Comparison of Intercondylar notch Width Index and Reverse Notch Width Index in Cases With and Without Anterior Cruciate Ligament Tears

S Gupta, R Sharma, N Saini, Y Saini

Citation

Abstract
Objective: To compare intercondylar notch width index and reverse notch width index in cases with and without anterior cruciate ligament tears. Patients and methods: 33 patients with a positive lachman’s test and pivot shift and a complete ACL tear on MRI were taken as cases. 33 patients with knee pain but a negative Lachman’s test and pivot shift and no ACL tear on MRI were taken as controls. To obtain the radiographic images of femoral intercondylar notch, the Holmblad (1937)(7) method was used. The Notch width index and the Reverse notch width index was calculated for all the cases and controls from radiographic measurements and the results were compared statistically using Pearson chi square test. Results: The maximum number of cases and controls were in the age group 21-30 years with mean age of 28.61 yrs for cases and 28.91 yrs for controls. Maximum number of cases (69.7%) and controls (75.8%) had NWI greater than 0.25. Maximum number of cases (45.5%) and controls (54.5%) had RNWI less than 4.7 indicating wide notch. Conclusion: No significant relation could be established between Notch width Index and Reverse notch width index with anterior cruciate ligament injury.

INTRODUCTION
Anterior Cruciate Ligament ruptures are among the most common ligamentous injuries.

The acute tear of anterior cruciate ligament (A.C.L.) is common in sports requiring frequent rotational movements, rough stops or jumps. It is a belief that the morphology of the femoral intercondylar notch can predispose to the injuries of A.C.L., and its morphometry analysis could provide important data to be used in the prevention and prognostic of these injuries(1).

The intercondylar notch can be analyzed by computed tomography (C.T.)(2), by magnetic resonance imaging (M.R.I.), by film radiography and, also by the direct measurement in corpses.

The most common and accessible method to assess the femoral intercondylar notch morphology have been radiography(3). Studies using radiographic images have been linking femoral intercondylar notch morphologic and morphometry to A.C.L. injuries (1,3,4,5). Shelbourn and Kerr(4) was the first to correlate the femoral intercondylar notch proportions and A.C.L. injury predisposition. They observed that A.C.L. gets constitutionally a vulnerable position, being retaining over the lateral femoral condyle internal face during knees rotational movements, facilitating its rupture.

In the morphometric studies index of notch width (NWI) and index of notch shape (NSI) are commonly used(6).

According to Koukoubis et al(3), the most constant index to assess the morphology of the femoral intercondylar notch is considered to be the reverse notch width index(RNWI).

Our aim of study was to measure the notch width index and the reverse notch width index in chronic ACL deficient knees and controls and to compare the results and find out the relation between them.

MATERIALS AND METHODS
From the patients attending the outpatient department, 33 patients with knee pain with a positive Lachman’s test and pivot shift and a complete ACL tear on MRI were taken as cases. 33 patients with knee pain but a negative Lachman’s test and pivot shift and no ACL tear on MRI were taken as controls. To obtain the radiographic images of femoral intercondylar notch, the Holmblad (1937)(7) method was
used. The individuals were positioned on the examination table knees in 70° flexion with the hands and knees over the table (Figure 1) and x-rays projected posteroanteriorly.

**Figure 1**
Figure 1: Holmblad method of notch view

To measure the variables, reference lines were drawn according to the studies of Herzog et al. (8) and Ellera Gomes and Scarton (9) (Figure 2).

**Figure 2**

Drawing of reference lines for variable measurement: Line AB, tangent to the articular ventral surface of femoral condyles. Line CD, horizontally traced through the popliteal groove and parallel to line AB, to measure bicondylar distance (CD) and intercondylar notch width (EF). Line GH to measure the inter epicondylar distance.

The notch width index was calculated by taking the ratio of notch width to the bicondylar distance, the normal value of which ranged from 0.21 to 0.25 (3). A notch width index below the normal range indicates a smaller notch morphology.

The reverse notch width index was taken as the ratio of epicondylar width to notch width, the normal range being from 4.7 to 3.94 (3). A reverse notch width index of more than 4.7 is indicative of a narrow intercondylar notch.

The results were compared statistically using Pearson chi square test.

**OBSERVATIONS AND RESULTS**
**AGE GROUPS**
The maximum number of patients were in the age group 21-30 years for cases as well as controls with mean age of
Comparison of Intercondylar Notch Width Index and Reverse Notch Width Index in Cases With and Without Anterior Cruciate Ligament Tears

28.61 yrs for cases and 28.91 yrs for controls.

