSINALE APENAS UMA DAS OPÇÕES:

É AUTORIZADA A REPRODUÇÃO INTEGRAL DESTA TRABALHO APENAS PARA EFEITOS DE INVESTIGAÇÃO, MEDIANTE DECLARAÇÃO ESCRITA DO INTERESSADO, QUE A TAL SE COMPROMETE.	☐
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Faculdade de Medicina da Universidade do Porto, 25 / 03 / 2022

Assinatura conforme cartão de identificação:

Beatriz Silva

Dedicatória

À minha família: aos meus pais, Maria Luísa e António, que sempre permitiram que traçasse o meu próprio caminho, estando sempre do meu lado. Obrigada por me ensinarem o valor do trabalho e da integridade. Aos meus irmãos, André e Jorge, que cresceram comigo e me ensinaram a partilhar, a perdoar e a lutar pelo que acredito. Amo-vos muito.

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1 Distal radius fractures – how important is it to restore anatomy?

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23 **Keywords:** Distal Radius Fracture, Radiological Outcomes, Measurements,
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Abstract

Purpose: Objective measures such as radiological parameters are the most used to evaluate the outcome of surgically treated distal radius fracture (DRF) but the question of whether or not these correlate with patient perceived function remains unanswered. In order to assess if it is essential to restore anatomy of the wrist after distal radius fractures, we evaluated pre-operative and follow-up radiological parameters and their association with patient-perceived functional outcomes. Furthermore, we aimed to identify variables associated with fracture anatomical reduction and patient perceived functional outcome.

Methods: Radial height, radial inclination, volar tilt and ulnar variance were retrospectively measured and compared with standardized normal range values on pre-operative and follow-up radiographs of 77 patients following distal radius fracture. The DASH score was obtained over the telephone to quantify functional patient-perceived outcomes following DRF surgery, and its association with radiological, demographic and surgical variables was studied.

Results: No statistically significant association was found between achieving post-surgical normal radiological measurements and the DASH score. There was also no correlation of this score with age, time waiting for surgery, fracture classification or surgery technique.

Conclusions: We found that anatomical reduction of surgically treated distal radius fracture measured by radiological outcomes is not mandatory to achieve good overall function as perceived by the patient.

Level of Evidence: Level III, retrospective comparative study

Introduction

Distal radius fracture is the most common fracture, with its incidence peaking especially in older women and, to a lower extent, also in young men. While young men are injured more frequently due to high-energy trauma, post-menopausal women (>50 years) owe most of their injuries to falls from a standing height, a low-energy mechanism that reflects the high prevalence of osteoporosis, and other health conditions resulting in poor bone quality (such as chronic stroke, diabetes, rheumatoid arthritis, and kidney disease).^[1-4]

Chronic pain and functional decline are common complaints among people who have suffered a DRF, most of them regaining their function approximately 1 year after the injury; however, pain at rest and during activity persists for a minority of patients.⁵ While these 2 parameters might be the primary domains when measuring outcomes of distal radius fracture, the ability to return to activities of daily living is also a valuable outcome, given that this type of injury has a particularly significant impact in the elderly, altering their ability to prepare meals, perform housekeeping duties, climb stairs, shop, and get out of an automobile.^{4,6} In accordance with this, despite their limitations, patient reported outcome measures (PROMs) have assumed a leading role when it comes to measuring the overall impact of injury on a patient's quality of life and their sense of disability.⁶ The Disabilities of the Arm, Shoulder, and Head (DASH) score was developed as patient reported outcome measure in the form of a questionnaire whose purpose is to evaluate the functional status of the upper extremity as perceived by the patient, not only in its physical dimension, but also in its social and psychological senses, as well as common reported symptoms after a disorder and its subsequent treatment.⁷

There are multiple treatment options for distal radius fractures - historically, the option has been predominantly made between conservative treatment with casting or surgical percutaneous fixation.⁸ Following the reports of success of the use of volar locking plates, reduction and internal fixation methods became increasingly popular.⁹ Regardless of the technique used, radiological measurements are used to assess whether an anatomical reduction has been achieved.⁴

However, there seems to be a lack of consensus on the correlation between radiological measurements and functional outcomes, after distal radius fracture.^{4,11,12} Therefore, we retrospectively evaluated pre-operative and follow-up radiological parameters in patients with distal radius fracture, in order to assess if it is essential to restore anatomy of the wrist by comparing those radiological outcomes of surgical treatment with patient-perceived functional outcome, measured by the DASH score. Furthermore, we aimed to identify variables associated with fracture anatomical reduction and patient perceived functional outcome. Our hypothesis is that radiographic deformity can still be associated with a good overall function of the upper limbs.

Methods

We evaluated 475 clinical records on all distal radius fractures that were surgically treated in a level I Trauma University-level Central Hospital, in the period between January 2005 and November 2019. The inclusion criteria were unilateral closed distal radius fractures treated surgically with either percutaneous Kirschner wires or volar locking plates in patients 18 years or older, that had pre-operative and follow up imaging. Exclusion criteria were revision surgery, presence of other upper

extremities fractures (previous, concomitant or following the wrist fracture) and concurrent upper limb disabilities. Patients who presented for surgery after 2 weeks of fracture occurrence were excluded as they may already had developed stiffness and scarring. Using these criteria, 307 cases were excluded. Of the 168 patients left, 13 had died by the time of this study, 64 could not be contacted and 10 didn't perform most of the tasks evaluated by the DASH Score. Four patients with dementia were also excluded. Thus, there were 77 patients left in our study sample.

