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Survey Results Concerning Current Trends in Meniscus Repair Indications and Preferences from Members of the Pediatric Research in Sports Medicine (PRiSM) Society

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Conflict of Interest: J. Lee Pace: Consultant for Arthrex and JRF Ortho. Committee member for American Orthopedic Society for Sports Medicine (AOSSM) and Pediatric Research in Sports Medicine (PRiSM).

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Background: Meniscus repair has increased in frequency, especially among surgeons who focus on youth sports injuries.

Purpose: To determine current trends in meniscus repair amongst a specific subset of meniscus repair surgeons.

Study Design: Cross-Sectional Survey Study

Methods: A survey comprised of several clinical vignettes was administered to orthopedic surgeon members of the Pediatric Research in Sports Medicine (PRiSM) society to investigate surgeon experience and training, number of meniscus repair procedures performed, as well as surgical and rehabilitation preferences. Statistical analysis of the responses was performed to determine associations between years in practice or type of fellowship training vs. number of meniscus repair procedures performed, surgical indications, and rehabilitation preferences.

Results: The response rate to various questions ranged from 61.5% (59/96) to 63.5% (61/96). In all vignettes, a majority favored repair as well as some degree of weight-bearing and range of motion restrictions. Surgeons who had been in practice for 6-10 years performed significantly more meniscus repairs per year than those in practice for > 20 years ($p = 0.009$) and those in practice 0-5 years ($p = 0.05$). Surgeons who had been in practice > 20 years performed a significantly higher percentage of meniscectomies relative to meniscus repairs, compared to those in practice for 0-5 years ($p = 0.002$) or 6-10 years ($p = 0.0003$). When years in practice was grouped into < 10 years and > 10 years, surgeons in practice < 10 years performed a significantly higher percentage of meniscus repairs relative to meniscectomies, compared to surgeons in practice > 10 years ($p < 0.0001$).

Conclusions: Surgeons with fewer years in practice are more likely to perform meniscus repair than meniscectomy, but all surgeons surveyed had a general preference for repair in all clinical vignettes. Repair technique preferences as well as rehabilitation protocols varied widely among surgeons.

Key Terms: Meniscus repair, meniscectomy, all inside meniscus repair, inside out meniscus repair, outside in meniscus repair

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Table 2. Response options were grouped together into binary groups for statistical analysis.
 WBAT = weight bearing as tolerated; PWB = protected weight bearing

Response	Binary Response(s)
Years in Practice	< 10 years vs. > 10 years
Type of Fellowship	Pediatric vs. Adult
Treatment Options	Repair vs. Meniscectomy
Repair Technique	All Inside vs. Inside Out
Weight Bearing Restrictions	WBAT vs. PWB
Range of Motion Restrictions	Restricted Motion vs. Full Motion
Brace Use	Brace vs. No Brace

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Table 3. Summary of responses to clinical vignettes.

*23% of respondents favored conditional repair based on the tear translating past the midpoint of the lateral femoral condyle.

**9 respondents (15.3%) would only fix if there was a root tear component and meniscectomize the oblique radial component.

***Based on the wording of the question, several answers specified a range of motion brace being used without specifically stating how much motion to be restricted. Thus “less than 90°” was assumed for 32 (52.5%) respondents.

Vignette	% favoring repair	Most common type of repair (%)	% favoring weight-bearing restrictions	% favoring range of motion restrictions
Lateral meniscus radial tear	90.2%	Hybrid (58.2%)	Limited 0-50% weight bearing (91.8%)	Limited to 90° or less for 4-6 weeks (91.8%)***
Vertical tear in posterior horn of lateral meniscus	98.4%*	Capsular-based all inside (83.3%)	Limited 0-50% weight bearing (58.3%)	Limited to 90° or less for 4-6 weeks (98.3%)
Bucket-handle medial meniscus tear	100%	Capsular-based inside out (49.2%)	Limited 0-50% weight bearing (72.1%)	Limited to 90° or less for 4-6 weeks (95.1%)
Horizontal cleavage tear	61%	Capsular-based all inside (41.7%)	Limited 0-50% weight bearing (65%)	Limited to 90° or less for 4-6 weeks (86.7%)
Complex radial/oblique tear of lateral meniscus near posterior root	70.2%**	Meniscal-based all inside (42.4%)	Limited 0-50% weight bearing (89.8%)	Limited to 90° or less for 4-6 weeks (89.8%)