**Figure 3**

<table>
<thead>
<tr>
<th>AGE</th>
<th>20 AND &lt;20</th>
<th>21-30</th>
<th>31-45</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASES</td>
<td>4</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>CONTROLS</td>
<td>2</td>
<td>20</td>
<td>11</td>
</tr>
</tbody>
</table>

**SEX DISTRIBUTION**

Majority of patients were males in both groups 75.8% of cases and 78.8% of controls.

**Figure 4**

<table>
<thead>
<tr>
<th>SEX</th>
<th>FEMALES</th>
<th>MALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASES</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>CONTROLS</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>

**NOTCH WIDTH INDEX**

**Figure 5**

<table>
<thead>
<tr>
<th>Notch width index</th>
<th>&lt;0.21</th>
<th>0.21-0.25</th>
<th>&gt;0.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASES</td>
<td>3 (9.1%)</td>
<td>7 (21.2%)</td>
<td>23 (69.7%)</td>
</tr>
<tr>
<td>CONTROLS</td>
<td>2 (6.1%)</td>
<td>6 (18.2%)</td>
<td>25 (75.8%)</td>
</tr>
</tbody>
</table>

Mean NWI IS 0.29 for controls and 0.27 for cases. In both the groups it was greater than 0.25 thus showing a wide notch.

Pearson Chi Square after comparison of values of cases and controls was 0.769 [>0.05 Not significant]

**REVERSE NOTCH WIDTH INDEX**

**Figure 6**

<table>
<thead>
<tr>
<th>Reverse notch width index</th>
<th>&gt;4.7</th>
<th>3.94-4.7</th>
<th>&lt;3.94</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASES</td>
<td>8 (24.2%)</td>
<td>10 (30.3%)</td>
<td>15 (45.5%)</td>
</tr>
<tr>
<td>CONTROLS</td>
<td>6 (18.2%)</td>
<td>9 (27.3%)</td>
<td>18 (54.5%)</td>
</tr>
</tbody>
</table>

Mean RNWI was 3.96 for controls and 4.12 for cases. Both the groups had mean RNWI less than 4.7, thus showing wide notch.

Pearson Chi Square after comparison for cases and controls was 0.737 [>0.05 Not significant]

**DISCUSSION**

There are conflicting data about whether femoral intercondylar notch stenosis is a predisposing factor for an acute ACL tear. It has been reported that the intercondylar notch becomes narrowed with failed repair of the ACL or with chronic instability of the knee\(^{10}\). Most authors have found a statistically significant smaller notch width index in patients bilateral or unilateral ACL ruptures when compared with normal knees\(^{(1,4,11,12,13,14)}\). Fewer studies show no significant differences for the NWI in patients and without ACL ruptures\(^{(14,15,16,17)}\).

In our study only 3 cases and 2 controls had a notch width index below the normal range, indicative of a narrow notch. Among the rest of the patients, 7 cases and 6 controls had a NWI within the normal range while in the rest it was higher than normal. There was no significant correlation of NWI with ACL injury in this study. This is similar to the conclusions of Schickendantz MS et al\(^{(14)}\), Teitz CC et al\(^{(15)}\), Alizadeh et al\(^{(16)}\), Sward P et al\(^{(17)}\).

In our study, 8 cases and 6 controls had a reverse notch width index of >4.7, which indicates a narrow notch. Of the remaining patients, 10 cases and 9 controls had a RNWI in the normal range and 15 cases and 18 controls below the normal range. The above data from our study indicate that there may not be any significant correlation between RNWI & ACL injury. We could not find any study evaluating RNWI in ACL injury patients.

The mean NWI among our patients was 0.27 for cases and 0.29 were controls which is above the normal range while the mean RNWI was 4.12 for cases and 3.96 for controls which is normal. The above results again indicate that there might not be any significant notch narrowing in our ACL deficient patients.

Nevertheless, the small number of patients is a major drawback of our study. A much larger study with more number of patients is needed to draw any statistically significant conclusions about the correlation between notch width index, reverse notch width index and ACL deficiency.

**CONCLUSION**

This study gives some indication that there may not be any significant correlation between notch width index and ACL injury and also between reverse notch width index and ASCL injury.