Wrist standard radiographs (both anteroposterior and lateral) taken at the time of injury and at follow-up (at least 1 month after the fracture) were retrospectively evaluated and classified according to Frykman classification,¹³ by one of the authors. The measurements were taken using the Kreder radiological system.¹² Radial height, radial inclination, and ulnar variance were measured on the anteroposterior view; volar tilt was evaluated on the lateral radiograph (as pictured in Figs. 1, 2 and 3). Radial height was considered normal between 10 and 13 millimeters; ulnar variance between 0.7 and 1.5 millimeters; radial inclination between 21 and 25 degrees, and volar tilt between 7 and 15 degrees,¹¹ and used as reference.

The patient-perceived outcome was measured using the DASH score.⁷ The patients were questioned over the telephone by one of the authors. The DASH score was originally developed as a self-administered questionnaire, but it has been successfully applied over the phone before.^{14,15}

Statistical Analysis

Descriptive statistics were performed using absolute counts and proportions for categorical variables, and means and standard deviations, or medians and interquartile ranges, for continuous variables, as appropriate.

The 4 radiological parameters in study had symmetric distributions both pre- and post-operatively, and thus their means were compared with paired samples t-tests. These same parameters were also dichotomized in “normal” and “abnormal” according to the aforementioned standard criteria for normality, and the proportion of change in pre- and post-surgery status was assessed through McNemar tests.

The functional DASH scores’ association with patients’ age or number of days waiting for surgery was tested through Spearman’s correlation coefficients, and Mann-Whitney-U or Kruskal-Wallis tests were performed to evaluate potential significant differences of DASH score according to categorical variables, such as the dichotomized radiological parameters or the type of surgery the patient underwent.

The significance level was set at $\alpha=0.05$. All statistical analysis was conducted using SPSS statistical software package version 26 (SPSS inc., Chicago, IL, USA).

Results

The study sample included 77 patients, 49 of which (64%) were women (see Table 1). The median age at the time of fracture was 56 years (IQR=24) and was significantly higher amongst women (median 59 vs 41, $p=0.002$). The majority of patients (61%) fractured the left radius, and the mean waiting for surgery was 4.7 days. Volar locking plate was used in 67 patients (87%), while 10 (13%) were treated percutaneously with Kirschner wires. The follow-up x-ray was performed at a median time of 89 days post-surgery, and DASH score was obtained over the phone after a median of 68 months after surgery. Table 1 shows the distribution of the fractures according to Frykman classification.

Table 2 displays each of the 4 pre-operative and post-operative radiological parameters in study. All of them had significant differences in the follow-up x-rays, with mean values lying closer to normal ranges when compared to pre-surgery x-rays. However, the proportion of patients who achieved a normal post-operative value was only significantly higher than pre-operative proportions for radial inclination (17% with normal radial inclination pre-op vs 38% post-op; $p=0.007$) and volar tilt (14% with normal volar tilt pre-op vs 46% post-op; $p<0.001$). Figure 4 highlights the absolute difference between the radiological parameters and their normal values, before surgery and at follow-up.

The median DASH score was 3.3, the maximum DASH score was 71.4 and 26% of the patients reported a score of 0. The most common complaints were pain, both at rest and when performing any specific activity, and stiffness. In our sample, the DASH score result was not associated with the patients age (Spearman's rho correlation coefficient -0.16, $p=0.170$), the number of days waiting for surgery (rho coefficient -0.09, $p=0.430$) or the sex of the patient (median DASH of 4.2 in females vs 2.1 in males; $p=0.161$). There was also no significant difference in functional score according to treatment with volar locking plates or percutaneous Kirschner wires (median DASH of 3.3 and 1.25, respectively; $p=0.122$), or according to Frykman class ($p=0.818$).

Table 3 displays the DASH scores in patients whose post-operative radiological parameter laid within or outside the normal range. None of the 4 normal radiological parameters in study was independently associated with better DASH scores.

In fact, 19 patients (25%) had none of the 4 radiological parameters within normal ranges post-surgery, one isolated normal parameter was found in 25 (32%) patients and the remainder 43% had 2 or more parameters within the established

normal ranges (only 2 patients had all 4 parameters considered normal in the follow-up x-ray), and the DASH score was also not associated with the number of normal radiological parameters post-surgery (median DASH score 0.8, 3.3 and 5.8 for patients with 0,1 or more than 2 normal radiological parameters at follow-up, respectively; $p=0.115$).

Discussion

Hand surgery does not fit into the traditional surgical outcomes framework given the low associated mortality but large impact on quality of life. When it comes to distal radius fractures, there is a wide variety of outcome measures, such as pain scores, performance measures, radiological parameters, and increasingly valued patient-reported outcome measures (PROMs).⁶ While there has been a rising amount of literature comparing different outcome measures, there is still a big debate on how these different parameters could complement each other in a clinical setting. This study evaluated the correlation between the DASH score and radiological parameters after surgical treatment of distal radius fractures.

There is a wide variability of radiological parameters used across literature, which means radiographic criteria, acceptability ranges and mal-union definition tend to vary greatly.¹⁶ That, as well as variables such as patient characteristics, comorbidities or treatment options, translates in nonconsensual results when comparing subjective outcomes with radiological parameters. Dario¹¹ reported that small variations within normal range of radiographic parameters, except ulnar variance and volar tilt, do not influence the final functional outcome in distal radius fractures, while García-Cepeda¹⁷ found that radial shortening and articular step-off seem the

most important predictors for postoperative range of motion. Tsukazaki⁹ failed to find a relationship between radial shortening and loss of grip strength or loss of range of motion. Wilcke¹⁸ reported that radial shortening, dorsal angulation, and radial angulation correlated with the DASH score, when there was a certain degree of malunion and impairment. Other studies found varying associations between radiographic reduction with either function outcomes or PROMs.^[19-23] However, one thing seems to be consensual - radiological deformities are associated with significantly bad results only in case of greatly altered values, and minor deformities of the distal radius following distal radius fractures are unlikely to be clinically relevant, especially in elderly patients.^{11,17,23,24}

Our study results seem to follow the same pattern as the existing literature, since there was no statistically significant association found between radial height, radial inclination, volar tilt or ulnar variance and the DASH score, which means that having radiographic parameters closer to the considered normal value intervals did not mean having an improved function. Only 2 two patients had all radiological parameters within the normal range at follow-up, but 26% of the patients reported no disability.

