1 Title Page

2 Ulnar-sided wrist pain: A prospective analysis of diagnostic clinical tests

3 Running Head

4 Ulnar wrist pain

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56 **Abstract**

57

58 **INTRODUCTION**

59 Identifying the cause of pain on the ulnar side of the wrist can be challenging. The outcome and
60 recovery following surgery can be unpredictable. The aim of this study was to document and
61 analyse the clinical tests used to evaluate the cause of ulnar sided wrist pain and determine
62 their diagnostic relevance.

63 **METHODS**

64 This is a prospective evaluation of 110 patients who presented with pain on the ulnar side of
65 the wrist. The clinical evaluation and results from radiological investigations were documented
66 and analysed.

67 **RESULTS**

68 There were seventeen different diagnoses. Eighty-five percent of the diagnoses were triangular
69 fibrocartilage complex (TFCC) injuries, ulnocarpal abutment syndrome, pisotriquetral arthritis,
70 triquetral fracture or non-union, distal radioulnar joint arthritis and extensor carpi ulnaris
71 pathology. The ulnocarpal stress test and ulnar foveal sign was positive in several diagnoses.
72 The ulnar foveal sign had a sensitivity and specificity of 89% and 48% for TFCC injuries, and 85%
73 and 37% for ulnocarpal abutment syndrome. The sensitivity and specificity of pisotriquetral
74 shear test for pisotriquetral arthritis was 100% and 92%. Patients with pisotriquetral arthritis or
75 extensor carpi ulnaris pathology localised their pain better on the patient Pain Localisation
76 Chart.

77 **DISCUSSION**

78 Diagnosis of TFCC injuries, ulna-carpal abutment syndrome, distal radioulnar joint arthritis and
79 extensor carpi ulnaris injuries are challenging as the clinical symptoms and signs for the four
80 diagnoses were similar and required either MRI or computed tomography for diagnostic
81 confirmation after clinical examination. The ulnocarpal stress test and the ulnar foveal sign were
82 not sufficiently specific.

83

84 Keywords

85 Ulnar wrist pain; triangular fibrocartilage; carpal; distal radioulnar joint

86

87 Type of Study / Level of Evidence:

88 Prospective observational diagnostic study / Level of Evidence: II

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98 **INTRODUCTION**

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100 The aetiology of ulnar-sided wrist pain (USWP) can be difficult to determine. The clinical
101 symptoms and physical examination findings for various diagnoses causing USWP often
102 overlap.[1] Clinical evaluation develops a list of differential diagnoses that prompt the
103 examiner to selectively perform special tests and request relevant imaging studies.

104 The aim of this study was to document and analyse the clinical tests used to elicit signs
105 in a cohort of patients presenting with USWP as well as the radiological tests performed
106 in investigating these patients and determine their usefulness in making a diagnosis.

107

108 **METHODS**

109

110 Institutional ethics approval was obtained to prospectively evaluate a cohort of patients
111 who presented with USWP. Data collected included patient demographics and
112 completion of a Pain Localisation Chart (Figure 1). The Pain Localisation Chart was
113 developed for this study and has not been validated. It is a photograph of the hand and
114 wrist with surface markings of anatomical landmarks. Patients are asked to circle on the
115 chart sites corresponding to their pain. These sites were divided into eight locations:
116 radial, dorso radial, dorsal, dorso ulnar, ulnar, volar ulnar, volar and volar radial. Each
117 marked site was allocated one point and a patient-reported Pain Location Score was
118 calculated from the sum of sites marked and ranged from 1 to 8. Areas of tenderness
119 on clinical examination were marked on the Pain Localisation Chart and the Tenderness

