

1 Correlation between Magnetic Resonance Imaging and Surgical Exploration of the

2 Anterolateral Structures of the Acutely Anterior Cruciate Ligament Injured Knee

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7

8 9 10 Abstract

11 Background: Combined Anterior Cruciate Ligament (ACL) and Anterolateral ligament (ALL)
12 reconstruction is associated with improved clinical outcomes compared to isolated intra-
13 articular reconstruction but the indications are not precisely defined. It may be the case that
14 patients with proven anterolateral injury on pre-operative imaging are most likely to benefit
15 but the accuracy of MRI is not known.

16 Hypothesis/Purpose: To evaluate the correlation between MRI findings and intra-operative
17 anterolateral compartment exploration in acute ACL injured knees. The study hypothesis was
18 that a positive correlation would be identified between imaging and surgical findings for
19 injuries to the ALL/capsule and the iliotibial band and that pre-operative MRI would be
20 associated with high sensitivity, specificity and accuracy for these parameters.

21 Study Design: Case Series

22 Methods: Between January 2016 to May 2016 patients presenting with an acute ACL injury
23 were considered for study eligibility. A sample size calculation determined the numbers
24 enrolled. Included patients underwent 1.5T MRI and this was evaluated by three investigators
25 who attributed a Ferretti grade of injury to the anterolateral structures. At the time of ACL
26 reconstruction, a lateral exploration was undertaken and macroscopic injuries were

27 identified, classified and repaired. An evaluation of correlation between MRI and surgical
28 exploration findings was performed.

29 Results: 26 patients participated in the study. 96% had an ALL/capsule injury. The sensitivity,
30 specificity and accuracy of MRI in the evaluation of ALL/capsule injury, when using surgical
31 exploration as a gold standard were 88%, 100% and 88.5% respectively. For evaluation of
32 iliotibial band injury these values were 62.5%, 40% and 50%. The percentage agreement
33 between MRI and surgical findings for ALL/capsule injury was 88% but only 65% for the ITB.
34 The sensitivity and specificity of MRI for complete or partial tear of ALL and capsule were 78.6
35 and 41.7 respectively. The k test for correlation between surgical and MRI findings was 0.27
36 for ITB abnormalities, 0.47 for ALL/capsule abnormalities, 0.23 for ALL/capsule determination
37 of partial or complete tear and 0.49 for ALL/capsule determination of anterior or posterior
38 tear. The overall percentage agreement between MRI and the classification based on surgical
39 findings was only 53% and the Altman classification of kappa was fair. This suggests that whilst
40 the classification is useful for description of surgical findings the grade cannot be reliably
41 established from MRI, at least with the parameters used in the current study

42 Conclusion: Surgical exploration demonstrates that injuries occur to the anterolateral
43 structures in almost all acute ACL injured knees. Pre-operative MRI is highly sensitive,
44 specific and accurate, for detection of abnormalities of the ALL/capsule and shows a high
45 percentage of agreement with surgical findings. In contrast MRI has low sensitivity,
46 specificity, and accuracy for the diagnosis of ITB injury. The agreement between MRI and
47 surgical exploration with respect to ITB abnormality and determination of whether
48 ALL/capsular tears were partial or complete was only fair.

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50 Key terms: Anterolateral Ligament; Anterior Cruciate Ligament, magnetic resonance imaging,
51 Iliotibial band

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53 What is known about the subject: The recently renewed interest in extra-articular procedures
54 has led to them being carried out frequently in clinical practice. However, the indications are
55 not precisely defined. It is known that isolated ACL reconstruction in knees with an
56 anterolateral injury results in failure to restore normal knee kinematics. This suggests that
57 those patients who have an imaging proven anterolateral injury may be most likely to benefit
58 from such a procedure. However, the sensitivity, specificity and accuracy of MRI in diagnosing
59 anterolateral injury has not been studied to the knowledge of the authors