It has been reported that injury factors and patient factors impact the management and outcomes after DRF. Variables such as patients age, sex, socioeconomics factors, pain and disability in the hand and wrist at the time of injury are considered prognostic factors predictive of important health outcomes, including pain, disability, and subsequent fracture.⁵ While it is true that the incidence of DRF is significantly higher amongst elderly women,²⁵ we found that age and gender were not predictive of long-term disfunction. Neither was surgery technique, although there was only a small percentage (13%) of patients treated with Kirschner wires *versus* volar locking plates.

Despite the belief that an associated ulnar fracture implies a worse prognosis,¹³ our results did not show that occurrence of an ulnar fracture (using Frykman's classification) is associated with significantly worse chance of restoring any of the evaluated radiological parameters or the DASH score results. This finding is consistent with previous studies who reported no significant differences in both radiological and clinical results after fixation of a distal radius fracture in the presence of an associated ulnar styloid fracture, even suggesting that there is no benefit to be gained by fixing those associated fractures. Similar results were obtained regarding extra-articular fractures.^{9,26}

Many DRF patients report near-baseline PROM values at 3 months, which may reflect both the natural temporal course of this injury and a possible limitation of patient-reported outcome measures, such as the DASH score.⁶ In this study, the DASH score was applied over the phone after a median of 68 months after surgery with a median DASH score of 3, the maximum DASH score being 71.4. One could speculate that the DASH score might not be sensitive enough as a mean to evaluate the outcome of distal radius fractures. The DASH score is not a joint-specific questionnaire and does not discriminate dominant hand use. Instead, it measures the function of both extremities as a whole.⁵ Nevertheless, studies have demonstrated that DASH has a valid role as a measure of physical function and symptoms in any single or multiple disorders of the upper limb and proved to be a sensitive tool in wrist evaluation.^{27,28}

One of the limitations of our study is its retrospective design: the lack of a baseline score of the DASH score to use as control would allow evaluating change over time (its intended role)²⁷ and reduce the bias introduced by other comorbidities. We tried to reduce this risk by excluding patients with other upper arm disabilities or

241 bilateral fractures of the wrist. We also excluded patients with previous wrist fractures
242 that could affect measurement of radiological parameters.

243 Nevertheless, the authors consider that, despite the use of extensive exclusion
244 criteria in order to eliminate bias, this study has a considerable sample size that is
245 representative of all patients suffering from singular distal radius fracture. The strength
246 of our study is the fact that 77 patients were available for functional evaluation after a
247 long follow-up time.

248 This study demonstrated that anatomical reduction of surgically treated distal
249 radius fractures measured by radiological outcomes is not necessary to achieve good
250 overall function perceived by the patient. Still, while ultimately the most valuable
251 outcome is patient's quality of life and perception of disability, objective outcomes such
252 as radiographic parameters should not be replaced by subjective outcomes, but rather
253 be used in an integrated approach. The authors believe that while radiological
254 parameters might not have a direct association with patient's perceived outcome,
255 alignment of the joint is still a primary goal of distal radius fracture treatment, and that
256 further standardization of measurements in future studies is key to better understand
257 prognosis and outcome of patients with distal radius fracture.

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369

Figure Legends

Figure 1: Preoperative wrist radiographs. A: anteroposterior view with the measurement of radial height (8.4 millimeters), radial inclination (18.0°) and ulnar variance (0.0 millimeters). B: lateral view with the measurement of volar tilt (-7.9°).

Figure 2: Postoperative wrist radiographs of the same fracture treated with volar locking plate. A: anteroposterior view with the measurement of radial height (12.0 millimeters), radial inclination (21.9°) and ulnar variance (-1.7 millimeters). B: lateral view with the measurement of volar tilt (12.9°).

Figure 3: Follow-up wrist radiographs of the same fracture treated with volar locking plate. A: anteroposterior view with the measurement of radial height (10.9mm), radial inclination (21.5°) and ulnar variance (-0.6mm). B: lateral view with the measurement of volar tilt (11.6°).

Figure 4: Absolute difference between each measure and its normal values, before surgery and at follow-up – radial height (4A), radial inclination (4B), volar tilt (4C), ulnar variance (4D).

386 **Tables**

387 Table 1:

Table 1 - Sample characterization

	Total sample (n=77)
Female Gender - n(%)	49 (63.6)
Age at the time of fracture, years - median (range)	56 (18 - 74)
Side of fracture - n(%)	
Right	30 (39.0)
Left	47 (61.0)
Frykman classification of fracture - n(%)	
Type I	9 (11.7)
Type II	2 (2.6)
Type III	24 (31.2)
Type IV	4 (5.2)
Type V	2 (2.6)
Type VI	3 (3.9)
Type VII	27 (35.1)
Type VIII	6 (7.8)
Surgical Treatment - n(%)	
Volar locking plate	67 (87.0)
Kirschner wires	10 (13.0)
Days waiting for surgery - mean (s.d.)	4.7 (2.85)
Timing of follow-up X-ray, days - median (range)	89 (30 - 326)
Timing of DASH score, months - median (range)	68 (30 - 147)
DASH score - median (range)	3.3 (0.0 - 71.4)
s.d. - standard deviation	