120 Location score calculated. Similarly, the surgeon-reported Tenderness Location Score
121 ranged from 1 to 8. A score of 1 indicated localised tenderness, and a score of 8
122 indicated diffuse pain. Provocative tests specific to the diagnosis of USWP were
123 performed and recorded. These tests include distal radioulnar joint instability test,[2]
124 midcarpal instability test,[3] lunotriquetral shuck test,[4] ulnar carpal grind test,[5] ulnar
125 foveal sign, extensor carpi ulnaris instability test, and pisotriquetral shear test.[6,7] The
126 investigations performed for each patient were also recorded. They include plain
127 radiographs, computed tomography (CT) scan and magnetic resonance imaging (MRI).
128 Diagnosis of the cause of USWP was made after correlating the clinical features with the
129 available radiological investigations. Minimum follow-up for each patient was three
130 months. The sensitivity, specificity, positive predictive values, negative predictive
131 values, likelihood ratios and accuracy for each of the clinical tests were calculated using
132 fourfold tables. Unpaired Student's t-test was used to establish the p-values for Pain
133 and Tenderness Location Scores.

134

135 **RESULTS**

136

137 Between April 2017 and September 2018, 110 patients were enrolled into the study. The
138 demographic data of these patients are outlined in Table 1. Although there was a wide range
139 of diagnoses, 93 patients (85%) were diagnosed with triangular fibrocartilage complex
140 injuries (TFCC), ulno-carpal abutment syndrome (UCAS), distal radioulnar joint arthritis
141 (DRUJ OA), pisotriquetral arthritis (PTA), triquetral fracture or nonunion, or extensor carpi
142 ulnaris (ECU) tendinopathy (Table 2).

143

144 Symptoms such as pain on ulnar deviation, pain on loading the wrist in an extended position
145 (weight bearing) and to a lesser extent, pain on supination, were prevalent amongst all six
146 diagnostic groups (Supplementary Table 1). There were no symptoms specific to a particular
147 diagnosis.

148

149 Two clinical signs were particularly prevalent in the six most common diagnostic groups.
150 Specifically, the ulnocarpal grind test was positive in more than 50% of the patients with
151 TFCC injuries, UCAS, DRUJ OA and ECU tendinopathy (Supplementary Table 2). Similarly, the
152 ulnar foveal sign was positive in more than 50% of the patients with TFCC injuries, UCAS and
153 DRUJ OA. Subgroup analysis was performed for the two most common diagnoses, TFCC
154 injuries and UCAS (Table 3). The accuracy of the ulnocarpal grind test in diagnosing TFCC
155 injury without UCAS was 52%, and 64% for UCAS with associated TFCC injury. The accuracy
156 of a positive ulnar foveal sign in diagnosing TFCC injuries was 66%, and 46% for UCAS without
157 TFCC injury. Four patients with UCAS did not have an associated TFCC injury. The
158 pisotriquetral exam was an accurate test for PTA with sensitivity, specificity, positive and
159 negative predicted values of 100%, 92%, 58%, 100% respectively (Supplementary Table 2).
160 Eighty seven percent of patients with TFCC injuries underwent a diagnostic MRI scan. MRI
161 was required for 57 out of 74 patients to differentiate the diagnosis for TFCC injuries, UCAS,
162 DRUJ OA and ECU tendinopathy

163

164 Pain across three zones involving the dorsal ulnar, ulnar and volar ulnar regions were
165 common for TFCC injuries, UCAS, DRUJ OA and triquetrum fracture and nonunion groups.
166 Pain was more focally represented in the dorsal ulnar and ulnar region for ECU

167 tendinopathy, and in the volar ulnar region for PTA (Supplementary Table 3). Surgeon-
168 recorded tenderness location (Supplementary Table 4) was more precise than patient-
169 reported pain location for TFCC injuries and DRUJ OA (p=0.01 and p=0.03 respectively).
170 There was no statistically significant difference of the two scores for UCAS, ECU
171 tendinopathy, PTA and triquetral fracture or non-union groups (p>0.05).
172
173 Four patients were diagnosed with dual pathologies. These were lunotriquetral ligament
174 and a TFCC foveal tear, UCAS and juvenile rheumatoid arthritis, TFCC and ECU subsheath
175 tear, and DRUJ and radiocarpal OA. The ulnar wrist pain in two patients were undiagnosed
176 after clinical examination and radiological investigations.
177