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61 What this study adds to existing knowledge: To our knowledge this is the first study that has
62 correlated MRI findings of anterolateral injury in the acute ACL-injured knee with intra-
63 operative lateral exploration findings. This has allowed determination of the sensitivity,
64 specificity, and accuracy of MRI for injury to the anterolateral structures. The high percentage
65 agreement suggests that MRI is a useful modality for evaluation of injury to the anterolateral
66 ligament and capsule

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69 Introduction:

70 Lateral extra-articular procedures have recently been popularized due to the increasing
71 evidence that they improve the outcomes of ACL reconstruction. Recent studies have
72 demonstrated that anterolateral ligament (ALL) reconstruction performed at the time of
73 anterior cruciate ligament (ACL) reconstruction is associated with a significant reduction in

74 ACL graft rupture rates, and improved return to sport compared to isolated intra-articular
75 reconstruction^{10,26}. Systematic reviews have also shown that patients who undergo an
76 extra-articular procedure have a significantly lower pivot shift index than those undergoing
77 ACL reconstruction only^{23,25}. However, it is important to note that lateral extra-articular
78 procedures were widely abandoned in the 1980's due to concerns about high re-operation
79 rates and complications. Contemporary study has demonstrated that combined ACL and ALL
80 reconstruction appears to be a safe procedure. Thauinat³⁰ et al reported that the
81 reoperation rate after combined ACL and ALL reconstruction in a large series of patients
82 (n=548), with a minimum follow-up of two years, was broadly comparable to reoperation
83 rates after isolated ACL reconstruction. In addition, they reported that the high rates of
84 knee stiffness and reoperation reported in historical series of nonanatomic, lateral extra-
85 articular tenodesis were not observed in their series.

86 Despite these significantly improved clinical outcomes, the precise indications for the addition
87 of an extra-articular procedure remain undefined. It is perhaps the case that those patients
88 who have a demonstrable anterolateral injury on pre-operative imaging may be most likely
89 to benefit but this has not been proven to date.

90 Biomechanical studies have shown that when an anterolateral injury exists, normal knee
91 kinematics are only restored when an extra-articular procedure is performed at the time of
92 ACLR because isolated intra-articular reconstruction fails to restore IR control^{9,18,22}. It is
93 therefore important to note that anterolateral injury has been reported to occur in up to 90%
94 of acute ACL injured knees^{8,15,20,29}. The ability to identify these injuries on pre-operative
95 imaging may help to determine which patients are more likely to benefit from a combined
96 ACL reconstruction and extra-articular procedure. Several authors have therefore reported
97 rates of identification of ALL injury on MRI^{4,6,12,13,17,31}.

98 However, the rate of reported injury shows broad variation which raises concerns about its
99 reliability. To the knowledge of the authors, the sensitivity and specificity of MRI for
100 determining injury to the anterolateral structures has not been previously reported. This is
101 because published studies have not compared MRI findings with a lateral extra-articular
102 exploration. The only studies that correlated MRI with anatomy were performed in cadavers
103 with no anterolateral reported injuries^{2,11,12}.

104 Thus, the aim of this study was to evaluate the correlation between MRI findings and intra-
105 operative anterolateral compartment exploration in acute ACL injured knees. The study
106 hypothesis was that a positive correlation would be identified between imaging and surgical
107 findings for injuries to the ALL/capsule and the iliotibial band and that pre-operative MRI
108 would be associated with high sensitivity and specificity for these parameters.

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110 METHODS

111 Ethical approval was granted for this study by the Institutional Research Board. All patients
112 gave valid consent to participate. The sample size was derived from Bujang and Adnan¹ who
113 reported minimum numbers required for determining sensitivities and specificities in
114 diagnostic studies. The sample size was determined to be n=22, based on a prevalence of
115 injury to the ALL of 90% in acutely ACL-injured knees (assumed from Ferretti et al)⁸, a null
116 hypothesis sensitivity of 50%, alternate hypothesis 80%, power 80% and a p value of <0.05.