388 Table 2:

Table 2 - Pre- and post-op radiological parameters of the fracture

	Pre-op	Post-op	<i>p-value</i>
Radial Height, mm - mean (s.d.)	6.96 (4.42)	9.59 (3.42)	<0.001
Radial Height within normal range - n(%)	18 (23.4)	24 (31.2)	0.345
Radial Inclination, ° - mean (s.d.)	17.70 (7.29)	22.15 (4.86)	<0.001
Radial Inclination within normal range - n(%)	13 (16.9)	29 (37.7)	0.007
Volar Tilt, ° - mean (s.d.)	-3.34 (15.45)	5.67 (7.06)	<0.001
Volar Tilt within normal range - n(%)	11 (14.3)	35 (45.5)	<0.001
Ulnar Variance, mm - mean (s.d.)	1.70 (2.30)	1.04 (2.25)	0.008
Ulnar Variance within normal range - n(%)	9 (11.7)	13 (16.9)	0.454

s.d. - standard deviation

389

390 Table 3:

Table 3 - Association of DASH score with radiological parameters at follow-up

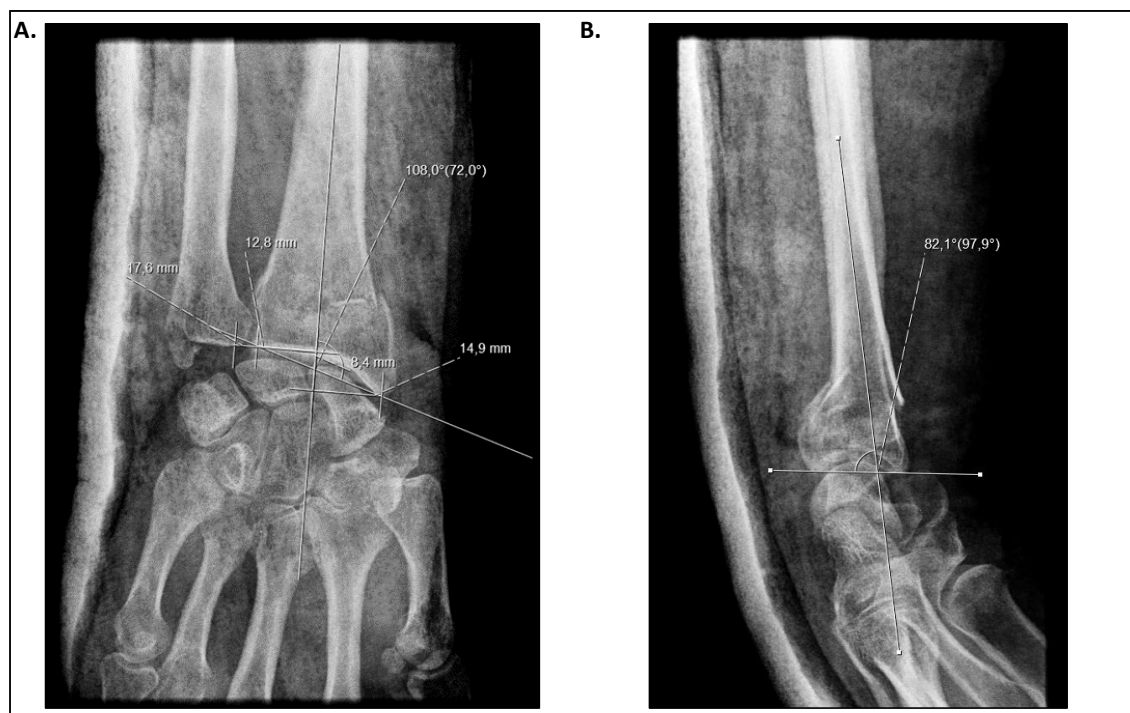
	Post-op Radiological Parameter		
	Within normal range	Outside normal range	<i>p-value</i>
DASH score - median (IQR)			
Radial Height	5.8 (9.6)	1.7 (10.5)	0.089
Radial Inclination	2.5 (9.2)	3.3 (14.0)	0.937
Volar Tilt	4.2 (12.6)	2.1 (9.4)	0.292
Ulnar Variance	5.8 (23.7)	2.5 (9.8)	0.333
IQR - interquartile range			

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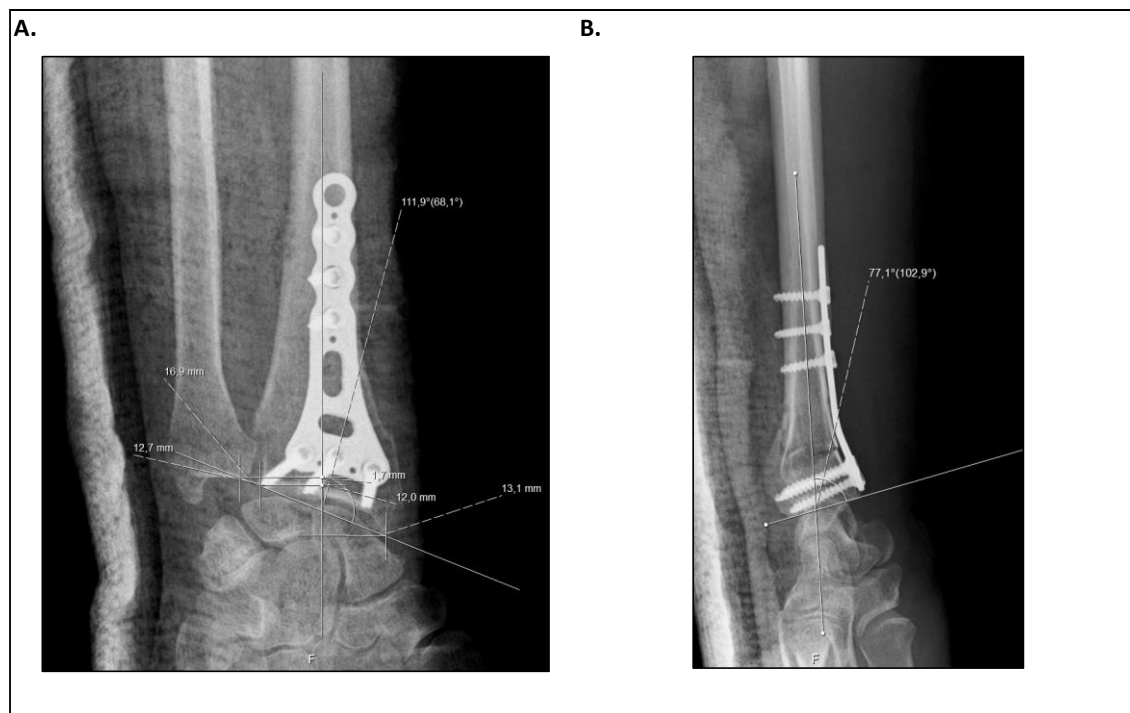
392

