ePoster # 112:

All-Inside Meniscus Implant Placement and Risks of Neuro-Vascular Injury – An Arthroscopic, Pediatric Anatomic Study

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Disclosures

- Henry Baird: no relevant disclosures
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Background

- Meniscal injury rates in skeletally immature patients are increasing rapidly.[1-5]
- In the pediatric population, arthroscopic treatment of meniscus tears, particularly those of the lateral meniscus, is becoming increasing common.[6-12]
- All-inside fixation has gained prominence in the arthroscopic field due to its relative ease of implantation, reduced surgical time, and decreased risk of complications.[1,13]
- The latest generation of all-inside devices seek to combine the strength of inside-out repair with the advantages of the all-inside technique.[14]
- Many all-inside devices rely on hollow needle penetration of the meniscus and joint capsule that may penetrate well beyond the posterior limits of the meniscus during repair.

Background

- While inside-out meniscal repair allows for placement of retractors that may protect neurovascular structures posterior to the knee joint,[13] all-inside repair does not utilize this technique which may put neurovascular structures at risk.

- Certain arthroscope approach angles may place all-inside meniscal devices even closer to neurovascular structures.[15]

- While there are both imaging[16-18] and anatomic[19-21] studies in the adult population that address vascular safety of all-inside devices, there remains a paucity of comparable anatomic studies in the pediatric population.[22]

- Therefore, with the rapidly increasing meniscus injury rates and growing popularity of all-inside devices used in the potentially higher-risk pediatric population, studies examining the proximity of these devices to neurovascular structures are needed.

Objective

- The purpose of this study was to provide distances to neurovascular structures from all-inside devices placed arthroscopically at both high-risk approach angles and zones of the lateral menisci of pediatric cadaveric specimen.

- We hypothesized that the neurovascular structures would be situated closely to arthroscopically placed all-inside lateral meniscal devices, particularly:

    1. PA, PV, and TN to devices placed at the posterior root when placed via a lateral port.

    2. PN to devices placed just medial to the popliteal hiatus via a medial port.

Materials and Methods

- The study involved twelve fresh-frozen cadaveric knee specimens (six matched pairs) of three male and three female children between the ages of six and ten.

- Two all-inside implants were placed in the lateral meniscus: one via a medial port just medial to the popliteal hiatus and one via a lateral port at the visible edge of the posterior root.

- Specimens were then dissected posteriorly to expose the posterior knee capsule and meniscal implants.

- The distance measurements between the implants and the popliteal artery (PA), popliteal vein (PV), tibial nerve (TN), and peroneal nerve (PN) were recorded.

Materials and Methods

- Stryker AIR (2nd Generation) devices were placed in two previously identified high risk zones and arthroscopic approach angles of the lateral meniscus:[15]
  1. Device A - just medial to the popliteal hiatus via anteromedial portal
  2. Device B - at the visible edge of the posterior root via anterolateral portal

- All device anchors were deployed with a depth limiter set at 10-12mm of penetration and traversed the meniscus with the intention of engaging the posterior joint capsule. Sutures were placed in a vertical mattress configuration.

- For each meniscus repair device, four measurements (distance to PA, PV, TN, and PN) were taken on each specimen at each of the four locations of the all-inside device anchors (two anchors per device, recorded as “first anchor” and “second anchor”) using digital calipers with a nominal precision of 0.02 mm.