117 Between January 2016 and May 2016, patients presenting to the emergency department with
118 a history of acute knee injury and physical examination findings consistent with ACL injury
119 were prospectively considered for study enrollment. Patients were excluded if they had a
120 previous history of either ipsilateral or contralateral knee injury/surgery or infection, multi-
121 ligament injury or inability to undergo MRI.

122 All patients underwent clinical assessment and a standard acute knee examination. This
 123 included an evaluation of the ACL with Lachman and pivot shift tests, and also relevant
 124 physical examination tests to exclude concomitant injuries.

125 After clinical evaluation, patients were referred for magnetic resonance imaging of the injured
 126 knee. MRI scans were performed on a 1.5T device (*Siemens Maestro Sonata, gradient 40mT,*
 127 *software syngo A35*) with the following parameters (Table 1).

128

	Sagittal PD	Sagittal FATSAT	T2	Coronal FATSAT	T2	Coronal T1	Axial FATSAT	T2
Field of view (FOV)	180 mm	180mm		180mm		180mm	180mm	
Repetition time (TR)	2800	3950		2950		3110	2940	
Echo time (TE)	33	30		30		33	33	
Thickness (mm)	3 mm	3mm		3mm		3mm	3mm	
Spacing (mm)	2 mm	2 mm		1.5mm		1.5mm	2mm	

129 **Table 1.** Parameters used in the MRI sequences. (*Siemens Maestro Sonata, gradient 40mT,*
 130 *software syngo A35*)

131

132 MRI scans were evaluated by three blinded observers (two musculoskeletal radiologists,
 133 with 15 years (main evaluator) and 8 years of experience respectively, and one orthopedic
 134 surgeon with 10 years of experience of interpreting MRI scans of the knee in daily practice).

135 The ALL was evaluated using coronal images, with the axial and sagittal planes used mainly
 136 for anatomical orientation. The ALL was defined as the low signal band originating from the

137 region of the lateral epicondyle of the femur, crossing the proximal surface of the lateral
138 collateral ligament (LCL), deep to the iliotibial band, to its tibial insertion between Gerdy's
139 tubercle and the fibular head. The fibers were considered abnormal when they presented
140 irregular contours, a wavy aspect, or areas of discontinuity. Joint capsule lesions were
141 defined by thickening and increased signal in T2-weighted sequences, as well as the
142 presence of periarticular fluid. For the purposes of this study the ALL/anterolateral capsule
143 were considered as a single unit. When the ALL and/or capsule were found to be abnormal
144 the injuries were also sub-classified. If a full thickness injury could be observed they were
145 classified as complete tears, otherwise they were classified as incomplete. In addition, the
146 observers also reported whether there was extension of the capsular tear (anterior or
147 anterior/posterior). The presence and absence of iliotibial tract (ITT) lesions was also
148 determined and recorded using the criteria established by Mansour et al.¹⁹ The iliotibial
149 tract was considered abnormal when thickening, signal change in its fibers, or edema of
150 adjacent planes were present, even if observed in a discrete manner. MRI evaluators were
151 then asked to attribute a Ferretti grade of injury (Table 2) to the anterolateral structures⁸.
152 Following MRI evaluation, in line with the standard of care for acute ACL ruptures at our
153 institution, all patients underwent ACL reconstruction within 10 days from injury. A
154 concomitant exploration of the lateral compartment was performed as part of the study
155 protocol. All procedures were performed by the senior author who has more than 25 years
156 of experience in this field. The lateral compartment was exposed in all cases regardless of
157 the degree of pivot shift (evaluated under general anaesthesia prior to surgery). This was
158 performed prior to ACL reconstruction. The lateral compartment was approached by a
159 hockey stick incision. After elevation of skin flaps, the fascia lata was exposed and evaluated
160 for evidence of macroscopic injury. It was then incised, in line with its fibers, to expose the

161 anterolateral compartment. When a lesion was found it was repaired by 3-4 parallel stitches
162 with square knots (No. 2 Vicryl; Ethicon) with the knee at 90 of flexion and neutral rotation.

