Significance of Scapholunate Gap Width as Measured by Probe from Midcarpal

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Abstract

Keywords

- carpal instability
- distal radius fracture
- scapholunate ligament
- triangular fibrocartilage complex
- ulnar impaction syndrome
- wrist trauma

Background Geissler's classification is widely accepted in arthroscopic diagnostics of scapholunate (SL) ligament injury. Thereby, probe insertion into the SL gap from the midcarpal would indicate treatment necessity in patients with SL tear as seen from radiocarpal view.

Purpose In this review, the SL gap width, examined by the probe from midcarpal, was arthroscopically assessed in patients with intact SL ligaments, who were treated for ulnar impaction syndrome. The review examined how often lax SL joints can be found in patients with no complaints with respect to the SL ligaments and in which the SL ligaments were proven to be intact from radiocarpal view. We suspected that probe insertion, as an indicator for a lax joint, does not affect the outcome in ulnar impaction treatment.

Patients and Methods A total of 32 patients with clinically diagnosed ulnar impaction syndrome were arthroscopically treated by central resection and debridement of the triangular fibrocartilage; 8 patients underwent concurrent ulnar shortening, and 4 of them finally hardware removal. All patients were examined preoperatively as well as after 3, 6, and 12 months following arthroscopy, respectively, after ulnar shortening or hardware removal.

Results In 14 patients, the probe could not, in 18 patients, the probe could be inserted into the SL gap. There was neither any significant difference in the improvement of pain, grip strength, Krimmer, or DASH score, nor for any of the radiographic angles between the two groups.

Conclusion Laxity of the SL ligament allows the probe to be inserted into the SL gap from midcarpal in some patients. This finding, therefore, does not necessarily imply the necessity of treatment when there is partial rupture seen from radiocarpal view.

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Diagnostics of scapholunate (SL) ligament lesions is still a challenge for hand surgeons. In 1996, Geissler et al classified SL ligament lesions arthroscopically in the context of distal radius fractures.¹ They rated the ligament by its appearance from radiocarpal view where attenuation or hemorrhage could be found combined with the width of the SL gap on probe examination from midcarpal. Whereas in grade 1 and 2 lesions, the SL gap would be too tight for the probe to get inserted into the gap, in grade 3 lesions the probe, and in grade 4 lesions even the arthroscope could be inserted into or even passed through the gap. The latter also referred to as “drive-through sign” would at the latest prove a complete SL tear.¹ This classification has been modified according to the amount of step-off and diastasis as seen from midcarpal.² In the context of distal radius fractures, worse radiographic results have been found in patients with a midcarpal diastasis of one mm or more.³

While these gradings are commonly accepted, we regularly encounter SL joint diastasis when we perform wrist arthroscopies in patients with other complaints than deriving from the SL ligament. Often the probe can be inserted or even turned within the SL gap from midcarpal, whereas from radiocarpal view the SL ligament does not show any sign of a tear. Moreover, independent raters do not necessarily classify this finding as partial or even complete SL tear.^{4–6} Instead, they judge this finding as normal without any pathological value for many patients.

The purpose of this clinical review was to arthroscopically examine, how often lax SL joints can be found in patients with no complaints with respect to the SL ligaments and in which the SL ligaments were proven to be intact from radiocarpal view. Another question was, if a lax SL ligament, that is, the ability to insert the probe from midcarpal, would affect clinical outcome in the treatment of ulnar impaction.

Patients and Methods

A total of 32 consecutive patients with ulnar-sided wrist pain due to ulnar impaction syndrome in whom conservative treatment failed to diminish symptoms were included in this retrospective review. Among the patients who were suspected to have ulnar impaction syndrome, only those who presented with an isolated positive fovea sign with no other pathological findings upon clinical examination were followed by routine clinical follow-ups. None of the patients had tenderness over the SL joint from dorsal. Five of them had snapping upon Watson's scaphoid shift test.⁷ However, in these patients, the test was not painful, and snapping was present on the contralateral wrist, as well. Thus, the test was rated as nonpathological. The included patients had no history of fractures of the affected arm or wrist, and beside treatment of the ulnar impaction, no other procedure was done in these patients. The patients were preoperatively assessed for their pain level on a visual analog scale regarding exertion and rest and the range-of-motion and grip strength of both the affected and contralateral wrist. The Krimmer⁸ and Disability of Arm, Shoulder, and Hand (DASH) scores were calculated. A radiographic examination included stan-

dard plain X-rays in the posteroanterior (pa) and lateral view and the pa views of both wrists under axial load. Radiographic assessment included the width of the SL joint, as measured on the pa view radiographs on rest and under axial load. The SL, the radiolunate, and the radioscapoid angles were measured on the radiographs in the lateral view. These angles were found to be highly sensitive for SL ligament pathologies.⁹ Ulnar variance was determined using perpendiculars.¹⁰