393 **Figures**

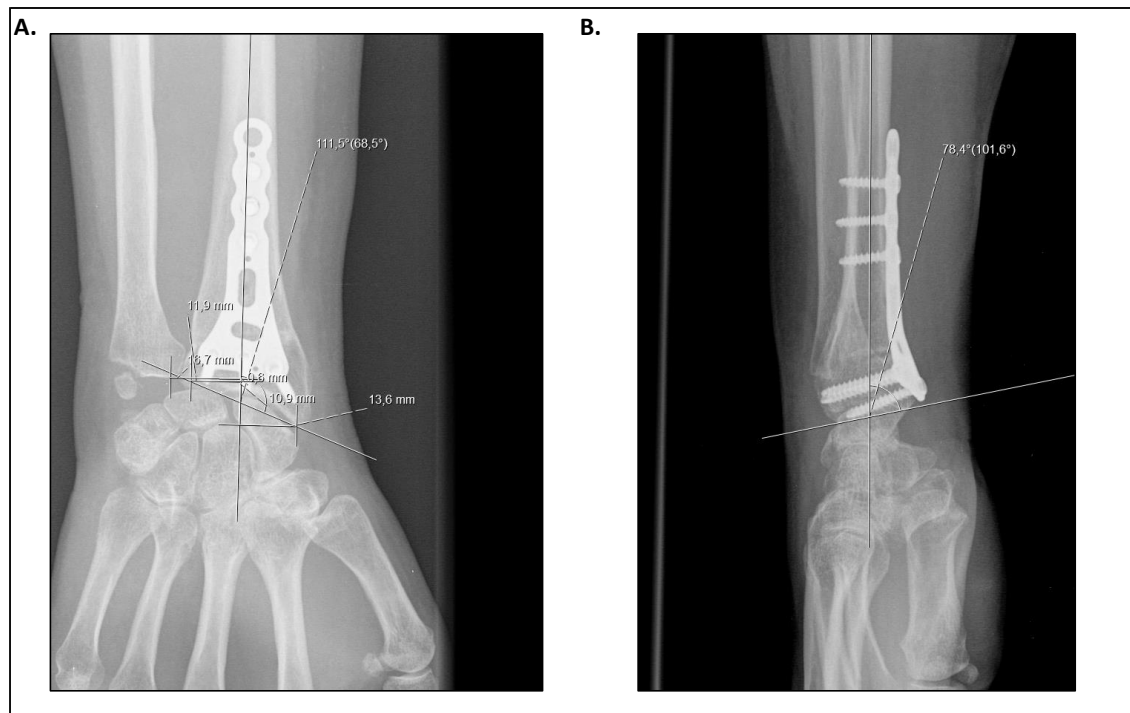
394 **Figure 1:**



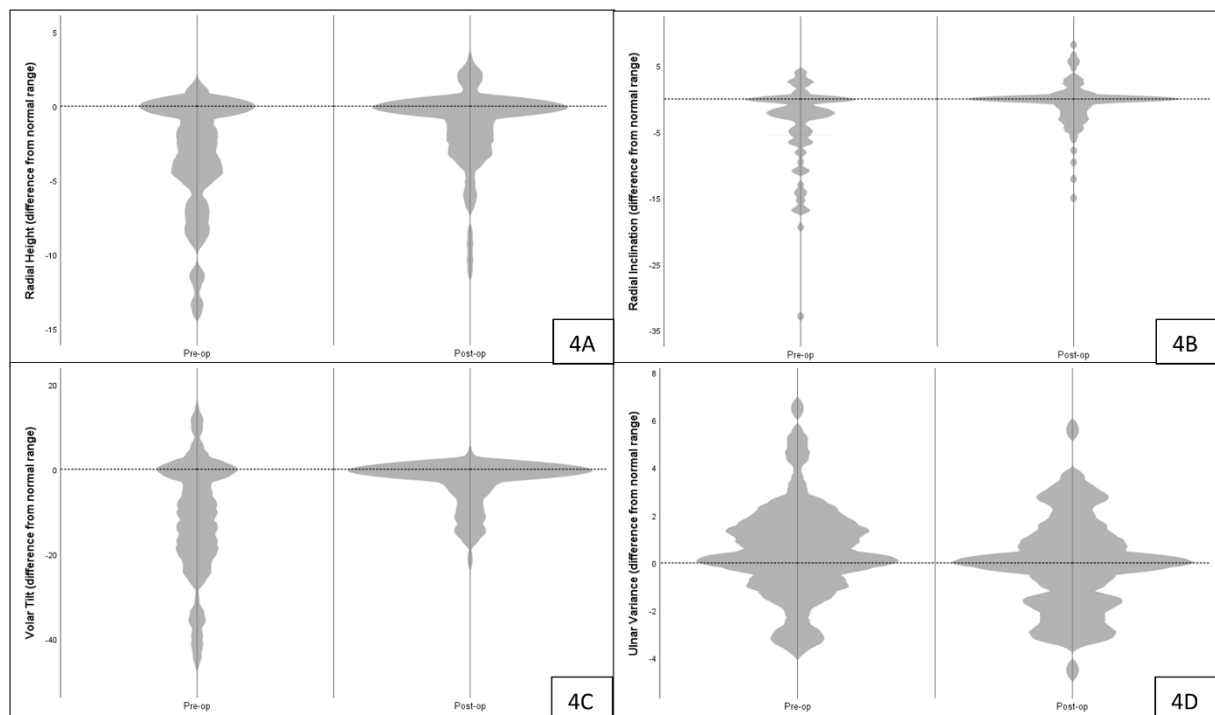
396 **Figure 2:**



399 Figure 3:



401 Figure 4:



STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract - Apesar de não se usar termo específico, está implícito em "Radial height, radial inclination, volar tilt and ulnar variance were retrospectively measured and compared with standardized normal range values on pre-operative and follow-up radiographs of 77 patients following distal radius fracture. The DASH score was obtained over the telephone to quantify functional patient-perceived outcomes following DRF surgery, and its association with radiological, demographic and surgical variables was studied." (b) Provide in the abstract an informative and balanced summary of what was done and what was found "No statistically significant association was found between achieving post-surgical normal radiological measurements and the DASH score. There was also no correlation of this score with age, time waiting for surgery, fracture classification or surgery technique."	7
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported "...there seems to be a lack of consensus on the correlation between radiological measurements and functional outcomes, after distal radius fracture."	9
Objectives	3	State specific objectives, including any prespecified hypotheses "...we retrospectively evaluated pre-operative and follow-up radiological parameters in patients with distal radius fracture, in order to assess if it is essential to restore anatomy of the wrist by comparing those radiological outcomes of surgical treatment with patient-perceived functional outcome, measured by the DASH score. Furthermore, we aimed to identify variables associated with fracture anatomical reduction and patient perceived functional outcome. Our hypothesis is that radiographic deformity can still be associated with a good overall function of the upper limbs."	9
Methods			
Study design	4	Present key elements of study design early in the paper "We evaluated 475 clinical records on all distal radius fractures that were surgically treated... Wrist standard radiographs (both anteroposterior and lateral) taken at the time of injury and at follow-up (at least 1 month after the fracture) were retrospectively evaluated.... Radial height was considered normal between 10 and 13 millimeters; ulnar variance between 0.7 and 1.5 millimeters; radial inclination between 21 and 25 degrees, and volar tilt between 7 and 15 degrees,11 and used as reference...The 4 radiological parameters in study had symmetric distributions both pre- and post-	11