163 At each step of the lateral exploration, a written record was made of the presence or
164 absence of injury to the anterolateral structures of the knee, including hemorrhage,
165 incomplete capsular tear, ALL/capsule complete tears, and fractures. Both positive and
166 negative findings were documented in every case by intra-operative photographs throughout
167 the dissection.

168 Macroscopic tears of the ALL/capsule were classified as suggested by Ferretti et al (Table 2):

Type I	multilevel rupture in which individual layers are torn at different levels with macroscopic hemorrhage involving the area of the anterolateral ligament (ALL) and extended to the anterolateral capsule only (incomplete tear of anterolateral capsule)
Type II	multilevel rupture in which individual layers are torn at different levels with macroscopic hemorrhage extended from the area of the ALL and capsule to the posterolateral capsule (incomplete tear of anterolateral and posterolateral capsule)
Type III	complete transverse tear involving the area of the ALL near its insertion to the lateral tibial plateau, always distal to the lateral meniscus (complete tear of anterolateral capsule)
Type IV	corresponding to bony avulsion (Segond fracture)

169 Table 2. Classification of injuries of anterolateral complex as described by Ferretti et al.⁸

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171 Following the lateral exploration, all of the identified ALL/capsular injuries underwent repair.
172 ACL reconstruction was performed in a standardized manner with a doubled semitendinosus
173 and gracilis tendon graft with an outside-in technique.

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175 **Statistical analysis**

176 All calculations were made using SPSS software (Version 20.0, SPSS Inc., Chicago, IL). Cohens
177 Kappa was used to determine inter- and intra-observer reliability between all MRI evaluators

178 and also to determine correlation between MRI and surgical findings. The latter was
179 performed using the main evaluators assessment. Strength of agreement was evaluated
180 according to the criteria of Altman. The sensitivity, specificity and accuracy of MRI in
181 evaluating injuries to the anterolateral structures were calculated using surgical exploration
182 findings as the gold standard.

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185 *RESULTS*

186 Twenty-six patients met the eligibility criteria and were enrolled to the study. Table 3 reports
187 the demographic details and patient characteristics of the study population

188

Age (Range)	26.7±7.1(17-46) years
Gender	
Male	21
Female	5
BMI (range)	20.6±1.3(19-23.5)
Time to surgery (range)	4.3±2.2(1-10) days
Pre-operative pivot-shift test (evaluated under general anaesthesia)	-
Grade 0	5
Grade 1	16

Grade 2	5
Grade 3	

189 **Table 3.** Demographics and patient characteristics of the study population

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191 *Results of MRI evaluation:* The ITB was considered normal in 15/26 (57.7%) cases and
 192 abnormal in 11/26 (42.3%) cases. The ALL/ anterolateral capsule was considered normal in
 193 4/26 (15.4%) cases and abnormal in 22/26 (84.6%) cases. Tears of the ALL and capsule were
 194 considered complete in 15/22 (68.2%) cases and incomplete in 7/22 (31.8%) cases.
 195 Extension of the capsular tear was observed to be anterior in 11/22 (50.0%) cases and
 196 anterior/posterior in 11/22 (50.0%). The inter- and intraobserver correlation indices are
 197 reported in table 4

Kappa Coefficient	ALL / capsule lesion (presence or not)	ALL / capsule lesion or (complete incomplete)	Capsular tear extension (anterior/posterior)	ITB tear (presence or not)
inter-observer	1	0.64	0.47	0.64
intra-observer 1	1	0.66	0.58	0.69
intra-observer 2	1	0.60	0.82	0.61
intra-observer 3	1	0.75	0.82	0,8

198 Table 4: The inter- and intraobserver correlation indices

199

200 *Surgical evaluation:* at surgical evaluation, the ITB was considered normal in 18/26 (69.2%)
 201 cases and abnormal in 8/26 (30.8%) cases. The ALL and capsule were considered normal in
 202 1/26 (3.8%) cases and abnormal in 25/26 (96.2%) cases. The ALL and capsular tear was
 203 considered complete in 10/25 (40.0%) cases and incomplete in 15/25 (60.0%) cases. Extension

204 of the capsular tear was observed to be anterior in 11/25 (44.0%) cases and anterior-posterior
 205 in 14/25 (56.0%).

