Intrarater and Interrater Reliability of the Soong Classification for Distal Radius Volar Locking Plate Placement

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Abstract

Background

The purpose of this study was to analyze the intra- and inter-rater reliability of the Soong classification for volar locking plate placement on a randomly selected, consecutive series of radiographs. Our hypothesis was that the classification would be reliable.

Methods

Six physicians of differing levels of training (orthopedic surgery intern to fellowship trained upper extremity staff) were asked to review 40 radiographs in a random order on two separate occasions, 4 weeks apart. All observers graded each image (0, 1 or 2) based on the corresponding Soong grade. A weighted κ was used to determine the intra-rater agreement. The inter-rater agreement was determined using an intra-class coefficient.

Results

The intra-rater reliability using a weighted κ ranged from 0.229 (95% CI: 0.048-0.411) to 0.946 (95% CI: 0.840-1.051). The inter-rater intra-class coefficient for Randomization 1 was 0.944 (95% 0.912-0.967) and Randomization 2 was 0.877 (95% CI: 0.797-0.930).

Conclusion

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The Soong classification is a reliable tool, both inter- and intra-rater, for assessing distal radius volar locking plate placement. The classification system remained reliable despite a randomly selected, consecutive series of images and physician observers of varying levels of training.

Introduction

Volar locking plate fixation has become a popular method of treatment for displaced and unstable distal radius fractures. Several randomized studies support this technique [6, 7, 11, 16] however, there are many complications associated with its use [3-5]. One complication worth considering is flexor tendon rupture, and plate prominence has emerged as a contributory factor [3, 4]. In 2011, Soong and colleagues proposed a grading scale for volar locking plate placement based on the plate's location to the watershed line of the volar distal radius, correlating plate placement with risk of tendon rupture [14]. The grade was based off a critical line drawn tangential from the most volar prominence of the distal radius and parallel to the volar cortex (Figure 1). Grade 0 was given to plates that did not extend volar to this line. Plates given a grade 1 were volar to the critical line but proximal to the volar rim of the distal radius. Plates that were directly on or distal to the volar rim were given a Grade 2. Since the grading scale was published in 2011, it has been referenced in several studies [1, 3, 8-10, 12 ,15].
The purpose of this study was to analyze the intra- and inter-rater reliability of the Soong classification for volar locking plate placement on a consecutive series of radiographs by surgeons of varying levels of experience. Our hypothesis was that the classification would be reliable.

Methods

Approval from our hospital's institutional review board was obtained. Informed consent was not required by the overseeing institution. We selected 6 physicians with varying levels of education: 3 orthopedic surgery residents at post-graduate years 1, 3, and 4, an orthopedic upper extremity fellow, and 2 fellowship-trained orthopedic upper extremity surgeons. The physicians were provided the original article by Soong et al. to familiarize themselves with the grading scale, and then they were asked to apply that scale to a series of radiographs.

Inclusionary criteria for image selection were 1) patients who had a fracture of the distal radius and were treated with volar plating, 2) patients who underwent radiographs of the lateral wrist secondary to plating, and 3) patient age was ≥ 18 years. Criteria for exclusion were 1) presence of multiple plates in the distal forearm, 2) presence of additional hardwire such as Kirschner wires, 3) images were inadequate for precise appraisal, and 4) features were present in the radiograph that would enable physicians to easily identify the patient at a later date.

We searched the database at our institution using CPT codes 25607, 25608, and 25609 between January 1st, 2013 and September 30th, 2015. We identified 479 patients who met inclusionary criteria. A random number generator was used to select a starting point, after which 65 consecutive patients were exported. Enforcing our exclusionary criteria resulted in the elimination of 25 patients; the remaining 40 patients constituted the study sample. The radiographs for this sample were reviewed, de-identified, saved, and assigned a number (1 through 40). The order of these images was randomized (Randomization 1) and they were shown to the 6 physicians. Each physician graded them as 0, 1, or 2 using the Soong classification system. After 4 weeks, the order of radiographs 1 through 40 was re-randomized (Randomization 2) and the physicians were asked to grade them a second time. All physicians completed this task within a week of the assignment date. Both evaluation sessions began with examples from the original article to act as a reference.