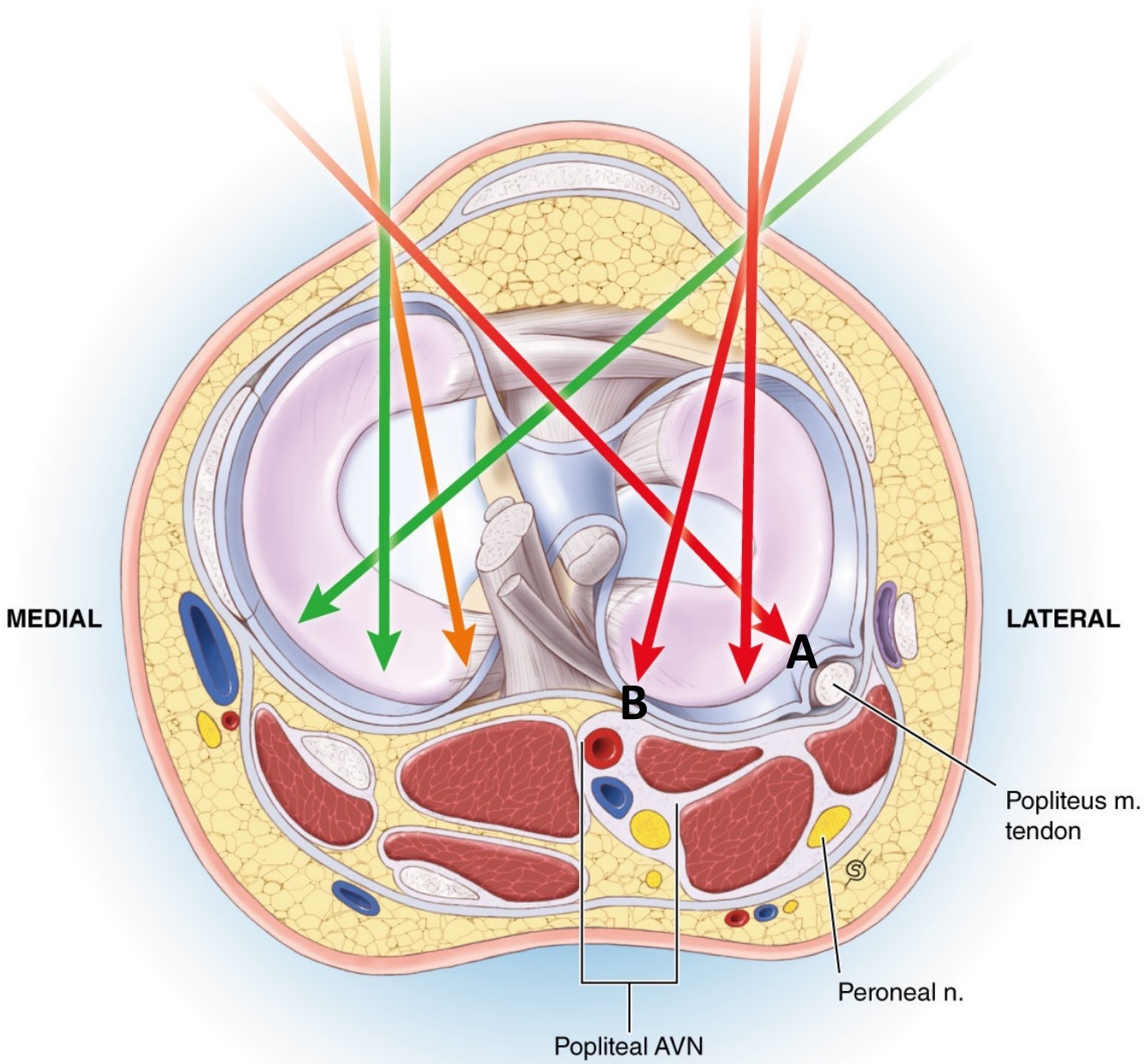

Figure 1: High Risk Zones and Approach Angles of Medial and Lateral Meniscus Repair