Table 4. Statistically significant correlations that were found between survey responses and type and/or number of fellowships performed. FET = Fisher's exact test, MCL = medial cruciate ligament.

*While significant, a majority either did not or only sparingly fenestrated the MCL.

	Pediatric vs. Adult	Sports vs. Pediatric	1 vs. 2 Fellowships	
MCL Pie Crusting			1 Fellowship less likely to pie crust MCL*	FET p = 0.0130
Vignette #1. Radial lateral meniscus tear. Repair vs. meniscectomy.		Sports trained more likely to repair		FET p = 0.0376
Vignette #4. Horizontal cleavage tear. Brace vs. no brace.			1 Fellowship more likely to brace**	FET p = 0.0334
Vignette #5 Radial oblique lateral meniscus tear. Brace vs. no brace.		Sports trained less likely to brace**	1 Fellowship more likely to brace**	Sports vs. Pediatric FET p = 0.0209 1 vs. 2 fellowship FET p = 0.0230

**Although significant differences were found in these instances, most surgeons (>70% in all cases) would apply a brace postoperatively.

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Introduction

The essential role of the meniscus as a shock absorber and secondary stabilizer of the knee has become well accepted. The repair of meniscus tears has increased in frequency over recent years. Recent studies evaluating the case logs of orthopedic surgeons taking Step II of the American Board of Orthopedic Surgery (ABOS) oral exam showed a significant increase in the rates of meniscus repair and a relative drop in the number of meniscectomies.^{1,2}

This increase in the number of meniscus repairs has focused attention on several aspects of meniscus repair that remain to be elucidated, including which tear types are amenable to repair, effective modes of fixation, use of biologic augmentation, and the optimal approach to post-operative movement and weight-bearing restrictions. While the literature on meniscus repair has significantly increased over the last several years³⁻⁷, there are still gaps in our understanding.

Thus, the purpose of this study was to perform a survey of orthopedic surgeon members of the Pediatric Research in Sports Medicine (PRiSM) Society to determine: 1) overarching principles and trends related to meniscus repair, 2) preferences and techniques for specific

meniscus tear types, and 3) preferences for post-operative restrictions. This subset of surgeons have a practice that is focused on young athletes who stand to benefit the most from a successful meniscus repair. Survey responses were analyzed to identify areas of consensus and disagreement such that further research questions can be formulated and focused to standardize the indications and treatment requirements for meniscus repair.

Materials and Methods

An online survey tool (Survey Monkey, San Mateo, CA) was used to send the survey to all 96 orthopedic surgeon members of PRiSM. The survey was sent twice over the course of two weeks. The survey began with 6 general questions as described in Table 1. These questions were followed by 5 clinical vignettes, each of which described a specific type of meniscus tear. The five different types of meniscus tears were: 1) a full thickness radial tear through the mid-body of the lateral meniscus in a 13-year-old male; 2) a 1.5-cm full-thickness vertical tear at the junction of the red-red and red-white zones in the posterior horn of the lateral meniscus in association with an anterior cruciate ligament (ACL) tear in a 15-year-old male, 3) a bucket-handle medial meniscus tear in a 17-year-old male, 4) an inner 50% irreparable chronic radial tear in the body of the lateral meniscus with an associated horizontal cleavage tear that is 2.5 cm long in a 15-year-old female; and 5) a complex radial/parrot beak tear of the posterior horn of the lateral meniscus within 1 cm of the posterior root in association with an ACL tear in a 17-year-old female. These tears were chosen because they are commonly seen in the adolescent population and thus tear patterns that the PRiSM members would be familiar with.