206 The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of
 207 MRI for parameters of injury to the anterolateral structures of the acutely ACL-injured knee,
 208 when using surgical exploration as a gold standard are reported in Table 4.

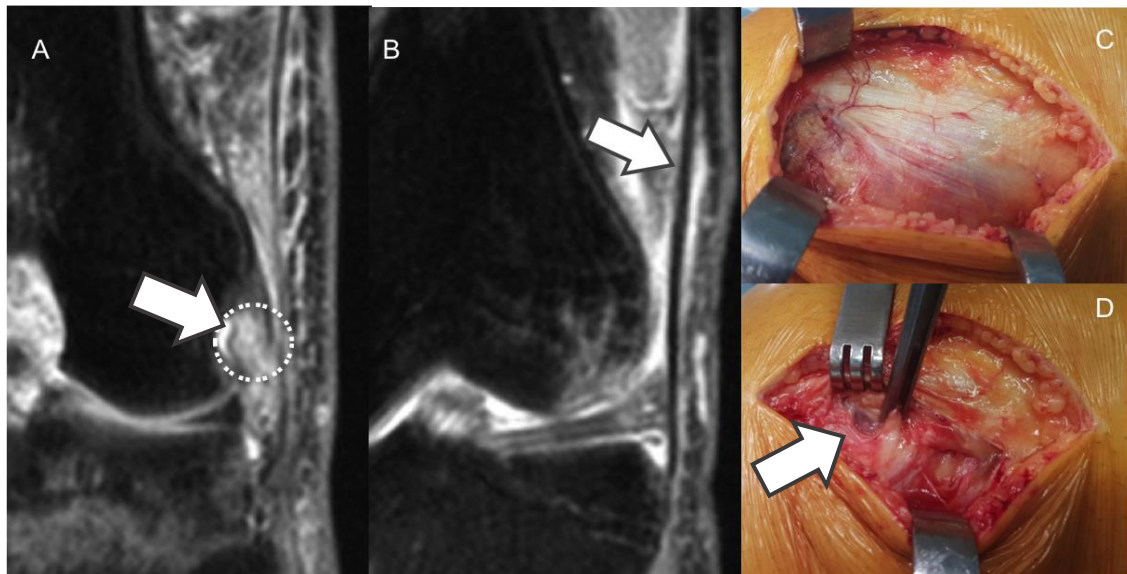
209 Table 5: Sensitivity, Specificity, PPV – Positive Predictive Value, NPV – Negative Predictive Value and Accuracy of

	Sensitivity	Specificity	PPV	NPV	Accuracy
ITB Abnormality	62.5	40.0	45.5	57.1	50.0
95% CI	24.49 to 91.48	12.16 to 73.76	28.49 to 63.54	29.2 to 81.17	26.02 to 73.98
ALL/Capsule Abnormality	88.0	100.0	100.0	25.0	88.5
95% CI	68.8 to 97.4	2.5 to 100	n/a	10.34 to 49.07	69.85 to 97.55
ALL/Capsule complete/partial tear	78.6	41.7	61.1	62.5	61.5
95% CI	49.2 to 95.34	15.17 to 72.33	47.53 to 73.16	33.29 to 84.77	40.57 to 79.77
ALL/Capsule anterior/posterior	75.0	64.3	54.6	81.8	68.2
95% CI	34.91 to 96.81	35.14 to 87.24	34.83 to 72.93	56.02 to 94.08	45.13 to 86.14

210 MRI for parameters of injury to the anterolateral structures of the acutely ACL-injured knee, when using surgical
 211 exploration as a gold standard

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 214 The K test for correlation between surgical and MRI findings is reported in Table 5 along with
 215 the strength of agreement according to Altman 1991.