Arthroscopy was performed in a standardized fashion with the wrists thoroughly examined from radiocarpal and midcarpal and documented as has been described in the literature.^{11,12} From the radiocarpal view, a lesion of the SL ligament was excluded by the thorough probe examination of the palmar, proximal, as well as dorsal part. For the latter, the optic was retracted slowly to display the dorsal aspect of the ligament. From the midcarpal view, the probe examined the SL joint to test its tightness. The joint was classified as tight when the probe could not be inserted into it (► Fig. 1; ► Videos 1A, B). It was rated as being lax when the probe could be inserted into or even twisted inside the gap (► Fig. 2; ► Videos 2A, B).

Video 1A

Intact scapholunate ligament from radiocarpal view.
Online content including video sequences viewable at:
www.thieme-connect.com/ejournals/html/doi/10.1055/s-0037-1602847.

Video 1B

Tight scapholunate joint from midcarpal view.
Online content including video sequences viewable at:
www.thieme-connect.com/ejournals/html/doi/10.1055/s-0037-1602847.

In 16 of the 32 patients, arthroscopy revealed a central triangular fibrocartilage complex (TFCC) perforation; the other 16 patients had no central TFCC lesion from radiocarpal view. In both situations, the TFCCs were first centrally resected by the use of a punch and then debrided using an oscillating shaver. Thereby, the ulnocarpal compartment was decompressed, and the lesions' margins were prevented from being pinched between the head of the ulna and the carpus. During TFCC resection, the joints were irrigated using saline. Arthroscopy was followed by the intra-articular injection of cortisone and bupivacaine into the radiocarpal and midcarpal joint space. The patients received a short arm cast for 1 week and were asked to limit load for two additional weeks. All patients were reached for follow-up examinations at 3, 6, and 12 months, respectively. Additional follow-ups were performed in patients who underwent ulnar

Fig. 1 (A–C) Standard radiographs and posteroanterior stress radiographs of a 37-year-old female patient with a native scapholunate (SL) joint width of 1.6 and 1.7 mm under stress and with an SL angle of 56 degrees on the lateral view. Arthroscopy revealed an intact SL ligament from radiocarpal view (Video 1A) with a tight SL joint from midcarpal (►Video 1B).

Fig. 2 (A–C) Standard radiographs and posteroanterior stress radiographs of a 36-year-old female patient with a native scapholunate (SL) joint width of 1.8 and 1.9 mm under stress and with an SL angle of 54 degrees on the lateral view. Arthroscopy revealed an intact SL ligament from radiocarpal view (►Video 2A) with a lax SL joint from midcarpal. The probe could be inserted and even twisted a bit inside the joint (►Video 2B).

shortening osteotomies (ulnar approach, 3.5-mm 7-hole plate placed palmarly, KLS Martin, Tuttlingen, Germany) or hardware removal after that, respectively, provided that symptoms persisted that long. Follow-up assessments were conducted in concordance with the ethical standards of the appropriate ethical committee. Furthermore, the ethical committee approved the clinical review of this cohort of patients.

Video 2A

Intact scapholunate ligament from radiocarpal view.
Online content including video sequences viewable at:
www.thieme-connect.com/ejournals/html/doi/10.1055/s-0037-1602847.

Video 2B

Lax scapholunate joint from midcarpal view.
Online content including video sequences viewable at:
www.thieme-connect.com/ejournals/html/doi/10.1055/s-0037-1602847.

Statistical Methods

The characteristics of the patients with a tight SL joint from midcarpal were compared with those patients with a lax joint, in whom the probe could be inserted into the SL gap

from midcarpal or even twisted within the gap, with the latter two groups being combined. A *t*-test was applied to the patients' age and SL width, Mann–Whitney test for the duration of symptoms until arthroscopy was performed, for the duration of working disability, and SL joint width and carpal angles as measured according to the radiographs. Fisher's exact test was used for ulnar variance and chi-square test for the affection of the dominant hand and the distribution of TFCC findings.