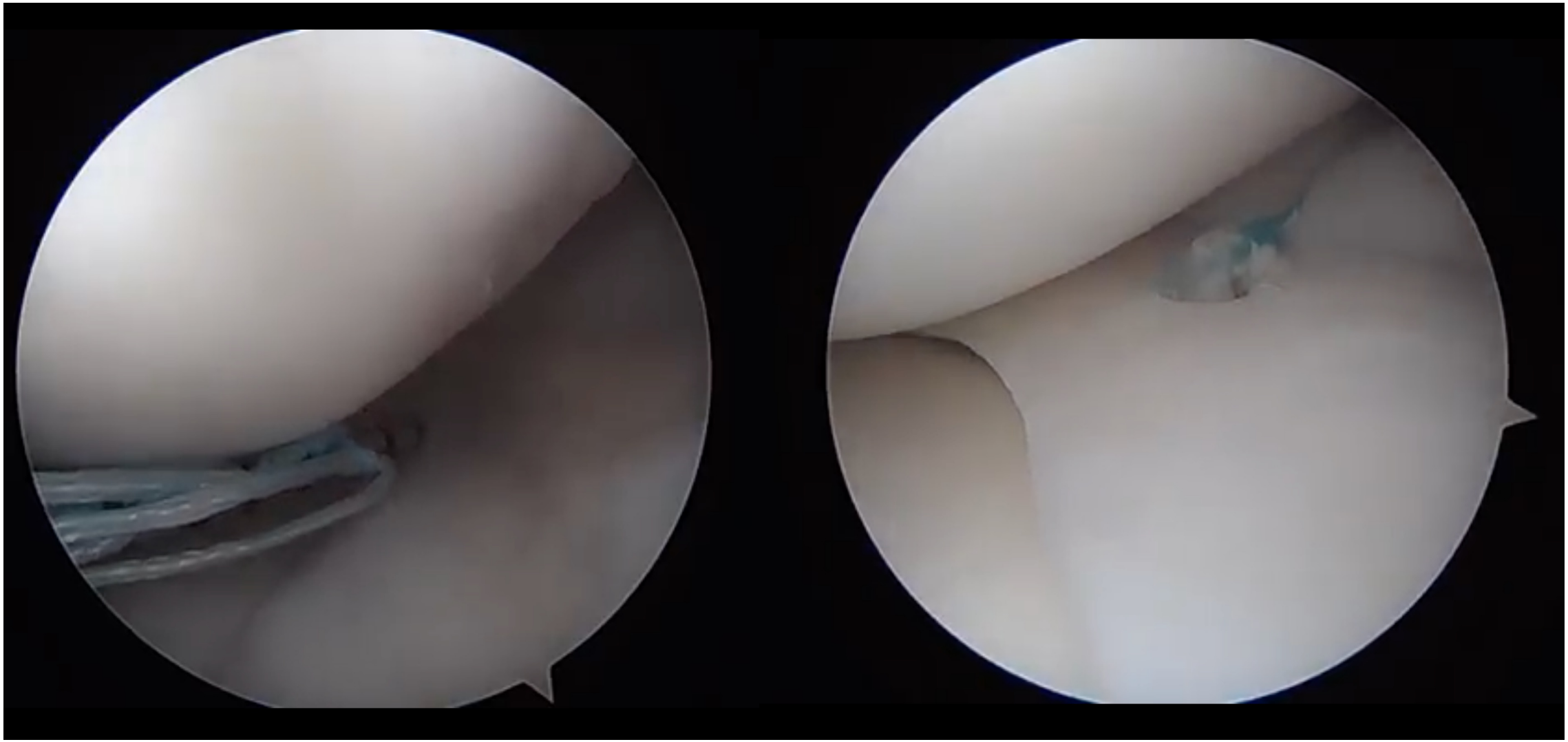

Figure 2. Arthroscopic Images of All-Inside Device A Placement at the Medial Side of the Popliteal Hiatus via the Anteromedial Portal.

