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Validation of the Clenched Fist View in Detecting Scapholunate Ligamentous Injury

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Abstract

Background: The purpose of this study was to determine the predictive value of the clenched fist stress views in identifying scapholunate ligament injuries. **Methods:** An institutional review board–approved retrospective chart review was conducted of adult patients who underwent diagnostic arthroscopy with a ligamentous wrist injury from 2015 to 2020. Standard posteroanterior, lateral, and clenched fist stress radiographs were reviewed and scapholunate ligament gaps recorded. **Results:** A total of 124 patients were included, of which 88 had normal standard radiographs and clenched fist radiographs. The positive predictive value of the clenched fist view was 69%, whereas the negative predictive value was 58%. The sensitivity of the clenched fist view was 40%, while the specificity was 82%. Of those patients with a negative clenched fist view, 42% were found to have an arthroscopic Geissler classification of 3 or higher scapholunate ligament injury. **Conclusions:** Despite the emphasis on stress radiographic views, a normal stress clenched fist view does not preclude arthroscopic findings of a Geissler class 3 or greater injury in symptomatic patients. The sensitivity of a clenched fist view is only 40%. These findings question the utility of stress radiographs when assessing for scapholunate ligament injuries.

Keywords: radiograph, scapholunate ligament, stress views, wrist arthroscopy, clenched fist

Introduction

Injury to the scapholunate (SL) ligament is common but may be difficult to diagnose in the clinical setting on physical examination alone. Often times, patients may present with a history and examination suspicious for SL injury, yet standard radiographs often appear unremarkable. Radiographic stress views are thought to help identify a dynamic injury, but even these stress views can be inconclusive.[1]

The forces generated during a clenched fist view were initially described in 1972 by Linscheid et al[2] as a way to identify dynamic SL injury. There are variations on the clenched fist view including radiographs taken in radial or ulnar deviation and a stress view with a pencil.[3] Regardless of the variations of these stress views, when the goal is to correctly diagnose a symptomatic SL injury, radiographs should provide an additional data point to direct the clinician toward the diagnosis for the patient. In the case of a static SL diastasis, stress views are not necessary.

In patients who present with a clinical suspicion of an SL injury and negative radiographs (unloaded and loaded stress views), additional testing may be necessary such as a magnetic resonance imaging (MRI) scan. Despite this, the sensitivity and specificity of MRI can vary.[4] The purpose of this study was to determine the predictive value of the clenched fist stress view in identifying dynamic SL injuries by comparing arthroscopic findings at the time of surgery with the preoperative radiographic findings.

Methods

An institutional review board–approved retrospective case study was conducted of all patients with the *International Classification of Diseases, Tenth Revision* (*ICD-10*) codes for intercarpal ligament injury (M25.331, M25.332, M25.339) and *Current Procedural Terminology* (*CPT*) codes for wrist arthroscopy (29840, 29844, 29845, 29846,

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29847) at a single institution between 2015 and 2020. Inclusion criteria were patients who were first identified by *ICD-10* codes for intercarpal ligament injury and *CPT* codes for wrist arthroscopy who presented with a clinical suspicion of SL ligament injury after review of the medical record. Only patients with a complete series of radiographs (posteroanterior [PA], lateral, and clenched fist stress views) and a wrist arthroscopy were included. The PA clenched fist view in the neutral position was obtained with the patient seated with both hands placed palm down on the image receptor with the wrist, elbow, and shoulder in neutral rotation allowing the patient to make a clenched fist and maintain constant pressure while the image was taken. Exclusion criteria included those patients without an SL injury; static SL injuries; a lack of a PA, lateral, and clenched fist stress view radiographs after injury; patients with inflammatory arthritis; and those who had undergone previous wrist surgery such as a previous proximal row carpectomy or scaphoid excision and limited carpal fusion.