The complete questionnaire is available for review in the Supplemental Appendix. Each vignette had questions about whether to fix or debride the tear, what type of fixation would be

preferred if the tear was repaired, and postoperative restrictions related to weight-bearing and range of motion. The options for meniscus repair were as follows:

- Inside-out capsular-based repair through either a posteromedial or posterolateral incision
- All-inside capsular-based repair with a device that deploys either polyetheretherketone (PEEK) or all suture-based anchors on the capsule
- Outside-in capsular-based repair
- All-inside meniscal-based repair in which two limbs of a suture are passed and contained entirely within the meniscus, and a knot is tied to secure the repair.

Capsular-based repair is defined as a repair in which the fixation is anchored on the capsule of the knee. Meniscal-based repair is defined as fixation that is contained entirely within the meniscus. Examples of the devices used for meniscal-based repair include the Knee Scorpion (Arthrex, Naples, FL) and the Ceterix Novostitch Pro (Smith & Nephew, Andover, MA).

Statistical Analysis

Categorical variables were reported with frequencies and proportions. The Chi-square test or Fisher's exact test was used to test associations between categorical questionnaire items. Analysis of variance (ANOVA) was used to investigate the association between continuous variables and categorical variables. Statistical significance was set at $p = 0.05$. Statistical analyses were performed with SAS version 9.4 (SAS Institute, Inc., Cary, NC). A secondary analysis of the dataset was performed after the responses were regrouped into binary variables (e.g., any type of repair vs. meniscectomy, any type of weight-bearing restriction vs. full weight-bearing). Specific binary groups are detailed in Table 2.

Results

There were 61 respondents (either in full or partial, as appropriate) to all six general questions and the first 4 clinical vignettes for a response rate of 63.5% (61/96). The fifth vignette had a response rate of 61.5% (59/96). The complete tallied results are in the Supplemental Appendix. Results of the first six questions are detailed in Figures 1-6. Responses to the clinical vignettes were grouped into 4 categories: 1) percentage of respondents favoring repair; 2) type of repair performed; 3) percentage of surgeons favoring limited weight-bearing for 4-6 weeks; and 4) percentage of surgeons favoring range of motion restrictions for 4-6 weeks (Table 3). In all vignettes, a majority favored repair (in various fashions), as well as restriction of weight-bearing and range of motion to some degree. Repair technique preferences as well as rehabilitation protocols varied widely among surgeons. While range of motion restrictions between 0-90° were consistently recommended, several surgeons prescribed more specific restrictions. These more specific restrictions varied widely among surgeons.

Surgeons who were in practice for 6-10 years performed significantly more meniscus repairs per year than surgeons who had been in practice for > 20 years ($p = 0.009$) or 0-5 years ($p = 0.05$). Surgeons who had completed a pediatric sports medicine fellowship performed significantly more meniscus repairs than surgeons who had completed a pediatric orthopedics fellowship ($p = 0.04$).

Surgeons who had been in practice > 20 years performed a significantly higher percentage of meniscectomies relative to meniscus repairs than surgeons who had been in practice 0-5 years ($p = 0.002$) or 6-10 years ($p = 0.0003$). When years in practice was grouped into < 10 years and > 10 years, responses from surgeons in practice < 10 years showed a significantly higher percentage of meniscus repairs relative to meniscectomies than surgeons in practice > 10 years ($p < 0.0001$).

Regarding the clinical vignettes, years in practice affected response patterns as follows:

- Vignette #1: for the radial lateral meniscus tear, 97% of surgeons in practice for < 10 years but only 79% of surgeons in practice > 10 years preferred repair via any technique vs. meniscectomy ($p = 0.0307$).
- Vignette #5: for the complex radial oblique tear of the posterior horn of the lateral meniscus, 70% of surgeons < 10 years in practice preferred a meniscal-based repair (Chi-Square $p = 0.0013$, FET $p = 0.0024$).