		operatively, and thus their means were compared with paired samples t-tests. These same parameters were also dichotomized in “normal” and “abnormal” according to the aforementioned standard criteria for normality... Mann-Whitney-U or Kruskal-Wallis tests were performed to evaluate potential significant differences of DASH score according to categorical variables”	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection “We evaluated 475 clinical records on all distal radius fractures that were surgically treated in a level I Trauma University-level Central Hospital, in the period between January 2005 and November 2019.”	9
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up “Exclusion criteria were revision surgery, presence of other upper extremities fractures (previous, concomitant or following the wrist fracture) and concurrent upper limb disabilities. Patients who presented for surgery after 2 weeks of fracture occurrence were excluded as they may already had developed stiffness and scarring. Using these criteria, 307 cases were excluded. Of the 168 patients left, 13 had died by the time of this study, 64 could not be contacted and 10 didn’t perform most of the tasks evaluated by the DASH Score. Four patients with dementia were also excluded.” (b) For matched studies, give matching criteria and number of exposed and unexposed	9, 10
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable “Radial height was considered normal between 10 and 13 millimeters; ulnar variance between 0.7 and 1.5 millimeters; radial inclination between 21 and 25 degrees, and volar tilt between 7 and 15 degrees,11 and used as reference... dichotomized in “normal” and “abnormal” according to the aforementioned standard criteria for normality, and the proportion of change in pre- and post-surgery status was assessed through McNemar tests.”	10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group “Wrist standard radiographs (both anteroposterior and lateral) taken at the time of injury and at follow-up (at least 1 month after the fracture) were retrospectively evaluated and classified according to Frykman classification, by one of the authors. The measurements were taken using the Kreder radiological system. Radial height, radial inclination, and ulnar variance were measured on the anteroposterior view; volar tilt was evaluated on the lateral radiograph. Radial height was considered normal between 10 and 13 millimeters; ulnar variance between 0.7 and 1.5 millimeters; radial inclination between 21 and 25 degrees, and volar tilt between 7 and 15 degrees, and used as reference. The patient-perceived outcome was measured using the DASH score. The patients were questioned over the telephone by one of the authors.”	10