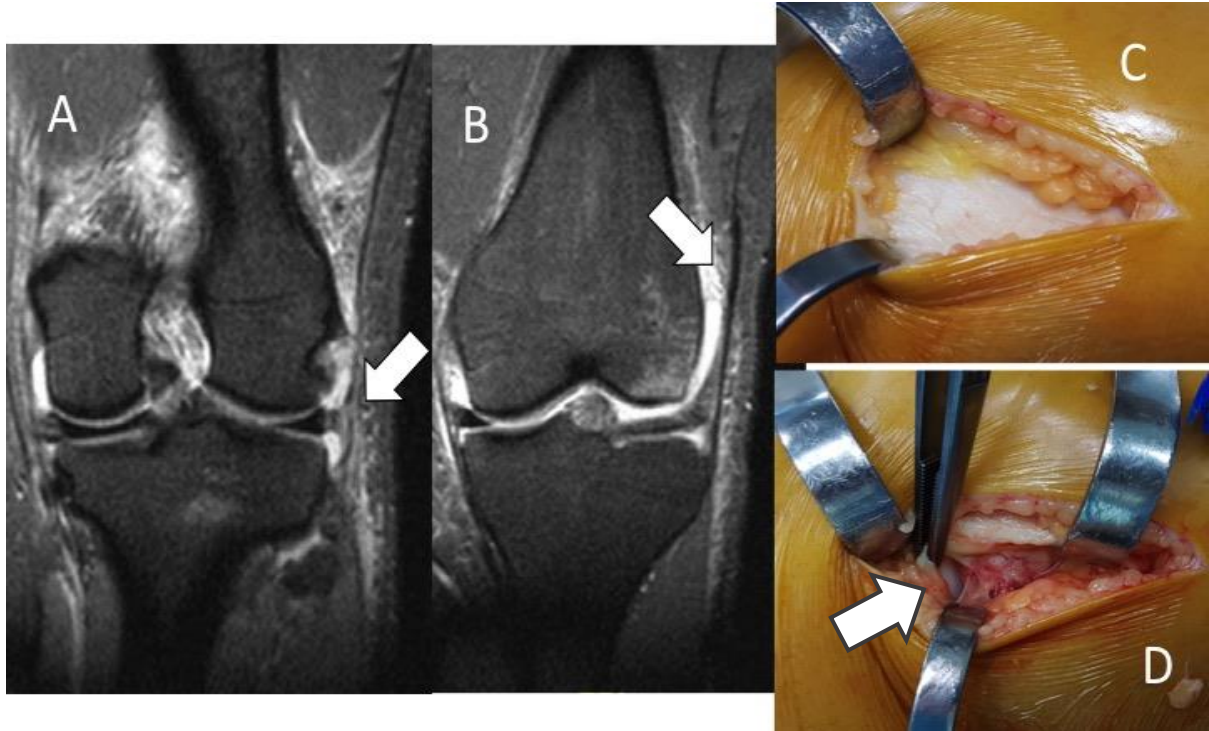
	Kappa	Class
ITB Abnormality	0.27	
ALL/Capsule Any Abnormality	0.47	Mo
ALL/Capsule: Determination of complete/partial tear	0.23	