There were several significant correlations between the type and/or number of fellowships performed and survey responses. These are summarized in Table 4.

Discussion

Analysis of the survey responses collected for this study revealed significant associations between years in practice and approaches to meniscus repair among orthopedic surgeons who have a practice focused on younger athletes who stand to benefit the most from a meniscus repair. The most interesting findings were that surgeons in practice < 10 years performed significantly more meniscus repairs than surgeons in practice >10 years, and they also performed a significantly higher percentage of meniscus repairs relative to meniscectomies. While surgeons in practice 6-10 years performed more meniscus repairs per year than those in practice 0-5 years, the relative proportion of meniscus repairs to meniscectomies was significantly greater in both groups, compared to surgeons in practice > 10 years.

A recent study showed that surgeon candidates with sports medicine or pediatric fellowship training who were sitting for Step II of ABOS certification who performed combined

ACL and meniscus surgery on patients 19 years or younger were more likely to perform a repair than a meniscectomy.¹ This study's finding that 97% of surgeons with < 10 years in practice but 79% of surgeons > 10 years in practice elected to repair the radial lateral meniscus tear in Vignette #1 ($p = 0.0307$) supports the prevalence of a “repair-first” approach, even for more difficult tear patterns, among pediatric sports medicine-focused surgeons with < 10 years in practice. There are several possible explanations for this paradigm shift. First, our understanding of the essential function of the menisci with regards to cartilage protection has improved.⁸⁻¹³ However, if this were the sole reason, one would expect to see a more uniform shift in surgeons of all levels of experience. The preference for meniscus repairs among surgeons with < 10 years in practice may reflect this group's relative comfort with the required technology and/or familiarity with the relevant educational resources. Numerous meniscus repair devices are currently available. The aforementioned ABOS-based analyses^{1,2} support the importance of education related to meniscus repair, as does this study's finding that surgeons who had completed a pediatric sports medicine fellowship performed a higher percentage of meniscus repairs vs. meniscectomies. Conversely, it is possible that a more experienced surgeon has experienced failures with certain tear types and thus understands that certain tear patterns are better off with a meniscectomy while a younger surgeon may still need to consider indications more carefully. A recent study by Wu et al demonstrated equivalent outcomes for radial meniscus tear repair vs bucket handle tear repair¹⁴ that provides some evidence that the “repair first” strategy adopted by younger surgeons in this study for radial tears, and meniscus tears in general^{4,7,15}, has support in the literature. Data collected from a prospective cohort study of patients undergoing meniscus repair or meniscectomy would provide the strongest evidence and guidance to date on indications for meniscus repair and looks to be a worthy pursuit.

For all vignettes posed to the study respondents, most surgeons tended to favor repair, but there was noticeable variation in the preferred technique for meniscus repair. One commonality was the popularity of all-inside capsular-based repair devices (e.g., Fast Fix 360 [Smith & Nephew, Andover, MA], Fiberstitch [Arthrex, Naples, FL]). These devices have become ubiquitous in recent years¹⁶ and have largely supplanted the technology for other forms of capsular-based repair, namely inside out repair, and recent literature has generally shown equivalent outcomes between the two techniques.^{3,17-19} Surgeons generally speak to the speed and ease of use of these devices as primary drivers of their popularity. While there are studies showing similar efficacy of these devices compared to those used for inside-out repair, the research is far from settled. For the vignette describing a bucket-handle meniscus tear, all-inside capsular-based repair was favored only slightly less than the traditional inside-out technique (49.2% vs. 45.9%). The rising popularity of all-inside capsular-based repair is notable, given that bucket-handle meniscus tears have traditionally been repaired only with an inside-out approach. All-inside capsular-based repair was the most favored technique for treating the vertical tear in the posterior horn of the lateral meniscus (Vignette #2) and the horizontal cleavage tear (Vignette #4) and was the second most-favored technique for the oblique radial tear in the lateral meniscus (Vignette #5). A cohort study designed to evaluate the use of a given repair technique for various tear patterns could help establish preferred methods of repair that could be more broadly generalizable throughout the orthopedic sports medicine community.

