DEFINING A SAFE ZONE FOR ALL INSIDE LATERAL MENISCUS REPAIRS IN PEDIATRIC PATIENTS: A MAGNETIC RESONANCE IMAGING STUDY

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OBJECTIVES

The purpose of this study was to establish a safe zone of all-inside meniscal fixation in pediatric patients using MRI measurements between the popliteus tendon (PT) and popliteal neurovascular bundle (PNVB). The authors hypothesize that males and older age groups will have a larger distance between the PT and the PNVB.

METHODS

- Patients aged 5-16 years old with near normal or normal knee MRIs were included
- Patients were grouped by age: group I (5-7yrs.): 61; II (8-10yrs.): 59; III (11-13yrs.): 60; IV (14-16yrs.): 70
- MRIs that contained axial sequences that visualized both the lateral meniscus and the PT were included
- The first reference line (D1) was drawn from the lateral edge of the patellar tendon to the medial edge of the PT
- The second reference line (D2) was drawn from the lateral edge of the patellar tendon to the lateral edge of the PNVB
- A line from the medial edge of PT to D2 along meniscocapsular junction of the PHLM was drawn (D3)
- Finally, the angle (α) between D1 and D2 was measured
- D1, D2, and the α angle were used to mathematically calculate the distance from PT to lateral PNVB on the anterior edge of the lateral meniscus, assuming it measures approximately 8mm in depth (D4), in order to simulate the anterior edge of the PHLM
- Measurements were each made by three authors; one senior pediatric orthopaedic surgeon, one orthopaedic resident, and one second year medical student. The orthopaedic resident then measured the MRI's at a second separate time at least one week after the first measurements
- Statistical Analysis:
  - Paired t-tests were used to assess inter- and intra-observer reliability
  - Power analysis was conducted using a standard deviation of 1.9mm, power of 80%, and alpha level of 0.05, indicating that 60 patients per age group is required to detect differences of 1mm or smaller
  - A General Linear Model was established for each of the dependent variables: D3 and D4
  - The independent variables were age group and sex
  - In addition, Pearson correlation analysis was conducted to assess any correlations between D1, D2, D3 and D4 against patient age

RESULTS

- Inter- and Intra-Observer Reliability
  - Although statistically significant differences were found among the observers, the average differences in the same measurements were small from a clinical standpoint
  - While there were statistically significant differences between the two measurements, these differences were small from a clinical standpoint
  - A total of 250 MRI scans (128 Male: 122 Female) were evaluated and included (Table 3)
  - D3 measurements showed gradually increasing size with age group as expected with growth of the knee. Significant differences between sexes and age groups ($p<0.0001$) were found. There were significant differences among all age groups ($p<0.001$), except between the age groups 3 and 4 ($p=0.671$) (Table 4)
  - D4 measurements, expectedly smaller than D3, also showed gradually increasing size with age group as expected with growth of the knee. Significant differences between sexes and age groups($p<0.0001$) were found. There were significant differences among all age groups ($p<0.001$), except between the age groups 3 and 4 ($p=0.671$) (Table 5)

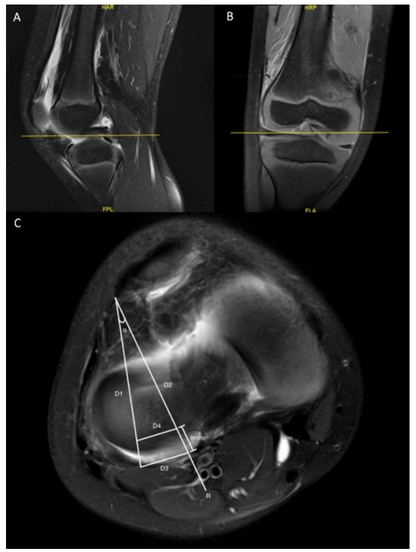

Figure 1A-C
1A, B: Sagittal and coronal scout MRI images confirming location of popliteus tendon at superior border of posterior horn of lateral meniscus
1C: Measuring the α angle between D1 and D2

Age Group	Male	Female	All
5-7 Years	37	24	61
8-10 Years	30	29	59
11-13 Years	30	30	60
14-16 Years	31	39	70
Total	128	122	250

Table 3. Number of MRI's By Age and Sex

Age Group	Male (mm±SD)*	Female (mm±SD)*	All (mm±SD)
5-7 Years	14.44±3.28**	13.62±2.66*8	14.11±3.06**
8-10 Years	16.13±2.35**	15.37±2.71**	15.76±2.54**
11-13 Years	18.68±2.83	15.26±2.86	16.97±3.26
14-16 Years	18.89±2.34**	15.82±3.03**	17.18±3.13**

Table 4. D3 by Age and Sex

Age Group	Male (mm±SD)*	Female (mm±SD)*	All (mm±SD)
5-7 Years	11.69±2.83**	10.94±2.28**	11.39±2.63**
8-10 Years	13.65±2.07**	12.82±2.36**	13.24±2.24**
11-13 Years	16.17±2.49	13.02±2.38	14.59±2.89
14-16 Years	16.43±2.06**	13.51±2.64**	14.80±2.79**

Table 5. D4 by Age and Sex

CONCLUSIONS

This study provides normative data of the distance between popliteal neurovascular bundle and popliteus tendon at the meniscocapsular junction (D3) and anterior edge of the posterior horn lateral meniscus (D4) with the knee in full extension. Combined with previous studies showing the addition of knee flexion increases the distance between the meniscus and the neurovascular bundle, surgeons can use this data to improve safety of posterior horn lateral meniscus repair in pediatric patients.

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