178 **DISCUSSION**

179
180 Though not all patients underwent treatment, nor did all patients respond favourably to
181 treatment, the presumption of correct aetiology is based on the correlation of patient
182 symptoms, signs derived from clinical examination and the radiographic investigations used.
183 In contrast to Diaz,[2] we found that a diagnosis could be made in most patients presenting
184 with USWP. In two patients, the diagnosis was unresolved. Eighty-five percent of the causes
185 were from six diagnoses, namely TFCC injuries, UCAS, DRUJ pathologies, ECU tendinopathy,
186 triquetral fracture/non-union and PTA. The most-common diagnosis was TFCC injury and
187 contributed to 40% of our patient series. Together with UCAS, the two groups accounted for
188 56% of the patients. Pain on weight bearing and with ulnar deviation, was a common
189 symptom for all six groups and did not help to differentiate the diagnoses. Patients with
190 TFCC injuries, UCAS and DRUJ OA share similar symptoms.

191

192 Nakamura et al. stated that the ulnocarpal grind test may be positive in patients with TFCC
193 injury, UCAS, DRUJ OA, LT OA, ECU pathologies or loose bodies. They suggested that wrist
194 arthroscopy was warranted after relevant radiological investigations.[5] We found that
195 ulnocarpal grind test and the ulnar foveal sign (Table 3) were not sufficiently sensitive or
196 specific to differentiate TFCC injury alone or with UCAS as patients with DRUJ OA or ECU
197 pathology may also test positive. Though not very specific, patients with a negative
198 ulnocarpal grind test are unlikely to suffer UCAS. Similarly, patients with a negative foveal
199 sign are unlikely to suffer with symptoms from TFCC injury or UCAS.

200

201 Tay at al. reported a much higher sensitivity and specificity rates of a positive foveal sign in
202 detecting foveal disruption or UT ligament injuries. [8] However, it was a retrospective study
203 of patients who had undergone wrist arthroscopy and may be subject to selection bias.
204 Similarly, the sensitivity and specificity of the test may be increased in this study as our
205 patient cohort suffered with symptoms sufficiently severe to warrant clinical examination
206 and radiological investigations.

207

208 Schmauss et al,[9] in a retrospective analysis of the diagnostic value of the ulnar foveal sign
209 and ulnocarpal grind test in patients who had undergone MRI imaging and wrist
210 arthroscopy, reported that both clinical tests had low positive predictive values for TFCC
211 pathologies, with a score of 0.53 and 0.55 respectively. Additionally, Prosser et al. [10]
212 prospectively evaluated the diagnostic value of provocative wrist tests and MRI for
213 suspected wrist ligament injuries. In their prospective cross-sectional study, clinical tests for
214 TFCC pathology had a low positive and negative likelihood ratio of 1.88 and 0.53. This was

215 classified as not useful.[10, 11] We agree with Schmauss et al.[9] and Prosser et al.[10] that the
216 ulnocarpal grind test and foveal sign were not sufficiently sensitive to differentiate the
217 different diagnoses of ulnar-sided wrist pathology.

218

219 Prosser et al.[10] also reported that MRI together with appropriate provocative tests
220 improved the likelihood of correct diagnoses of TFCC injuries by 13%. The positive and
221 negative likelihood ratio was 5.56 and 0.15, respectively. This was classified to be
222 moderately useful. The interpretation of MRI requires clinical correlation as it is a highly
223 sensitive investigation and radiological pathologies identified on MRI may not necessarily
224 be symptomatic,[12, 13] and its use should be to confirm the clinical suspicion after examination
225 and not as a universal investigative tool.

226

227 Other investigations required for UCAS were standard posteroanterior and lateral wrist
228 plain radiographs and posteroanterior clenched fist and radial and ulnar deviated wrist
229 radiographs to evaluate static and dynamic ulnar positive variance[14], and the diagnostic
230 criteria is that described by Nakamura et al.[5] Correlation is also made with MRI specifically
231 assessing for signs of ulnar head, lunate or triquetral oedema or cysts which may be
232 accompanied with a tear of the TFCC.

233

234 Although patients with DRUJ OA had similar clinical features to those with TFCC injuries and
235 UCAS groups, DRUJ OA was diagnosed from plain radiographs. MRI scan is used to exclude
236 concurrent soft tissue pathology if clinical signs were not confined to the DRUJ.