Of note, the survey responses showed that surgeons commonly elected to perform all-inside meniscal-based repair. Despite ongoing efforts to characterize the feasibility and indications for this new technology²⁰⁻²⁴, all-inside meniscal-based repair was the most popular technique (42.4%) for treatment of a complex oblique radial tear near the posterior root of the

lateral meniscus (Vignette #5). Seventy percent of surgeons who had been in practice < 10 years preferred use of all-inside meniscal-based repair to any capsular-based technique (70% vs. 30%, respectively, Chi-Square $p = 0.0013$, ($p = 0.0024$). Furthermore, one recent biomechanical study showed various meniscal-based repair techniques to be superior to capsular-based repair techniques for radial tear patterns.²² Additional studies will be necessary to systematically evaluate early clinical outcomes after meniscal-based repair.

There were several statistically significant associations found with regards to MCL fenestration and post operative range of motion and weight bearing restrictions. Admittedly, it is difficult to ascertain if any of these findings were due to anything other than chance given the study design. Regarding MCL fenestration, recent studies have shown it to be a viable technique that does not lead to residual valgus laxity.^{25,26} However, further literature is needed to determine if MCL relaxation improves healing and patient reported outcomes after meniscus repair. With regards to post operative restrictions and rehab, prior literature reviews have shown a lack of high-quality evidence in this area.⁵ Regarding range of motion and weight bearing restrictions, there is likely a lot of dogma at play here combined with a very understandable concern to lessen any possible stress across the repair site. Thus, there is often a preference to be more conservative early on despite high level evidence to support it and at least anecdotes to the contrary from other surgeons who are less conservative with early post surgical restrictions. From a patient's perspective, crutch and brace use are often the most bothersome aspects of the early post operative phase. Determining when these are truly necessary would be very useful to clinical practice.

Limitations of this study are inherent to its design. Specifically, it is difficult to accurately elucidate the exact rationale for meniscus repair vs. meniscectomy. Factors other than the

number of years a surgeon had been in practice may play a role. In addition, the vignettes provided to surgeons for review included only a small selection of meniscus tear types. Furthermore, all clinical vignettes described adolescent patients with traumatic meniscus injuries. Thus, any conclusions drawn may not be applicable to the adult population or patients with a discoid meniscus. However, the purpose of this study was to discover and highlight trends in meniscus repair that could generate meaningful research questions.

Conclusion

While all surgeons surveyed had a general preference for meniscal repair over meniscectomy, younger surgeons tended to perform repair at a higher rate than older surgeons. While these differences are highly likely to be multifactorial, there is literature support behind this trend. Given the diversity of preferences with regards to repair technique and post operative restrictions, higher level study is warranted.