Preoperative radiographic information was recorded for each case including SL gap on both the unloaded and stress PA views, SL angle and radiolunate (RL) angle as described by Larson et al,[5] lunate type, and dorsal scaphoid translation. Dorsal scaphoid translation was defined as dorsal positioning of the proximal pole of the scaphoid within the scaphoid facet on the distal radius as seen on the lateral radiograph as described by Chan and colleagues using the concentric circles methodology.[6] Normal reference values used were SL gap less than 3 mm, SL angle less than or equal to 60°, and RL angle between −15° and 15°.[1] Lateral radiographs specifically were evaluated for adequate technique, confirming collinearity of the radius, capitate and long metacarpal, and alignment of the scaphoid tubercle and pisiform.[7] Two members of the research team reviewed the films with 100% inter-rater agreement assessment of the radiographs. When available, MRI reports were included. All MRIs were read by musculoskeletal (MSK) consultant radiologists and were performed with and without contrast per the radiologist's discretion. No MR arthrograms were included. Operative reports were reviewed for arthroscopic evidence of an SL injury using the Geissler classification system.[8]

Statistical Analysis

The data were summarized using means and standard deviations for continuous variables and counts and percentages for categorical variables with normal distribution. The analysis focused on evaluating the accuracy of radiographic imaging relative to intraoperative findings in identifying SL injuries. Sensitivity, specificity, predictive values, and overall accuracy were calculated and reported with 95% confidence intervals. Overall accuracy was defined as agreement between identification of SL injury on clenched fist radiographs, MRI, and intraoperative diagnosis. The association of anatomical and imaging factors with this accuracy was analyzed using log-binomial regression in a generalized linear model framework. Anatomical factors included lunate type and dorsal scaphoid translation. Imaging factors included SL angle and quantitative SL gap recorded on stress views. All statistical tests were 2-sided and values of $P < .05$ were considered statistically significant. All analyses were conducted using SAS version 9.4 (SAS Institute, Inc, Cary, North Carolina) and R version 3.6.2 (R Foundation for Statistical Computing, Vienna, Austria, 2019).

Results

A total of 1878 patients were identified by *ICD*/*CPT* codes of which 124 patients met the inclusion criteria. The demographics of the cases are described in Table 1. The mean age at the time of surgery was 39 years old (SD = 14.81), and the range was 13 to 71 years. A total of 45.2% of the cases were women (56), and 54.8% of the cases were men (68). The dominant hand was involved in 53.2% of cases (66). Eighty-eight of the 124 patients (71%) had normal PA, lateral, and stress PA clenched fist radiographs (Table 1). The remaining 36 patients had dynamic widening on stress PA views when compared with the unloaded, ipsilateral radiograph. Contralateral wrist radiographs were also reviewed for confirmation of a positive stress radiograph. Within the patients with dynamic widening, 11 (30.6%) had stages 1 to 2 arthroscopic findings and 25 (69.4%) had stages 3 to 4 instability as judged by fellowship-trained consultant hand surgeons within the hand division.

Of the 88 patients with negative plain and stress radiographs, 49% were found to have no evidence of SL injury on their MRI scans as interpreted by our MSK radiologists. During the time of their arthroscopic evaluation, 21 patients (24%) had normal SL interval with no evidence of injury, 5 (5.7%) had stage 1 SL attenuation or hemorrhage, 25 (28%) had stage 2 injury, 26 (29.5%) had stage 3 instability, and 11 (12.5%) had stage IV instability (Table 2). A total of 42% of patients with normal radiographs had a stage 3 or greater SL joint instability diagnosed at the time of wrist arthroscopy (Table 2). The sensitivity and specificity of the clenched fist radiograph for diagnosis of a stage 3 or greater SL injury was 40% and 82%, respectively. The positive predictive value of the stress radiograph was 69%, whereas its negative predictive value was 58%.

Relative risk analysis of variables including lunate type (1 or 2), SL angle with a cutoff of 60°, and absolute SL gap measured on PA radiographs with a cutoff of 3 mm did not affect the accuracy of the clenched fist view in identifying Geissler 3 or greater SL injuries (Table 3). The only variable that was found to have a statistically significant increased accuracy in relative risk analysis was dorsal scaphoid translation on lateral radiographs. Fifteen of the 124 total

Table 1. Demographics.