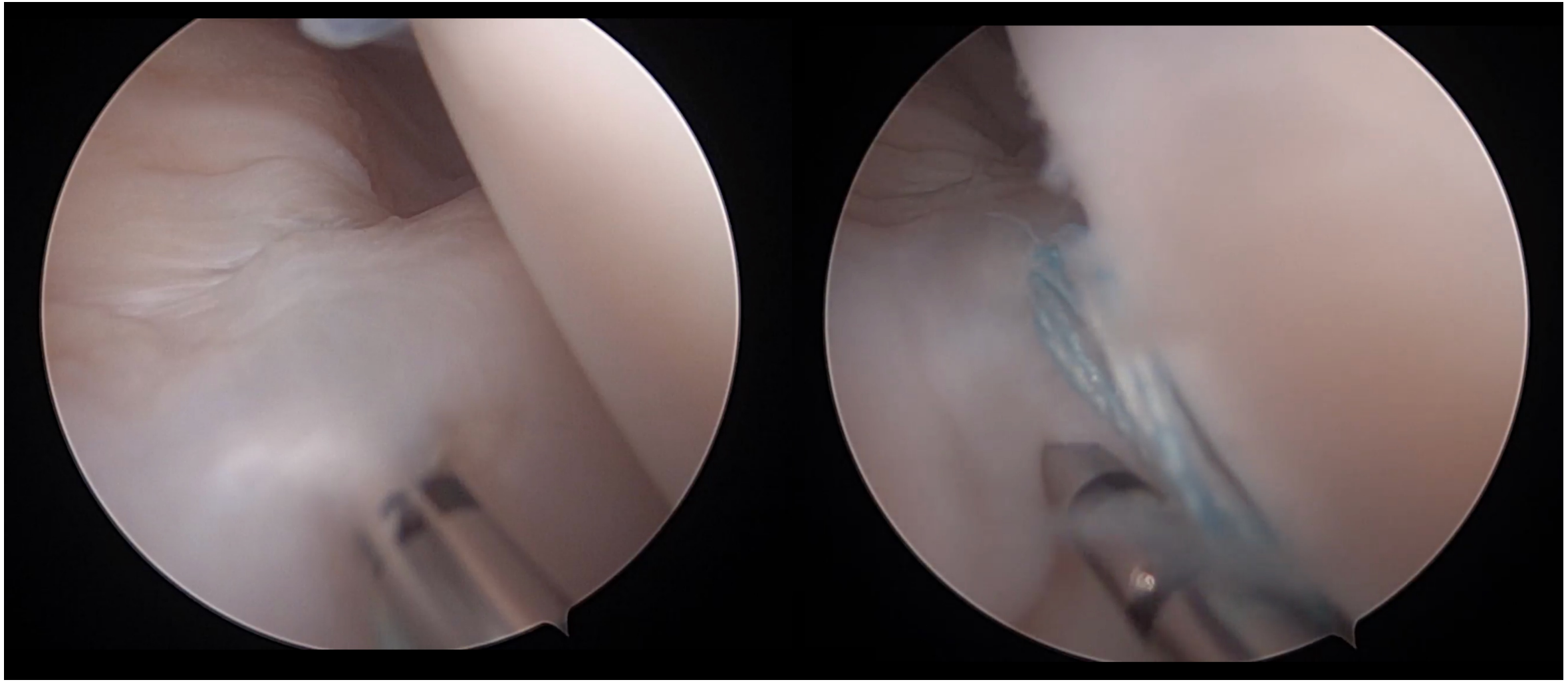

Figure 3. Arthroscopic Images of All-Inside Device B Placement at the Visible Edge of the Posterior Root via the Anterolateral Portal

Table 1: Age, Sex, and Laterality of Specimens with Individual Distances from Suture Anchors to Neurovascular Structures (mm)

Device Location				Popliteal Hiatus								Meniscus Root							
				First Anchor				Second Anchor				First Anchor				Second Anchor			
Specimen	Age (y)	Sex	Side	PA	PV	TN	PN	PA	PV	TN	PN	PA	PV	TN	PN	PA	PV	TN	PN
1	6	M	L	45.0	45.0	45.0	30.0	50.0	50.0	50.0	35.0	8.0	5.0	7.0	13.0	13.0	8.0	15.0	14.0
2			R	28.8	29.6	30.4	8.2	-	-	-	-	3.1	4.2	5.3	21.8	-	-	-	-
3	8	F	L	45.0	43.0	43.0	20.0	42.0	40.0	40.0	17.0	-	-	-	-	12.0	19.0	21.0	28.0
4			R	47.0	44.0	50.1	38.0	48.9	48.5	52.4	40.1	-	-	-	-	17.9	12.0	19.0	12.1
5	9	M	L	42.0	43.0	46.0	22.8	-	-	-	-	10.3	13.0	16.9	-	10.3	13.0	16.9	-
6			R	59.8	57.5	53.2	10.4	57.1	53.6	51.2	14.6	13.8	12.0	10.5	11.1	17.2	16.7	10.8	15.2
7	10	F	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8			R	43.4	47.2	49.6	18.5	44.4	44.3	44.7	16.4	6.5	9.0	10.2	23.7	-	-	-	-
9	10	M	L	27.0	30.0	37.0	-	25.0	28.0	35.0	-	-	-	-	-	20.0	15.0	21.0	-
10			R	-	-	-	-	-	-	-	-	6.7	8.3	9.6	13.6	-	-	-	-
11	10	F	L	29.6	29.6	32.9	6.3	-	-	-	-	-	-	-	-	3.5	3.5	6.5	12.6
12			R	56.0	58.0	63.0	34.2	50.0	53.0	63.0	35.0	2.3	4.1	12.6	7.9	5.1	9.5	13.4	9.5