216 Table 6: Correlation between MRI and Surgical findings using Cohens Kappa and the Altman classification of
217 strength of agreement and overall percentage agreement
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220 **Figure 1** A: Coronal T2 weighted MRI image. Discontinuity at the proximal (femoral) portion of the anterolateral ligament
221 (circle) with marked regional edema. B: Coronal T2 weighted MRI image. Non-insertional iliotibial band strain (arrow)
222 characterized by adjacent edema, with no fiber discontinuity. C: surgical exploration of the fascia lata showing edema and
223 incomplete tear. D: surgical exploration of the capsule showing a complete tear of the anterolateral capsule and ligament
224 (arrow; type 3 according to Ferretti classification).
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Figure 2. MRI T2 weighted images with fat saturation. **A.** Anterolateral ligament presenting abnormal signal and irregular aspect of its fibers (arrow). **B.** Iliotibial band with normal signal and thickness (arrow). **C.** surgical exploration of the fascia lata that is normal. **D.** surgical exploration of the capsule showing a complete tear of the anterolateral capsule and ligament (arrow; type 3 according Ferretti classification).

241 Discussion

242 The most important finding of this study was that when considering surgical exploration as
 243 the gold standard, MRI evaluation demonstrated high sensitivity, specificity and accuracy for
 244 detection of abnormalities of the ALL/capsule. The sensitivity and specificity for other
 245 parameters such as whether there was a complete tear or not, and anterior/posterior
 246 extension were not as high, and for evaluation of the ITB, the values were low. These
 247 findings were mirrored in the kappa correlation data for agreement between surgery and

248 MRI evaluations. Although there was moderate agreement between them for ALL/capsular
249 abnormalities and determination of anterior/posterior extension of tears, the agreement
250 between them with respect to ITB abnormality and determination of whether ALL/capsular
251 tears were partial or complete was only fair.

252 To the knowledge of the authors this is the first study that has compared MRI findings with
253 intra-operative anterolateral exploration in the acute ACL-injured knee. However, several
254 previous cadaveric studies have compared MRI findings with laboratory exploration in
255 normal knees. Catherine et al and Helito et al both reported that they were able to fully
256 visualise the ALL and subjectively and objectively correlate 1.5T MRI findings with dissection
257 in all specimens^{2,12}. Subsequent authors have not demonstrated such a high degree of
258 reliability in identification of the ALL in clinical studies, and published rates of full
259 visualisation (11-100%)^{24,28}, partial visualisation (11.5-48.5%)^{5,11} and non-visualisation (0-
260 49%)^{24,28} show broad variation in normal knees. Part of the reason for this discrepancy is
261 that the aforementioned cadaveric studies used MRI protocols with very thin (0.4mm and
262 0.6-1.5mm) slices. This has the advantage of reducing the partial volume effect and
263 improving spatial resolution. However, in clinical practice the increased scan duration with
264 thinner slices is prohibitive and more typically a slice thickness of 3mm is used.

265 Rates of MRI identification of abnormalities of the anterolateral ligament in the ACL injured
266 knee also demonstrate broad variation which may be influenced by factors such as magnet
267 strength, slice thickness, experience of evaluators, and the timing of injury (acute/chronic).

268 Rates of injury between 32.6-88% are reported, with the majority of authors reporting values
269 around 40%, towards the lower end of the spectrum^{4,7,12,13,31}. These lower values are
270 inconsistent with the clinical findings of surgical exploration studies by Hughston¹⁵, Terry²⁹,

271 Muller²⁰ and more recently by Ferretti⁸ et al that demonstrated a much higher rate of injury
272 of approximately 90%

273 More recent imaging studies have tended to report higher rates of ALL and capsule injury
274 which are more in keeping with the rate previously reported at surgical exploration.

275 Muramatsu et al.²¹ with the use of 3D-MRI demonstrated that 87.5% of acute ACL-injured
276 knees and 55.6% of chronic ACL injured knees were associated with an ALL injury. This trend
277 towards reporting higher rates of injury may reflect increasing experience and knowledge
278 regarding MRI evaluation of these structures and a consequently improved detection rate.