**DATA SHEET CASES**
Comparison of Intercondylar Notch Width Index and Reverse Notch Width Index in Cases With and Without Anterior Cruciate Ligament Tears

<table>
<thead>
<tr>
<th>SNO</th>
<th>AGE (yrs)</th>
<th>SEX</th>
<th>SIDE</th>
<th>NW (cm)</th>
<th>ECD (cm)</th>
<th>HED (cm)</th>
<th>NWI</th>
<th>RNWI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>M</td>
<td>L</td>
<td>2.0</td>
<td>7.6</td>
<td>8.1</td>
<td>0.23</td>
<td>4.05</td>
</tr>
<tr>
<td>2</td>
<td>34</td>
<td>M</td>
<td>R</td>
<td>1.7</td>
<td>7.5</td>
<td>8.1</td>
<td>0.23</td>
<td>4.7</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
<td>M</td>
<td>R</td>
<td>2.8</td>
<td>9.8</td>
<td>10.4</td>
<td>0.29</td>
<td>3.71</td>
</tr>
<tr>
<td>4</td>
<td>42</td>
<td>F</td>
<td>R</td>
<td>2.1</td>
<td>9.3</td>
<td>10.2</td>
<td>0.25</td>
<td>4.86</td>
</tr>
<tr>
<td>5</td>
<td>28</td>
<td>M</td>
<td>R</td>
<td>2.2</td>
<td>7.1</td>
<td>8.0</td>
<td>0.31</td>
<td>3.64</td>
</tr>
<tr>
<td>6</td>
<td>22</td>
<td>F</td>
<td>R</td>
<td>1.5</td>
<td>7.8</td>
<td>8.4</td>
<td>0.36</td>
<td>3.6</td>
</tr>
<tr>
<td>7</td>
<td>19</td>
<td>M</td>
<td>R</td>
<td>3.1</td>
<td>8.6</td>
<td>9.8</td>
<td>0.36</td>
<td>3.16</td>
</tr>
<tr>
<td>8</td>
<td>32</td>
<td>M</td>
<td>R</td>
<td>2.0</td>
<td>7.3</td>
<td>7.9</td>
<td>0.29</td>
<td>3.95</td>
</tr>
<tr>
<td>9</td>
<td>25</td>
<td>M</td>
<td>L</td>
<td>2.2</td>
<td>7.5</td>
<td>8.4</td>
<td>0.31</td>
<td>3.65</td>
</tr>
<tr>
<td>10</td>
<td>27</td>
<td>F</td>
<td>R</td>
<td>2.5</td>
<td>7.3</td>
<td>7.9</td>
<td>0.34</td>
<td>3.16</td>
</tr>
<tr>
<td>11</td>
<td>23</td>
<td>M</td>
<td>R</td>
<td>2.3</td>
<td>7.8</td>
<td>8.5</td>
<td>0.26</td>
<td>3.76</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
<td>M</td>
<td>L</td>
<td>2.6</td>
<td>8.6</td>
<td>10.2</td>
<td>0.31</td>
<td>3.92</td>
</tr>
<tr>
<td>13</td>
<td>24</td>
<td>M</td>
<td>R</td>
<td>1.8</td>
<td>8.8</td>
<td>9.2</td>
<td>0.20</td>
<td>5.11</td>
</tr>
<tr>
<td>14</td>
<td>32</td>
<td>M</td>
<td>R</td>
<td>2.2</td>
<td>7.8</td>
<td>8.7</td>
<td>0.28</td>
<td>3.95</td>
</tr>
<tr>
<td>15</td>
<td>36</td>
<td>F</td>
<td>R</td>
<td>2.4</td>
<td>8.4</td>
<td>9.0</td>
<td>0.28</td>
<td>3.75</td>
</tr>
<tr>
<td>16</td>
<td>41</td>
<td>M</td>
<td>L</td>
<td>2.1</td>
<td>7.7</td>
<td>8.5</td>
<td>0.27</td>
<td>4.04</td>
</tr>
<tr>
<td>17</td>
<td>21</td>
<td>M</td>
<td>R</td>
<td>2.3</td>
<td>8.5</td>
<td>9.2</td>
<td>0.20</td>
<td>3.68</td>
</tr>
<tr>
<td>18</td>
<td>25</td>
<td>M</td>
<td>R</td>
<td>2.4</td>
<td>8.2</td>
<td>8.8</td>
<td>0.29</td>
<td>3.67</td>
</tr>
<tr>
<td>19</td>
<td>28</td>
<td>M</td>
<td>R</td>
<td>2.0</td>
<td>8.8</td>
<td>9.4</td>
<td>0.23</td>
<td>4.7</td>