237

238 Pisotriquetral shear test was an accurate and useful test for the diagnosis of PTA and its
239 diagnosis was confirmed by plain radiographs or computed tomography. As the provocative
240 tests were not specific for triquetral fracture or non-union, its diagnosis was made from
241 clinical suspicion, localised tenderness and plain radiographs. Similarly, patients with ECU
242 pathology did not present with specific clinical features and though these patients had more
243 localised pain and tenderness, ultrasound or MRI was required for diagnosis.
244
245 The Pain Localisation Chart was a helpful document that allowed patients to objectively
246 outline the site of their symptoms and for the clinician to examine structures relevant to the
247 patient marked areas.
248
249 Limitations of this investigation are that though the diagnosis of USWP is derived from a
250 combination of clinical symptoms, signs from provocative tests, and confirmation with
251 relevant radiographic investigations, the diagnosis and its treatment may not necessarily
252 result in alterations to the patient outcome. The number of patients we enrolled were
253 insufficient for diagnostic subgroup statistical analysis. As a specialist group of hand and
254 wrist surgeons, there may be a bias with our patient population. It is likely that the majority
255 of patients with USWP, in the early stages, resolve without a diagnosis or investigation and
256 those that attend our clinic have more prolonged symptoms and potentially more likelihood
257 for a diagnosis.
258
259 The relevance of this study is that localisation of tenderness and provocative tests were not
260 sufficiently sensitive or specific to indicate aetiology of ulnar wrist pain but required the
261 interpretation of appropriate radiology after close examination.

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267 relationships that may pose a conflict of interest to the content or preparation of this
268 report.

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323 Figure Legend

324

325 Figure 1. Pain localisation chart

326 Table 1. Demographic data

327 Table 2. Diagnoses of ulnar-sided wrist pain

328 Table 3. Subgroup analysis of diagnostic tests for triangular fibrocartilage
329 injury and ulnar carpal abutment syndrome.

330 Supplement 1. Presenting symptoms from ulnar side of the wrist

331 Supplement 2. Clinical signs in patients with ulnar-sided wrist pain

332 Supplement 3 Pain location from pain localization chart

333 Supplement 4. Surgeon-recorded tenderness location on pain localisation chart

334

335 Table 1.
336

Age	13 – 76 years (Av. 45)
Male : Female	60 : 50
Compensable Cases	29
Mechanism of Injury	
Gradual, no apparent incident	28
Fall	23
Sports-related	15
Twisting	13
Lifting	10
Ulnar impaction activities	6
Previous trauma	5
Hyperextension injury	5
MVA	3
Computer-work related	2

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340 Table 2
341

USWP diagnoses	N (%)
TFCC (Palmar 1)	44 (40%)
UCAS	18 (16%)
PTOA	11 (10%)
Triquetrum fracture / nonunion	8 (7%)
DRUJ OA	7 (6%)
ECU pathology	5 (5%)
Undetermined	2 (2%)
Ulnar styloid Non-union	3 (3%)
Distal radius malunion	2 (2%)
Flexor carpi ulnaris tendinopathy	1 (1%)
Intersection syndrome	1 (1%)
Volar wrist ganglion	1 (1%)
midcarpal OA	1 (1%)
scapholunate ganglion occult	1 (1%)
Ulnar sided giant cell tumour	1 (1%)
Lunotriquetral tear and foveal tear	1 (1%)
Total	110

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345 Table 3
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DIAGNOSTIC TEST STATISTICS				
	Ulnocarpal grind Test		**Ulnar Foveal Sign**	
USWP pathologies	TFCC	UCAS	TFCC	UCAS
	Value (95% CI)	Value (95% CI)	Value (95% CI)	Value (95% CI)
Subgroup numbers	44	18	44	18
Sensitivity	52% (37, 67)	90% (67, 99)	89% (76, 96)	85% (62, 97)
Specificity	52% (39, 64)	58% (47, 69)	48% (36, 61)	37% (27, 48)
Positive Predictive Value	44% (35 53)	31% (25, 37)	55% (49, 62)	23% (19, 28)
Negative Predictive Value	60% (51, 69)	96% (54, 73)	86% (72, 94)	92% (79, 97)
Positive Likelihood Ratio	1.08 (0.74,1.57)	2.14 (1.61, 2.86)	1.73 (1.34, 2.24)	1.34 (1.05, 1.71)
Negative Likelihood Ratio	0.93 (0.63,1.36)	0.18 (0.05,0.68)	0.22 (0.09, 0.53)	0.41 (0.14, 1.20)
Accuracy	52% (42,62)	64% (54,73)	66% (56, 74)	46% (36, 55)