-: data unavailable

Table 2: Distances (mm) of All Anchors to Neurovascular Structures

Neurovasculature	All	NVB	PA	PV	TN	PN
Range	2.3 - 63.0	2.3 - 63.0	2.3 - 59.8	3.5 - 58.0	5.3 - 63.0	6.3 - 40.1
Median (IQR)	21.0 (12.0-44.0)	28.4 (11.1-45.0)	26.0 (10.3-45.0)	28.8 (10.1-44.8)	31.7 (12.8-48.7)	16.4 (12.1-28.0)
P-value	PA vs. PV	PA vs. TN	PA vs. PN	PV vs. TN	PV vs. PN	TN vs. PN
	1.000	1.000	1.000	1.000	1.000	0.227

Table 3: Comparative Analysis of Distances (mm) of Anchors to Neurovascular Structures by Device Location*

Neurovasculature	Device A: Popliteal Hiatus Anchors	Device B: Meniscus Root Anchors	P-value
PA	45.0 (35.8-50.0)	10.3 (5.1-13.8)	**<0.001**
PV	44.3 (35.0-51.5)	9.5 (5.0-13.0)	**<0.001**
TN	46.0 (38.5-51.8)	12.6 (9.6-16.9)	**<0.001**
PN	20.0 (14.6-35.0)	13.3 (11.4-20.2)	0.057
Neurovascular Bundle (PA, PV, TN)	44.3 (30.4-50.1)	12.0 (6.6-17.1)	**<0.001**
Total (PA, PV, TN, PN)	41.1 (26.5-48.6)	12.1 (8.2-18.5)	**<0.001**

*Data are presented as median (IQR)

Conclusions

- The distances from the anchors to the PA, PV, TN, and PN ranged from 2.3 to 59.8 mm, 3.5 to 58.0 mm, 5.3 to 63.0 mm, and 6.3 to 40.1 mm, respectively.

- Implants at the meniscus root were closer to the neurovascular bundle (PA, PV, and TN) than implants at the popliteal hiatus ($p \leq 0.001$ for all). There was no difference in distances to the PN between the two devices ($p=0.057$).

- This study illustrates the proximity of neurovascular structures to all-inside meniscus repair device anchors in pediatric knee specimens, particularly those directed at the posterior horn using the anterolateral portal. However, all inside devices may be placed safely if used appropriately.

Conclusions

- Prior pediatric anatomic research has suggested that the higher risk zones are the posterior meniscus region extending from the root to the popliteal hiatus, and these locations were the focus of this study.[15, 23-24]

- The distances between these devices and critical neurovascular structures can be as close as 2.3-6.3 mm, with devices placed at the meniscus root via a lateral port being the closest.

- In adult studies, less than 5 mm between the repair device and the neurovascular structures is considered to pose a high risk. [20-21]

- With this definition, lateral meniscal repair at both device sites and approach angles utilized in our study should be regarded as higher risk.

Clinical Relevance

- With increasing meniscus injury rates and growing popularity of all-inside implants used in the potentially higher-risk pediatric population, this study provides much needed data to the growing body of knowledge regarding meniscal injuries and repair in the pediatric population.