For the pre- to postoperative comparisons, the Shapiro–Wilk test showed significant deviation from a normal distribution for all data. Therefore, the nonparametric Wilcoxon test was applied for comparisons.

Improvements in the variables pain, grip strength, and Krimmer score at the different follow-ups demonstrated no normal distribution on the Shapiro–Wilk test. Comparisons between the two groups were therefore performed using the Kruskal–Wallis test. Analysis of variance testing was used to compare the improvements in DASH score. Fisher's exact test was used to compare the patients' satisfaction at follow-ups. The significance level was set at $p < 0.05$.

Results

Of the 32 included patients with intact SL ligament from radiocarpal view, 14 were found to have a tight joint on probe examination from midcarpal. ►Fig. 1 and ►Videos 1A, B represent such a patient with physiological angles with respect to the SL joint. In 14 further patients, the probe could be inserted into the SL joint, and in 4 patients, the SL joint was so lax, that the probe could be even twisted inside the gap. ►Fig. 2 and ►Videos 2A, B represent a patient with

Table 1 Characteristics of 32 patients treated for ulnar impaction with respect to SL joint laxity on probe examination from midcarpal

	Tight SL joint N = 14	Lax SL joint N = 18	Comparison of the two groups (<i>p</i> value)
Age (y)	34 (range, 18–60)	34 (range, 18–55)	0.989
Affected wrist	7 right/7 left	8 right/10 left	–
Affected wrist is dominant wrist	9 yes/5 no	9 yes/9 no	0.419
Duration of symptoms (mo)	10.2 (range, 1.5–36)	8.3 (range, 1–24)	0.292
Symptoms related work disability (wk)	0.7 (range, 0–3)	3.0 (range, 0–8)	0.040
Ulnar variance	Mean	Mean	0.578
	+0.93 mm	+0.94 mm	
	0x – 1 mm	1x – 1 mm	
	5x ± 0 mm	8x ± 0 mm	
	6x + 1 mm	3x + 1 mm	
	2x + 2 mm	3x + 2 mm	
	1x + 3 mm	3x + 3 mm	
TFCC perforation found on arthroscopy	8 No/6 yes	8 No/10 yes	0.476

Abbreviations: Lax SL joint, probe insertable or even twistable within the SL gap from midcarpal; SL, scapholunate; TFCC, triangular fibrocartilage complex; tight SL joint, probe not insertable into the SL gap from midcarpal.

Table 2 Comparison of radiographic measurements of 32 patients treated for ulnar impaction with respect to SL joint laxity on probe examination from midcarpal

	Tight SL joint N = 14	Lax SL joint N = 18	Comparison of the two groups (p value)
SL joint width on rest (mm)	1.90 (SD 0.28) Range, 1.50–2.42	2.00 (SD 0.40) Range, 1.40–2.70	0.431
SL joint width on exertion (mm)	2.09 (SD 0.35) Range, 1.52–2.80	2.20 (SD 0.39) Range, 1.68–3.05	0.420
Scapholunate angle (degrees)	58 (IQR 7) Range, 48–82	60 (IQR 9) Range, 38–74	0.221
Radiolunate angle (degrees)	0 (IQR 2.5) Range, –8 to 8	0 (IQR 0) Range, –8 to 10	0.965
Radioscaphoid angle (degrees)	59 (IQR 11.5) Range, 48–82	60 (IQR 8.5) Range, 34–74	0.515

Abbreviations: IQR, interquartile range; Lax SL joint, probe insertable or even twistable within the SL gap from midcarpal; SD, standard deviation; SL, scapholunate; TFCC, triangular fibrocartilage complex; tight SL joint, probe not insertable into the SL gap from midcarpal.

Note: Results displayed by mean and SD, respectively, and by median and IQR.

physiological carpal angles and in whom the probe could be inserted into the SL joint from midcarpal. The patients' characteristics are listed in ►Table 1. The patients' age, duration of symptoms, the affection of the dominant hand, ulnar variance, and TFCC findings according to Palmer did not differ between the groups. Work disability, instead, was significantly longer in the patients with lax SL ligaments.