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351 Supplementary Table 1

		ULNAR-SIDED WRIST SYMPTOMS									
USWP PATHOLOGY	N	Pain on ulnar deviation (%)	Pain on radial deviation (%)	Pain on flexion (%)	Pain on extension (%)	Pain on pronation (%)	Pain on supination (%)	Pain on weight bearing (%)	Click (%)	Clunk (%)	Swelling (%)
TFCC	44	***50***	23	16	16	***52***	***57***	***59***	18	9	18
UCAS	18	***78***	0	28	6	33	***50***	***61***	17	0	17
DRUJ	7	14	14	0	0	29	***57***	***71***	14	14	43
ECU	5	***60***	20	40	***60***	20	40	***80***	20	0	***80***
TRIQUETRUM	8	***75***	25	25	25	25	25	***88***	0	0	38
PTOA	11	45	0	18	9	9	9	***73***	18	0	9

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357 Supplementary Table 2
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ULNAR-SDIED WRIST PAIN-SPECIFIC SIGNS

USWP pathology	N	Ulnocarpal Stress test (%)	Ulnar Fovea sign (%)	ECU instability (%)	Midcarpal instability (%)	LT shuck (%)	PT exam (%)	DRUJ instability (%)	DRUJ instability in pronation (%)	DRUJ instability in supination (%)	DRUJ instability in neutral position (%)	DRUJ instability globally (%)
TFCC	44	***50***	***89***	2	5	11	7	16	9	2	2	2
UCAS	18	***89***	***83***	0	6	6	0	0	0	0	0	0
DRUJ	7	***71***	***71***	0	0	14	0	14	14	0	14	0
ECU	5	***60***	40	20	0	0	0	0	0	0	0	0
triquetrum	8	25	38	0	0	25	38	0	0	0	0	0
PTOA	11	18	9	0	0	9	100	0	0	0	0	0

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363 Supplementary Table 3
364

PATIENT PAIN LOCATION										
USWP pathology	N	Radial (%)	Radial dorsal (%)	Dorsal (%)	Doral ulnar (%)	Ulnar (%)	Volar ulnar (%)	Volar (%)	Volar radial (%)	Average number of pain locations ± SD (max 8)
TFCC	44	7	7	30	***82***	***80***	***61***	16	11	2.9±1.5
UCAS	18	0	0	33	***78***	***67***	***56***	6	0	2.3±1
DRUJ	7	29	29	43	***86***	43	***71***	14	0	3.3±1.6
ECU	5	0	0	0	***100***	***80***	20	0	0	2±0.7
triquetrum	8	0	0	13	***88***	***75***	***50***	0	0	2.3±0.9
PTOA	11	0	0	18	36	45	***73***	18	9	2±1.4

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368 Supplementary Table 4
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USWP pathology	N	Radial (%)	Radial dorsal (%)	Dorsal (%)	Doral ulnar (%)	Ulnar (%)	Volar ulnar (%)	Volar (%)	Volar radial (%)	Average number of tenderness locations ± SD (max 8)
		Tenderness Location								
TFCC	31	2	2	18	41	45	34	5	0	2.1±1.1
UCAS	15	0	0	22	***50***	***50***	33	0	0	1.9±0.7
DRUJ	6	0	0	29	***57***	29	14	0	0	1.6±0.6
ECU	5	0	0	0	***100***	20	20	0	0	1.4±0.6
triquetrum	7	0	13	13	***75***	38	13	0	0	1.7±0.8
PTOA	9	0	18	18	18	9	***82***	9	0	1.9±0.8

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