279 In the current study, it was hypothesised that there would be good agreement between MRI
280 and anterolateral exploration. An attempt to reduce confounding was made by only including
281 acute ACL injured knees and having three imaging evaluators with considerable expertise in
282 ALL evaluation. Despite that, using the Altman classification of Cohen's kappa, none of the
283 parameters studied showed good agreement between MRI and surgical findings. However, it
284 is important to highlight that for the category ALL/capsule injury, the strength of agreement
285 is lower than expected, principally because over 90% of observations were in the "abnormal"
286 category. This skewness of data is a well-recognised cause of paradox where the kappa
287 coefficient appears to be lower than expected based on the percentage agreement. As such
288 the percentage agreement in this particular group (88%) is a more useful metric than the
289 kappa coefficient, but for other parameters it is an appropriate evaluation. The Altman
290 classification for agreement between MRI and surgical findings was moderate for
291 anterior/posterior extension of ALL and capsular injuries but only fair for determination of
292 whether the injury was complete or partial, and for evaluation of ITB abnormalities.

293 The overall percentage agreement between MRI and the Ferretti classification, based on
294 surgical findings, was only 53% and the Altman classification of kappa was fair. This suggests

295 that whilst the classification is useful for description of surgical findings the grade cannot be
296 reliably established from MRI, at least with the parameters used in the current study. The
297 main reasons for this lack of correlation are that the percentage agreement between MRI and
298 surgery for the parameters of complete/partial injury and anterior/posterior extension were
299 only 61% and 57% respectively. This is reflected in the fact that MRI has a moderate sensitivity
300 and low specificity for both of these injury characteristics.

301 It is important to note that surgical exploration identified injury to the ITB in only 8 patients,
302 whereas almost all patients had an injury to the ALL/capsule. More importantly, it should be
303 specifically stated that 19/26 (73.1%) patients had an injury to the ALL/capsule with a
304 completely normal ITB. This is somewhat in contrast to the laboratory-based concept that the
305 ITB is the primary restraint to internal tibial rotation and the ALL a secondary restraint¹⁶. This
306 important clinical finding is likely a reflection of the reliance of laboratory studies on
307 artificially created injury patterns which do not easily replicate in-vivo mechanisms. It should
308 also be stated that there was fair agreement with respect to kappa and a 65% agreement
309 between surgical findings and MRI with respect to ITB abnormalities. However, the accuracy
310 of MRI was only 50%. Where there was disagreement between MRI and surgery the most
311 common reason (66.6%) was that MRI had suggested an ITB injury but no abnormality was
312 identified at surgery. This is also an important finding because MRI evidence of injury to the
313 ITB has been reported as an indication for performing a LET but the findings of the current
314 study suggest that the accuracy of MRI for this parameter is low and that using it in this way
315 may lead to overtreatment²⁷.

316

317 **Limitations**

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319 The small study population could be considered a limitation given that ACL rupture is a very
320 common injury in the sports medicine scenario. However, a sample size calculation was
321 specifically performed in order to include an adequate number of patients to answer the
322 research question studied. It was a deliberate decision not to include a much larger number
323 of patients because it is not useful to access the lateral compartment in every ACL-injured
324 knee and there is a potential associated morbidity of this additional procedure. Specifically,
325 it is not known which patterns of anterolateral injury warrant direct surgical repair and this
326 study did not attempt to define that. A further limitation of the study was that there is no
327 published, validated, standardized imaging protocol for evaluation of injury to the
328 ALL/anterolateral capsule. This may have been mitigated to some extent by the fact that the
329 MRI evaluators in this study had considerable experience in evaluating these structures in
330 their daily practice. However, it should be noted that evaluators were specifically instructed
331 to identify injuries to the anterolateral structures. It is plausible that this lack of blinding of
332 the study purpose may have influenced the rate of diagnosis of injury to these structures.

333

334 **Conclusions**

335 Surgical exploration demonstrates that injuries occur to the anterolateral structures in
336 almost all acute ACL injured knees. Pre-operative MRI is highly sensitive, specific and
337 accurate, for detection of abnormalities of the ALL/capsule and shows a high percentage of
338 agreement with surgical findings. In contrast MRI has low sensitivity, specificity, and
339 accuracy for the diagnosis of ITB injury

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