</tr>
<tr>
<td>20</td>
<td>29</td>
<td>M</td>
<td>L</td>
<td>2.2</td>
<td>8.2</td>
<td>9.0</td>
<td>0.26</td>
<td>4.09</td>
</tr>
<tr>
<td>21</td>
<td>25</td>
<td>F</td>
<td>R</td>
<td>1.9</td>
<td>9.0</td>
<td>9.6</td>
<td>0.24</td>
<td>5.05</td>
</tr>
<tr>
<td>22</td>
<td>27</td>
<td>M</td>
<td>R</td>
<td>2.3</td>
<td>8.0</td>
<td>8.6</td>
<td>0.29</td>
<td>3.74</td>
</tr>
<tr>
<td>23</td>
<td>34</td>
<td>M</td>
<td>R</td>
<td>1.6</td>
<td>8.3</td>
<td>8.9</td>
<td>1.19</td>
<td>5.56</td>
</tr>
<tr>
<td>24</td>
<td>38</td>
<td>M</td>
<td>R</td>
<td>2.2</td>
<td>9.5</td>
<td>10.3</td>
<td>0.23</td>
<td>4.77</td>
</tr>
<tr>
<td>25</td>
<td>19</td>
<td>M</td>
<td>R</td>
<td>2.4</td>
<td>7.2</td>
<td>8.6</td>
<td>0.25</td>
<td>3.58</td>
</tr>
<tr>
<td>26</td>
<td>24</td>
<td>F</td>
<td>R</td>
<td>2.1</td>
<td>7.5</td>
<td>8.0</td>
<td>0.28</td>
<td>3.89</td>
</tr>
<tr>
<td>27</td>
<td>22</td>
<td>M</td>
<td>R</td>
<td>1.8</td>
<td>7.5</td>
<td>8.9</td>
<td>0.24</td>
<td>4.94</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>F</td>
<td>L</td>
<td>2.9</td>
<td>10.0</td>
<td>11.6</td>
<td>0.36</td>
<td>4.0</td>
</tr>
<tr>
<td>29</td>
<td>25</td>
<td>M</td>
<td>R</td>
<td>2.2</td>
<td>8.8</td>
<td>9.6</td>
<td>0.25</td>
<td>4.36</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>M</td>
<td>L</td>
<td>3.0</td>
<td>8.3</td>
<td>9.3</td>
<td>0.32</td>
<td>3.1</td>
</tr>
<tr>
<td>31</td>
<td>40</td>
<td>M</td>
<td>R</td>
<td>2.1</td>
<td>7.8</td>
<td>8.4</td>
<td>0.27</td>
<td>4.0</td>
</tr>
<tr>
<td>32</td>
<td>42</td>
<td>M</td>
<td>R</td>
<td>1.8</td>
<td>8.2</td>
<td>8.5</td>
<td>0.22</td>
<td>4.72</td>
</tr>
<tr>
<td>33</td>
<td>20</td>
<td>F</td>
<td>R</td>
<td>2.5</td>
<td>7.1</td>
<td>8.0</td>
<td>0.35</td>
<td>3.2</td>
</tr>
</tbody>
</table>

NW= Notch width, BCD= Bicondylar Distance, IED= Interepicondylar Distance; NWI= Notch Width Index; RNWI= Reverse Notch Width Index

References
6. Stijak L, Nikolić V, Blagojević Z, Radonjić V, Santrac-
Comparison of Intercondylar Notch Width Index and Reverse Notch Width Index in Cases With and Without Anterior Cruciate Ligament Tears

Comparison of Intercondylar Notch Width Index and Reverse Notch Width Index in Cases With and Without Anterior Cruciate Ligament Tears

Author Information

**Sachin Gupta, MBBS; MS (Ortho)**
Assistant Professor, Department of Orthopaedics, SGRD Medical College

**Rohit Sharma, MBBS; DNB (Ortho); MNAMS**
Assistant Professor, Department of Orthopaedics, SGRD Medical College

**Nitin Saini, MBBS; DNB (Ortho)**
Senior Resident, Department of Orthopaedics, SGRD Medical College

**Yogeshwar Saini, MBBS; MS (Ortho)**
Professor and Head, Department of Orthopaedics, SGRD Medical College