Parameters	Total (N = 124)
Age	
N	124
Mean (SD)	39.0 (14.81)
Median	39.0
Range	13.0, 71.0
Sex, n (%)	
Female	56 (45.2)
Male	68 (54.8)
Hand dominance, n (%)	
Left	15 (12.5)
Right	105 (87.5)
Operative side, n (%)	
Left	56 (45.2)
Right	68 (54.8)
Dominant hand involved, n (%)	
No	58 (46.8)
Yes	66 (53.2)
Radiographic evidence of SL widening, n (%)	
No	88 (71.0)
Yes	36 (29.0)
MRI read, without SL widening[a], n (%)	
Normal	43 (48.9)
Membranous SL	4 (4.5)
Volar SL	14 (15.9)
Dorsal SL	22 (25.0)
Missing	5 (5.7)
MRI read, SL widening, n (%)	
Normal	8 (22.2)
Membranous SL	1 (2.8)
Volar SL	4 (11.1)
Dorsal SL	22 (61.1)
Missing	1 (2.8)
Dorsal scaphoid translation, n (%)	
No	109 (87.9)
Yes	15 (12.1)
Geissler stage, without SL widening, n (%)	
0 (normal findings)	21 (23.9)
1	5 (5.7)
2	25 (28.4)
3	26 (29.5)
4	11 (12.5)
Geissler stage, SL widening, n (%)	
0 (normal findings)	5 (13.9)
1	2 (5.6)
2	4 (11.1)
3	6 (16.7)
4	19 (52.8)

Note. n = number; SL = scapholunate; MRI = magnetic resonance imaging.
[a]Scapholunate widening on plain radiographs.

patients were noted to have dorsal scaphoid translation on lateral films as described by Chan et al.[6] Twelve of the 15 patients (80%) were found to have a relative risk of 1.4 (95% confidence interval, 1.01-1.84), meaning that the likelihood of an accurate identification of an SL ligament injury by clenched fist imaging was 1.4 times higher in the presence of dorsal scaphoid translation relative to no dorsal scaphoid translation.

Discussion

In our study, we noted that more than 70% of patients with normal loaded and stress radiographs had evidence of grade II or more instability of the SL joint. Imaging, including clenched fist stress PA neutral (without radial or ulnar deviation) radiographs, did not accurately reflect the presence of an SL injury when correlated with intraoperative arthroscopic findings.

The diagnosis of SL injury is challenging. In addition to a focused history and clinical examination, imaging in the forms of radiographs (unloaded and loaded) and MRI is often obtained. Stress radiographs are obtained when static radiographs are normal. The PA clenched fist stress view demonstrates pathologic SL widening under axial loaded conditions.[1] It is critical that the diagnosis is made both accurately and timely as failure can lead to degenerative changes within the wrist or long-term functional sequelae.[9-12] Magnetic resonance imaging can be helpful for diagnosis, but with an overall sensitivity and specificity of 63% and 86%, respectively, it is also not considered a gold standard for diagnosis of carpal ligament injuries.[4]

Lee et al[3] concluded that the clenched pencil view and PA clenched fist view with ulnar deviation resulted in diastasis of the SL joint. In this study, the sensitivity of the clenched fist view was found to be 40.3%, indicating a high false negative rate. The specificity was 82.3%, which aligns with the fact that a positive clenched fist view is often accurate in diagnosing an SL injury.

Arthroscopy affords the surgeon the opportunity to directly visualize the SL interval, assess the degree of ligament injury, the reducibility of the SL joint, the health of the cartilage of the carpus and injury to critical extrinsic stabilizers. Regarding these ligaments, Lee et al[3,13] conducted a cadaveric study correlating the Geissler classification with sequential sectioning of SL intrinsic and extrinsic ligaments. Results noted a progressive increase in Geissler grade with serial sectioning. Arthroscopic sectioning of the volar and dorsal intrinsic SL ligaments resulted in grade 2 injury, and only after additional sectioning of the volar extrinsic ligaments, grade 3 instability was noted. Grade 4 instability was seen when additional dorsal extrinsic and scaphotrapeziotrapezoid (STT) ligaments were sectioned.[3] These findings

Table 2. Radiograph Association With Intraoperative Geissler Staging.