Bias	9	Describe any efforts to address potential sources of bias "Exclusion criteria were revision surgery, presence of other upper extremities fractures (previous, concomitant or following the wrist fracture) and concurrent upper limb disabilities. Patients who presented for surgery after 2 weeks of fracture occurrence were excluded as they may already had developed stiffness and scarring."	9,10
Study size	10	Explain how the study size was arrived at "The inclusion criteria were unilateral closed distal radius fractures treated surgically with either percutaneous Kirschner wires or volar locking plates in patients 18 years or older, that had pre-operative and follow up imaging. Exclusion criteria were revision surgery, presence of other upper extremities fractures (previous, concomitant or following the wrist fracture) and concurrent upper limb disabilities. Patients who presented for surgery after 2 weeks of fracture occurrence were excluded as they may already had developed stiffness and scarring. Using these criteria, 307 cases were excluded. Of the 168 patients left, 13 had died by the time of this study, 64 could not be contacted and 10 didn't perform most of the tasks evaluated by the DASH Score. Four patients with dementia were also excluded. Thus, there were 77 patients left in our study sample."	9,10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why "Descriptive statistics were performed using absolute counts and proportions for categorical variables, and means and standard deviations, or medians and interquartile ranges, for continuous variables, as appropriate. The 4 radiological parameters in study had symmetric distributions both pre- and post-operatively, and thus their means were compared with paired samples t-tests. These same parameters were also dichotomized in "normal" and "abnormal" according to the aforementioned standard criteria for normality, and the proportion of change in pre- and post-surgery status was assessed through McNemar tests."	10,11
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses "Descriptive statistics were performed using absolute counts and proportions for categorical variables, and means and standard deviations, or medians and interquartile ranges, for continuous variables, as appropriate. The 4 radiological parameters in study had symmetric distributions both pre- and post-operatively, and thus their means were compared with paired samples t-tests. These same parameters were also dichotomized in "normal" and "abnormal" according to the aforementioned standard criteria for	10,11

normality, and the proportion of change in pre- and post-surgery status was assessed through McNemar tests.

The functional DASH scores' association with patients' age or number of days waiting for surgery was tested through Spearman's correlation coefficients, and Mann-Whitney-U or Kruskal-Wallis tests were performed to evaluate potential significant differences of DASH score according to categorical variables, such as the dichotomized radiological parameters or the type of surgery the patient underwent.

The significance level was set at $\alpha=0.05$. All statistical analysis was conducted using SPSS statistical software package version 26 (SPSS inc., Chicago, IL, USA)."

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram Incluído nos métodos.	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount) "The study sample included 77 patients, 49 of which (64%) were women. The median age at the time of fracture was 56 years (IQR=24) and was significantly higher amongst women (median 59 vs 41, $p=0.002$). The majority of patients (61%) fractured the left radius, and the mean waiting for surgery was 4.7 days. Volar locking plate was used in 67 patients (87%), while 10 (13%) were treated percutaneously with Kirschner wires." + Tabela 1	11,24
Outcome data	15*	Report numbers of outcome events or summary measures over time "the proportion of patients who achieved a normal post-operative value was only significantly higher than pre-operative proportions for radial inclination (17% with normal radial inclination pre-op vs 38% post-op; $p=0.007$) and volar tilt (14% with normal volar tilt pre-op vs 46% post-op; $p<0.001$). Figure 4 highlights the absolute difference between the radiological parameters and their normal values, before surgery and at follow-up." "Table 3 displays the DASH scores in patients whose post-operative radiological parameter laid within or outside the normal range. None of the 4 normal radiological parameters in study was independently associated with better DASH scores." Tabela 3	12, 25

Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period “None of the 4 normal radiological parameters in study was independently associated with better DASH scores. In fact, 19 patients (25%) had none of the 4 radiological parameters within normal ranges post-surgery, one isolated normal parameter was found in 25 (32%) patients and the remainder 43% had 2 or more parameters within the established normal ranges (only 2 patients had all 4 parameters considered normal in the follow-up x-ray), and the DASH score was also not associated with the number of normal radiological parameters post-surgery (median DASH score 0.8, 3.3 and 5.8 for patients with 0,1 or more than 2 normal radiological parameters at follow-up, respectively; p=0.115).”	12,13
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses “Table 2 displays each of the 4 pre-operative and post-operative radiological parameters in study. All of them had significant differences in the follow-up x-rays, with mean values lying closer to normal ranges when compared to pre-surgery x-rays. However, the proportion of patients who achieved a normal post-operative value was only significantly higher than pre-operative proportions for radial inclination (17% with normal radial inclination pre-op vs 38% post-op; p=0.007) and volar tilt (14% with normal volar tilt pre-op vs 46% post-op; p<0.001). Figure 4 highlights the absolute difference between the radiological parameters and their normal values, before surgery and at follow-up. The median DASH score was 3.3, the maximum DASH score was 71.4 and 26% of the patients reported a score of 0. The most common complaints were pain, both at rest and when performing any specific activity, and stiffness. In our sample, the DASH score result was not associated with the patients age (Spearman’s rho correlation coefficient -0.16, p=0.170), the number of days waiting for surgery (rho coefficient -0.09, p=0.430) or the sex of the patient (median DASH of 4.2 in females vs 2.1 in males; p=0.161). There was also no significant difference in functional score according to treatment with volar locking plates or percutaneous Kirschner wires (median DASH of 3.3 and 1.25, respectively; p=0.122), or according to Frykman class (p=0.818).”	12,25
Discussion			
Key results	18	Summarise key results with reference to study objectives “Our study results seem to follow the same pattern as the existing literature, since there was no statistically significant association found between radial height, radial inclination, volar tilt or ulnar variance and the DASH score, which means that having radiographic parameters closer to the considered normal value intervals did not mean having an improved function. Only 2 two patients had all radiological parameters within the normal range at follow-up, but 26% of the patients reported no disability.”	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias “One of the limitations of our study is its retrospective design: the lack of a baseline score of the DASH score to use as control would allow evaluating change over time (its intended role)²⁷ and reduce the bias introduced by other comorbidities. We tried to	15,16