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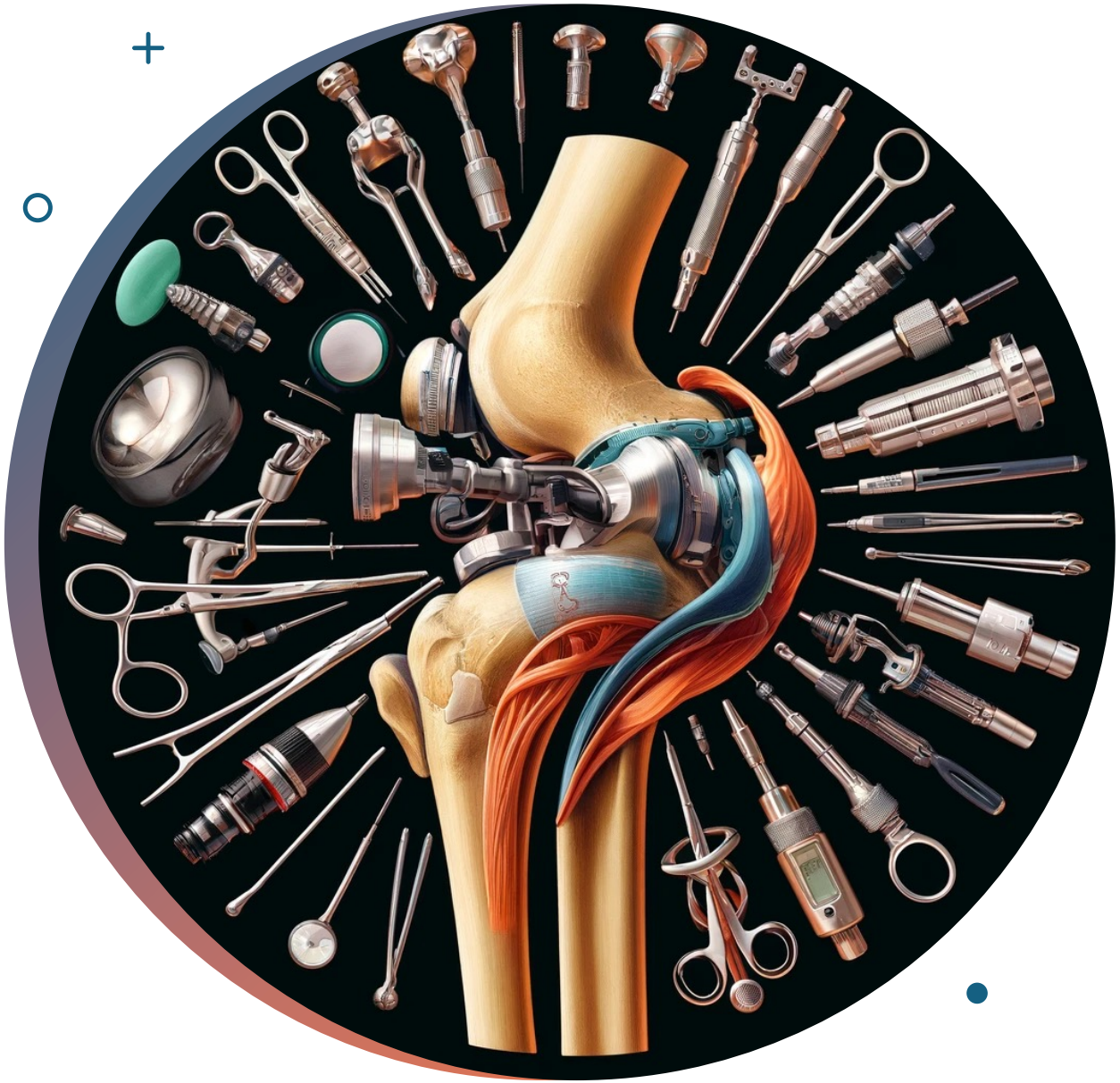

Questions

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