	Normal SL	Geissler 1	Geissler 2	Geissler 3	Geissler 4	Total
Negative radiographs[a]	21 (23.9%)	5 (5.7%)	25 (28.4%)	26 (29.5%)	11 (12.5%)	88

Note. SL = scapholunate.
[a]Posteroanterior, lateral, and clenched fist views.

Table 3. Relative Risk Analysis of Factors Potentially Affecting Accuracy of Clenched Fist View.

Variable	Parameter	Incidence	Relative risk	95% CI	*P* value
Lunate type	2	29/50 = 58%	1.0		
	1	47/74 = 63.5%	1.1	(0.82-1.47)	.54
SL angle (°)	>60	27/44 = 61.4%	1.0		
	≤60	49/79 = 62%	1.0	(0.76-1.35)	.94
Stress view SL gap, mm	<3	53/91 = 58.2%	1.0		
	≥3	23/33 = 69.7%	1.2	(0.90-1.59)	.22
Dorsal scaphoid translation	No	64/109 = 58.7%	1.0		
	Yes	12/15 = 80%	1.4	(1.01-1.84)	.04

Note. CI = confidence interval; mm = millimeter; SL = scapholunate.

suggest the spectrum of injury that can exist with differing degrees of Geissler findings at arthroscopy.

Ruby et al[14] recognized the radiographic finding of static dorsal scaphoid translation after a complete rupture of all stabilizers (intrinsic SL and volar/dorsal extrinsics). In our study, of the 15 patients with dorsal scaphoid translation on lateral radiographs, 12 (80%) had a positive clenched fist view. It was the only statistically significant risk factor to increase the accuracy of a positive clenched fist view. Interestingly, 3 of the 15 cases of dorsal scaphoid translation had normal clenched fist views. This only highlights that stress radiographs are not a reliable way to assess the integrity of SL stability.

There are several limitations of this study. Despite being a retrospective study, we were able to define a cohort of patients who presented with suspected SL injury with negative radiographs (unloaded and loaded) who went onto arthroscopic examination. We did not report on their clinical outcome as that was not the focus of this study. Radiographs were taken per the standardized protocol that exists within our institution, but despite this, there may have been variability in the patients' effort in loading their wrist. Lateral radiographs specifically were evaluated for adequate technique, confirming collinearity of the radius, capitate and long metacarpal, and alignment of the scaphoid tubercle and pisiform.[5] Measurement of intercarpal angles is subject to variability among the interpreting physician, and we tried to mitigate this by having 2 observers review the radiographs independently. In reviewing the operative records, there is interobserver and intraobserver variability in arthroscopic assessment of the SL interval and Geissler staging. We tried to mitigate this by using the surgeons' descriptions of their findings from their operative reports and photos to categorize the injuries. In addition, we did not include information regarding injury to other extrinsic ligaments of the wrist (STT, dorsal radiocarpal, and dorsal intercarpal ligaments) which when disrupted, can also result in SL instability. The premise of this study was to highlight to the treating practitioner that in patients with suspected SL ligament injury with normal radiographs, a high degree of vigilance should be maintained regarding the occurrence of this injury.

Notwithstanding these limitations, the results of this study demonstrated that more than 70% of patients with normal clenched fist radiographic views were found to have Geissler 2 or greater SL joint instability and 42% had Geissler 3 or greater SL joint instability at the time of arthroscopic evaluation. In addition, 45% of patients were also noted to have normal MRI findings. The sensitivity and specificity of the clenched fist radiograph for diagnosis of a stage 3 or greater SL injury were 40.3% and 82.3%, respectively. The positive predictive value of the stress radiograph was 69.4%, whereas its negative predictive value was 58%.

We feel that this is important information to guide the treating surgeon on their assessment of patients with a clinical suspicion of SL injuries without dynamic radiographic evidence of injury, stressing the importance of diagnostic wrist arthroscopy. As such, in our practice, in patients with a history and clinical examination suspicious of SL injury, with normal radiographs (unloaded and stress views), we will consider proceeding with wrist arthroscopy for determination of their injury.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

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 2000 and 2008.

Statement of Informed Consent

Informed consent for research purposes was obtained per institutional protocol.

Declaration of Conflicting Interests

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