		reduce this risk by excluding patients with other upper arm disabilities or bilateral fractures of the wrist. We also excluded patients with previous wrist fractures that could affect measurement of radiological parameters."	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence "This study demonstrated that anatomical reduction of surgically treated distal radius fractures measured by radiological outcomes is not necessary to achieve good overall function perceived by the patient. Still, while ultimately the most valuable outcome is patient's quality of life and perception of disability, objective outcomes such as radiographic parameters should not be replaced by subjective outcomes, but rather be used in an integrated approach. The authors believe that while radiological parameters might not have a direct association with patient's perceived outcome, alignment of the joint is still a primary goal of distal radius fracture treatment, and that further standardization of measurements in future studies is key to better understand prognosis and outcome of patients with distal radius fracture."	16
Generalisability	21	Discuss the generalisability (external validity) of the study results "Nevertheless, the authors consider that, despite the use of extensive exclusion criteria in order to eliminate bias, this study has a considerable sample size that is representative of all patients suffering from singular distal radius fracture. The strength of our study is the fact that 77 patients were available for functional evaluation after a long follow-up time. This study demonstrated that anatomical reduction of surgically treated distal radius fractures measured by radiological outcomes is not necessary to achieve good overall function perceived by the patient."	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based "The authors received no financial support for the research, authorship, and/or publication of this article."	17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.



THE JOURNAL OF HAND SURGERY

An International Journal Devoted to Surgery of the Upper Extremity

AUTHOR INFORMATION PACK

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DESCRIPTION

The *Journal of Hand Surgery* publishes original, peer-reviewed articles related to the **diagnosis, treatment, and pathophysiology** of **diseases** and **conditions** of the **upper extremity**; these include both clinical and basic science studies, along with case reports. Special features include Clinical Perspective articles, Comprehensive Review manuscripts, and Surgical Technique articles that provide an overview of hand surgery, technical aspects of surgery, and current controversial topics.

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Aims and scope

The Journal of Hand Surgery publishes original, peer-reviewed articles related to the pathophysiology, diagnosis, and treatment of diseases and conditions of the upper extremity; these include both clinical and basic science studies. Special features include Review Articles (including Current Concepts and The Hand Surgery Landscape), reviews of books and media, and Letters to the Editor. Before beginning to write for *The Journal of Hand Surgery*, prospective authors should read these instructions completely. Authors will also benefit from reading:

- Manske PR. Structures and format of peer-reviewed scientific manuscripts. *J Hand Surg Am.* 2006;31(7):1051–1055.
- Flatt AE. Words. *J Hand Surg.* 2000;25(2):201–210.

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Review Articles

If you wish to submit a review article to *The Journal of Hand Surgery* but have not explicitly received an invitation to do so, please complete the [Review Article Proposal](#) and email it to the Review Deputy Editor, Dawn M. LaPorte, MD, at jhs@assh.org for consideration. We ask that you do not submit your unsolicited review article to the journal unless the review editor accepts your review topic in writing.

The review section of the *Journal* will feature Current Concepts articles on a monthly basis, as well as review articles in a monthly Hand Surgery Landscape section.

Current Concepts is designed to provide review articles that focus on up-to-date information covering essential topics on a three-year rotation. Authors are invited based on their expertise. Unsolicited material is considered after contacting the Review Deputy Editor, Dawn M. LaPorte, MD, at jhs@assh.org with a completed [Proposal](#).

Current Concepts articles are no more than 3,000 words and include a one-paragraph abstract. They must review recent developments and must emphasize the best evidence for management and treatment strategies. In addition to the article, the authors must provide four choice continuing medical education (CME) questions together with a rationale and references for the best answer. Include at least one reference to a "classical article" that has stood the test of time.

While the Current Concepts manuscript should be able to "stand alone" in the print version of the *Journal*, the digital version will be able to provide hyperlinks to videos and other articles. The authors are encouraged to submit a technical video with their article. Links may also be provided to other articles already published in JHS that may have described techniques or give reference to evidence-based medicine.

Finally, Current Concepts articles should have no more than four authors and generally have no more than 20 references.

The Hand Surgery Landscape articles are designed to generate interest and comment among readers. These articles present content that otherwise might be outside the traditional scope of a typical review topic for *The Journal of Hand Surgery*. Invitations to contribute articles for this series are made either by the Review Deputy Editor or the Editor-in-Chief. Unsolicited submissions must first be made as a [proposal](#) to the Review Editor using the template and sent to Dawn M. LaPorte, MD, at jhs@assh.org. Some, but not all, unsolicited manuscripts may be sent out for peer review. The focus will be on encouraging thought leaders in the areas described below.

This monthly feature has a word count of no more than 2,000 words and includes a one-paragraph abstract. There is no prescribed format other than the maximum word count. References are required for any statements that should be supported by outside sources.

The spectrum of content considered for this series will include:

- Innovative clinical topics
- Education
- Advocacy
- Practice management
- Certification matters

The *Surgical Techniques* section is an online-only section that provides step-by-step details of various surgical procedures relevant to clinical practice. Articles discuss indications and contraindications, surgical anatomy, surgical technique, postoperative management, pearls and pitfalls, and complications; many articles also provide a case illustration. *Surgical Technique* articles will be solicited from experts and are open for submission upon receipt of a [Proposal](#). Articles should be no more than 2,500 words, and they should include a one-paragraph abstract. Videos and/or high-resolution photographs are strongly encouraged.

Review of books and media: The *Journal* publishes reviews of books and other media that will enlarge a reader's perspective even beyond specialty core knowledge and technical skills. Acceptable media include educational material in electronic formats, practice management software programs, and software applications for smart phones. For authors and publishers wishing to have a work reviewed, send 2 copies to Dr. Graham. We will not return material selected for review. We will return material not selected for review only when the sender has prepaid the shipping charges.

We encourage readers to submit unsolicited reviews of books and media that they think would be of interest to other readers. Limit reviews to 800 words and include the work's title, publisher, city, date of publication, and retail price. Such submissions will go through the same review and selection process as unsolicited scientific manuscripts.

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