Neither the SL joint width as measured on plain pa radiographs on rest and exertion nor the SL, the radiolunate or the radioscaphoid angles differed significantly between the two groups. Measurements are displayed in ►Table 2.

Among the 14 patients with a tight SL ligament, 3 patients underwent ulnar shortening for persisting or recurrent pain, 3, 8, and 16 months following arthroscopy.

Table 3 Results for 14 patients with tight SL, following central TFCC resection and debridement, consecutive ulnar shortening or hardware removal

	Pre-op N = 14	3 mo post-op N = 14	6 mo post-op N = 13	12 mo post-op N = 12	Final follow-up Mean 1.57 y N = 14
Pain on exertion (VAS)	7.5 (IQR 1.9)	3.3 (IQR 7.3) p = 0.008	2.5 (IQR 6.8) p = 0.008	2.8 (IQR 7.4) p = 0.014	1.8 (IQR 6.5) p = 0.004
Pain at rest (VAS)	1.0 (IQR 4.8)	0.0 (IQR 0.0) p = 0.007	0.0 (IQR 0.5) p = 0.027	0.0 (IQR 0.0) p = 0.007	0.0 (IQR 0.3) p = 0.007
Grip strength compared with contralateral hand	90% (IQR 20)	98% (IQR 18) p = 0.162	93% (IQR 24) p = 0.576	99% (IQR 19) p = 0.055	96% (IQR 20) p = 0.090
Extension (degrees)	65 (IQR 6.3)	60 (IQR 5) p = 0.230	65 (IQR 7.5) p = 0.609	70 (IQR 17.5) p = 0.117	70 (IQR 15) p = 0.034
Flexion (degrees)	73 (IQR 26)	75 (IQR 17.5) p = 0.380	70 (IQR 15) p = 0.323	80 (IQR 10) p = 0.504	80 (IQR 15) p = 0.150
Radial abduction (degrees)	30 (IQR 0)	30 (IQR 11) p = 0.783	30 (IQR 10) p = 0.931	30 (IQR 14) p = 1.000	30 (IQR 10) p = 1.000
Ulnar abduction (degrees)	30 (IQR 10)	30 (IQR 5) p = 0.670	30 (IQR 2.5) p = 0.472	32.5 (IQR 5) p = 0.156	32.5 (IQR 6.3) p = 0.048
Pronation (degrees)	80 (IQR 12.5)	80 (IQR 10) p = 0.206	80 (IQR 10) p = 0.349	80 (IQR 7.5) p = 1.000	80 (IQR 10) p = 0.564
Supination (degrees)	90 (IQR 10)	90 (IQR 10) p = 0.655	90 (IQR 10) p = 0.577	85 (IQR 10) p = 1.000	85 (IQR 10) p = 0.655
Krimmer score	79.2 (IQR 15)	87.5 (IQR 17) p = 0.017	85.0 (IQR 12) p = 0.017	85.0 (IQR 15) p = 0.006	95.0 (IQR 15) p = 0.002
DASH score	31.0 (IQR 13)	14.1 (IQR 30) p = 0.011	12.5 (IQR 19) p = 0.007	8.8 (IQR 11) p = 0.002	8.8 (IQR 12) p = 0.001
Satisfied yes/no	–	12/2	11/2	10/2	15/2

Abbreviations: DASH, disability of arm, shoulder and hand questionnaire; IQR, interquartile range; pre-op, preoperative; post-op, postoperative; TFCC, triangular fibrocartilage complex; VAS, visual analog scale.

Note: Results displayed in median and IQR.

Table 4 Results for 18 patients with lax scapholunate ligament, following central TFCC resection and debridement, consecutive ulnar shortening or hardware removal