Descriptive statistics characterized the percentages of Soong classifications (0, 1, and 2) present in the sample during both grading sessions. Intra-rater reliability was performed using weighted κ values. The strength of agreement was determined to be poor (<0.20), fair (0.21-0.40), moderate (0.41-0.60), good (0.61-0.80) or very good (0.81-1.00) based on criteria presented by Altman [2]. Inter-rater reliability was determined using the intra-class coefficient (ICC) on both Randomization 1 and Randomization 2 [13]. All statistical analyses were performed using SPSS Statistics version 24 (IBM Corporation, Chicago, IL, USA).

Results

Among the 6 physicians, a total of 240 images were reviewed in each randomization. In Randomization 1, there were 19 images (7.9%) scored as Grade 0, 137 images (57.1%) scored as Grade 1, and 84 images (35.0%) scored as Grade 2. In Randomization 2, there were 12 images (5.0%) scored as Grade 0, 113 images (47.1%) scored as Grade 1, and 115 images (47.9%) scored as Grade 2. The weighted κ values for intra-rater reliability can be found in Table 1. These ranged from 0.229 to 0.946. The inter-rater reliability for Randomization 1 had an ICC of 0.944 (95% CI: 0.912-0.967); for Randomization 2, the ICC was 0.877 (95% CI: 0.797-0.930).

Discussion

The present study found the intra-rater reliability of the Soong grading system to have strong agreement. Among the 6 physicians who reviewed the radiographs, 5 had weighted κ values that were classified as "good" or "very good" based on the criteria by Altman. The inter-rater reliability was also found to be very good for both Randomization 1 and Randomization 2. Interestingly, there was a broad range of weighted κ values when looking at the intra-rater reliability: the lowest was 0.229 (95% CI: 0.048-0.411) and the highest was 0.946 (95% CI: 0.840-1.051). These values did not appear to correspond to experience as the lowest value was recorded by the most experienced surgeon. When looking at Observer 1 who had the lowest κ value, there were 2 separate occasions a grade 0 in Randomization 1 was changed to a grade 2 in Randomization 2. Using the weighted κ values places a larger emphasis on a disagreement of 2 compared to 1. This could, along with 16 images that were changed from a 1 to a 2 could account for the fair rating for Observer 1. Overall, our results were found to be comparable to previously published data on the classification system. This may be attributable to differences in study design.

Lutsky et al. performed a reliability study of the Soong classification in 2016 and found it to have an intra-rater κ value between 0.94 and 0.80 [8]. They also found an inter-rater ICC of 0.78. In their study, all reviewers were fellowship-trained upper extremity surgeons and the images were selected to ensure an adequate number of Soong grades 0, 1, and 2. By comparison, our study used a series of consecutive radiographs; thus, the distribution of grades was not balanced. While this might account for some of the increased variability, it is a more approximate representation of data observed in the clinical setting. Our attempt to limit bias by avoiding deliberate selection of the best examples of each Soong grade resulted in the inclusion of images that could be considered borderline or between grades. This presented challenges in our effort to classify them consistently. Furthermore, the radiographs evaluated in the present study were taken at different times and by different technicians. As a result, there was variation in the amount of rotation in the lateral images, which made it more difficult to assess the true location of the volar rim required to draw the tangential line. Our inter-rater agreement may have also been affected by the wide variety of experience among our graders, ranging from a first post-graduate year orthopedic surgery resident to a fellowship-trained upper extremity surgeon with more than 30 years of experience.

Our study has several limitations. No power analysis was performed and only three board eligible/board certified surgeons were involved in the study. The physicians were provided static images that could not be annotated or drawn on, making it more challenging to fully assess the lines required for the classification system. There was also a low number of grade 0 images included which could have affected our results. However, despite imperfect images and different levels of training and expertise, the Soong classification was still found to be reliable when looking at a randomly selected, consecutive series of radiographs. We will continue to use the Soong grade as an effective tool for analyzing distal radius volar locking plate placement.

Conflict of Interest

The authors declare that they have no conflict of interest.

Source of Funding

No external source was involved in funding this study.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was not required by the overseeing institution.

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Figure Legend

Figure 1. Soong classification. a) Grade 0 (dorsal to critical line). b) Grade 1 (volar to critical line but proximal to the volar rim). c) Grade 2 (Volar to critical line and on or distal to the volar rim).