	Pre-op N = 18	3 mo post-op N = 18	6 mo post-op N = 16	12 mo post-op N = 15	Final follow-up Mean 1.73 y N = 17
Pain on exertion (VAS)	7.5 (IQR 1.5)	4.0 (IQR 5.0) <i>p</i> = 0.001	2.0 (IQR 4.9) <i>p</i> = 0.001	2.0 (IQR 5.0) <i>p</i> = 0.001	1.0 (IQR 3.5) <i>p</i> = 0.000
Pain at rest (VAS)	3.0 (IQR 3.3)	0.0 (IQR 0.6) <i>p</i> = 0.002	0.0 (IQR 0.8) <i>p</i> = 0.006	0.0 (IQR 1.0) <i>p</i> = 0.004	0.0 (IQR 0.5) <i>p</i> = 0.002
Grip strength compared with contralateral hand	85% (IQR 40)	94% (IQR 21) <i>p</i> = 0.011	98% (IQR 16) <i>p</i> = 0.079	100% (IQR 20) <i>p</i> = 0.038	94% (IQR 18) <i>p</i> = 0.033
Extension (degrees)	60 (IQR 11)	60 (IQR 11) <i>p</i> = 0.484	60 (IQR 19) <i>p</i> = 0.582	70 (IQR 10) <i>p</i> = 0.074	65 (IQR 10) <i>p</i> = 0.045
Flexion (degrees)	70 (IQR 15)	68 (IQR 17.5) <i>p</i> = 0.459	68 (IQR 8.8) <i>p</i> = 0.858	70 (IQR 20) <i>p</i> = 0.143	70 (IQR 20) <i>p</i> = 0.235
Radial abduction (degrees)	30 (IQR 5)	30 (IQR 10) <i>p</i> = 0.854	30 (IQR 8.8) <i>p</i> = 0.599	30 (IQR 5) <i>p</i> = 0.331	30 (IQR 7.5) <i>p</i> = 0.454
Ulnar abduction (degrees)	20 (IQR 15)	30 (IQR 5) <i>p</i> = 0.003	30 (IQR 5) <i>p</i> = 0.020	30 (IQR 10) <i>p</i> = 0.007	30 (IQR 7.5) <i>p</i> = 0.001
Pronation (degrees)	80 (ICR 10)	80 (IQR 20) <i>p</i> = 0.098	80 (IQR 10) <i>p</i> = 0.008	80 (IQR 20) <i>p</i> = 0.145	80 (IQR 20) <i>p</i> = 0.248
Supination (degrees)	90 (IQR 13)	90 (IQR 10) <i>p</i> = 0.317	90 (IQR 10) <i>p</i> = 0.167	90 (IQR 0) <i>p</i> = 0.141	90 (IQR 0) <i>p</i> = 0.167
Krimmer score	70.0 (IQR 25)	85.0 (IQR 22) <i>p</i> = 0.001	88.3 (IQR 16) <i>p</i> = 0.002	90.0 (IQR 20) <i>p</i> = 0.002	93.3 (IQR 15) <i>p</i> = 0.001
DASH score	46.3 (IQR 38)	23.7 (IQR 23) <i>p</i> = 0.001	9.2 (IQR 27) <i>p</i> = 0.001	8.3 (IQR 25) <i>p</i> = 0.001	7.5 (IQR 20) <i>p</i> = 0.000
Satisfied yes/no	–	14/4	14/2	14/1	16/1

Abbreviations: DASH, disability of arm, shoulder and hand questionnaire; IQR, interquartile range; pre-op, preoperative; post-op, postoperative; TFCC, triangular fibrocartilage complex; VAS, visual analog scale.

Note: Results displayed in median and IQR.

Among the 18 patients with lax SL ligament, six patients underwent further procedures for persistent or recurring ulnar-sided wrist pain. Ulnar shortenings were conducted in five patients 4, 5, 10, 12, and 14 months following arthroscopy. Of these patients, one 41-year-old patient underwent hardware removal 2 years following ulnar shortening. One 21-year-old patient complained of persistent discomfort at the ulnocarpal joint and along the site of the plate. Along with hardware removal 15 months after ulnar shortening, she underwent resection of her centrally regenerated TFCC defect, which relieved her pain. One 18-year-old patient was treated successfully for 18 months until his symptoms recurred. The patient refused ulnar shortening, so he underwent a second arthroscopy 19 months after the index procedure. Regeneration of the central TFCC portion was also diagnosed in this patient. Repeat resection and debridement again alleviated the patient's complaints.

One patient was satisfied with the result of arthroscopy 3 months postoperatively. However, she suffered a cerebrovascular accident 5 months postoperatively and was therefore excluded from further follow-up.

In both groups of patients, with tight and with lax SL ligament (– **Tables 3** and **4**), at all follow-up examinations, pain on exertion and rest, and the Krimmer and DASH scores

were significantly improved. In patients with tight SL ligament, improvement of extension and ulnar abduction was significant at final follow-up. In patients with lax SL ligament, improvement of grip strength was significant after 3 and 12 months and at final follow-up. Improvement of the extension was significant at final follow-up and pronation after 6 months, respectively. The ulnar abduction was significantly improved at all follow-up examinations. All other variables were not significantly changed.

Comparison of the two groups revealed no significant difference in outcome for any of the examined parameters (– **Table 5**).

Discussion

This review examined how often lax SL joints can be found in patients with no complaints with respect to the SL ligaments and in which the SL ligaments were proven to be intact from radiocarpal view. The review examined the impact of arthroscopically assessed SL gap width on outcome in patients with ulnar impaction syndrome. The study has shown no difference in outcome between patients with tight and with lax SL ligament. Nor did the radiographic measurements indicate any sign of SL instability in the patients with a lax SL

Table 5 Comparison of outcomes in 14 patients with tight to 18 patients with lax SL ligament as examined by probe from midcarpal

	Outcome compared with index values			
	3 mo	6 mo	12 mo	Final follow-up
Pain on exertion (VAS)				
With tight SL	−3.2 (SD 3.6)	−3.5 (SD 3.6)	−3.4 (SD 3.5)	−4.4 (SD 3.8)
With lax SL	−2.9 (SD 2.5)	−4.3 (SD 2.4)	−4.3 (SD 2.7)	−5.2 (SD 2.4)
Comparison	$p = 0.745$	$p = 0.435$	$p = 0.431$	$p = 0.513$
Pain at rest (VAS)				
With tight SL	−0.8 (IQR 4.8)	−1.0 (IQR 5.5)	−1.0 (IQR 5.4)	−1.0 (IQR 4.3)
With lax SL	−2.0 (IQR 3.6)	−2.8 (IQR 3.9)	−2.5 (IQR 3.5)	−2.5 (IQR 3.3)
Comparison	$p = 0.645$	$p = 0.675$	$p = 0.941$	$p = 0.561$
Grip strength compared with contralateral hand				
With tight SL	4.5% (IQR 22)	11% (IQR 41)	16% (IQR 27)	13% (IQR 30)
With lax SL	7.0% (IQR 16)	7.5% (IQR 27)	8.0% (IQR 11)	8.0% (IQR 28)
Comparison	$p = 0.704$	$p = 0.930$	$p = 0.625$	$p = 0.858$
Krimmer score				
With tight SL	14 (SD 17)	13 (SD 17)	14 (SD 14)	17 (SD 15)
With lax SL	14 (SD 14)	19 (SD 16)	18 (SD 15)	22 (SD 12)
Comparison	$p = 0.926$	$p = 0.313$	$p = 0.531$	$p = 0.328$
DASH score				
With tight SL	−16 (SD 17)	−18 (SD 18)	−25 (SD 11)	−25 (SD 10)
With lax SL	−23 (SD 19)	−32 (SD 20)	−34 (SD 20)	−34 (SD 17)
Comparison	$p = 0.249$	$p = 0.075$	$p = 0.214$	$p = 0.093$
Satisfied with treatment				
With tight SL	12/14	11/13	10/12	12/14
With lax SL	14/18	14/16	14/15	16/17
Comparison	$p = 0.672$	$p > 0.999$	$p = 0.569$	$p = 0.576$
Consecutive operations				
With tight SL	3x ulnar shortening out of 14			
With lax SL	6 out of 18 (4x ulnar shortening, 1x ulnar shortening and repeat arthroscopy, 1x repeat arthroscopy, thereof 2x hardware removal)			

Abbreviations: DASH, disability of arm, shoulder and hand questionnaire; IQR, interquartile range; SD, standard deviation; SL, scapholunate ligament; VAS, visual analog scale.

Note: Results displayed in mean and SD or median and IQR.

ligament. Since only patients with an isolated positive fovea sign, respectively, with specific signs of ulnar impaction were included in this review, we supposed that findings with respect to the SL ligament are fully independent of the findings and concurrent treatment with respect to the ulnar impaction. However, Czitrom et al found a statistical significant correlation between negative ulnar variance and SL ligament lesions.¹³ In contrast, in the context of distal radius fractures, the risk of a concurrent SL ligament lesion was found to be fourfold increased, when the fracture was associated with a loss of radial length of more than 2 mm³. As opposed to these findings, a correlation between ulnar variance and SL ligament lesions could neither be confirmed

by a study on 88 cadaver dissections, nor by a clinicoradiological study on 167 patients.¹⁴ All the same, in the present study, mean ulnar variance did not differ between patients with tight compared with patients with lax SL ligament ($p = 0.578$). Therefore, the findings in the patients examined in this study were assumed to be physiological with respect to the SL ligament.

Many authors that report on SL ligament repair or reconstruction differentiate between predynamic, dynamic, and static SL instability with or without dorsiflexed intercalated segment instability (DISI).^{15–18} This radiographic classification takes into account the SL gap width on plain radiographs on rest and under stress. The more arthroscopic techniques

developed with time, the more relevance arthroscopic classifications achieved. Thereby, Geissler's classification¹ is one of the most cited references in respect of SL ligament injuries.¹⁹ Geissler classified the lesions in the context of distal radius fractures. Other arthroscopic classifications do as well take into account an eventual step-off as seen from midcarpal view and the SL gap width as measured by the probe from midcarpal.^{2,20} Lindau et al modified Geissler's classification in the way that they rated the SL ligament lesion mainly by the radiocarpal findings.² They differentiated between partial and complete tears according to whether the palmar, membranous and/or dorsal part was affected. A midcarpal diastasis and step-off would indicate the degree of mobility and not necessarily pathological instability.² Nevertheless, a prospective observational study on 10 patients with distal radius fractures with concurrent grade-3 SL ligament lesion demonstrated significantly greater prevalence of pain at the SL joint on the Watson's test, worse subjective rating on Gartland and Werley score and a greater proportion of dynamic and static dissociation including a significantly greater relative difference in the SL angle between the injured and the uninjured wrist when compared with 41 patients with grade-0 to grade-2 lesions.³ In their study, the patients' fractures were treated by closed reduction or external or internal fixation, with none of the SL ligament lesions having been treated. van Kampen et al reported a patient, in whom they diagnosed a tear of the palmar portion of the SL ligament, whereas arthroscopy revealed a grade-3 lesion according to Geissler. They performed a reconstruction of the palmar portion by a flap of the radiolunate ligament with excellent result at 3 years post-operatively.²¹ Messina et al sequentially cut specific portions of the SL ligament itself and the secondary stabilizers, the extrinsic ligaments, in cadavers and checked SL instability arthroscopically and radiographically. They differentiated between widening of the palmar and dorsal SL joint portion by testing them separately with a probe from midcarpal. The ability to twist the probe within the joint would indicate instability. Thereby, this classification would allow differentiating between the two predynamic situations, with stage II signifying no instability on midcarpal testing, and stage III being characterized by laxity either palmar, dorsal, or both. The two latter situations would the latest require treatment.²⁰ The authors admitted that this classification has yet to be verified by clinical studies.

This study has some limitations besides the retrospective design. The patients were followed only clinically with no specific radiographic evaluation for SL ligament instability at follow-up examinations. Moreover, the number of patients is low, so that it is possible that the power of this study is not strong enough to eliminate a type 2 statistical error.

Arthroscopy indeed plays an essential role in the diagnostic algorithm of SL instabilities when treating distal radius fractures. When intraoperative radiographs show obvious signs of SL instability like DISI or increased SL gap, then according to our experience, SL instability is often chronic rather than acute. In this case, arthroscopy allows

fast access to the joint to explore for secondary cartilage lesions. If DISI is absent and the SL gap is narrow, then the traction test as described by Schädel-Höpfner et al allows examining for dynamic instability.²² If there is gapping while traction is applied to the thumb, then arthroscopy is recommended to verify SL ligament lesion. An acute tear of the membranous portion with intact dorsal portion of the SL ligament may be treated conservatively with a short arm cast for 4 weeks, no matter whether the SL joint is lax on probe examination from midcarpal or not. The results of this study seem to confirm this approach. In the case of an acute ligament tear with a positive drive-through sign, however, SL ligament repair is to be performed.

Ethical Review Committee Statement

The ethical committee of the University Hospital of Würzburg, Germany approved the clinical review of these patients.

Conflict of Interest

None.

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