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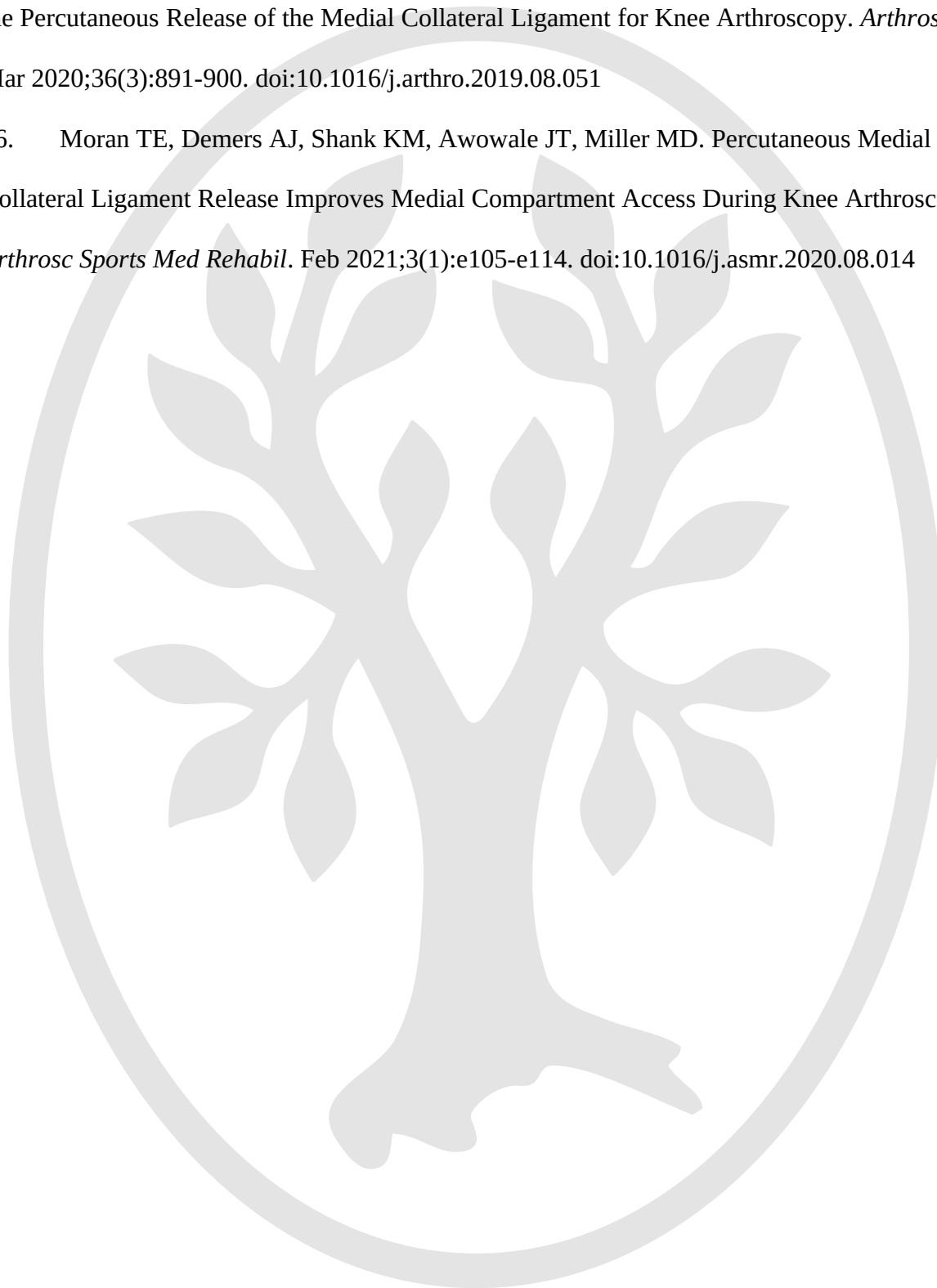
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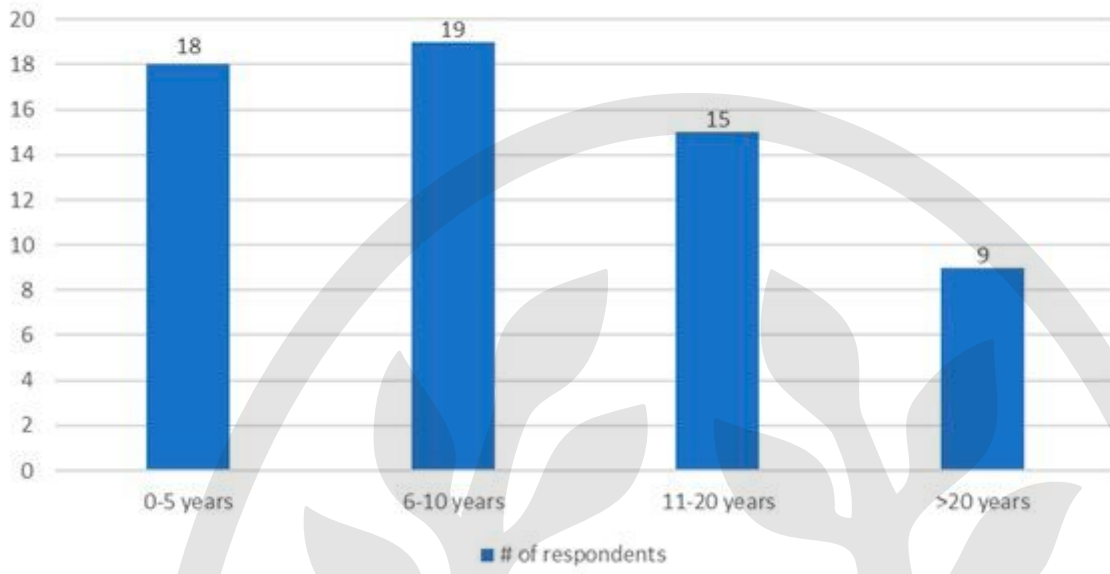
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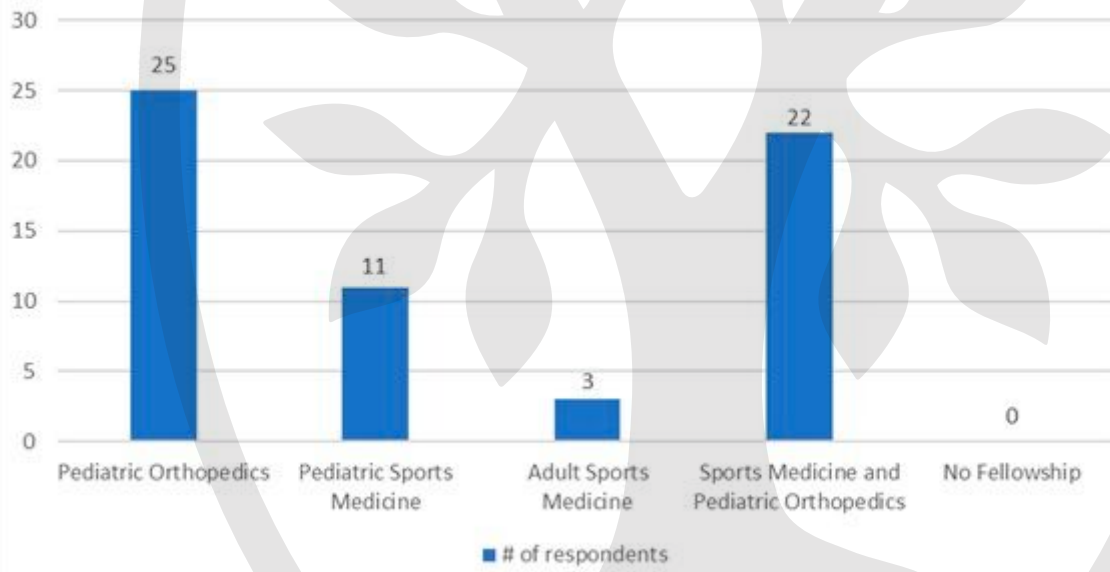
	A	B	C	D	E	F
How long have you been in practice?	0-5 years	6-10 years	11-20 years	>20 years		
Which of the following best describes your post residency training?	Fellowship Training in Pediatric Orthopedics	Fellowship Training in Pediatric Sports Medicine	Fellowship Training in Adult Sports Medicine	Fellowship Training in BOTH Sports Medicine and Pediatric Orthopedics	I did not complete a fellowship	
How many meniscus repairs do you perform per year?	0-10	11-20	21-30	31-40	41-50	>50
What percentage of meniscus repairs do you do relative to meniscectomies?	0-20% meniscus repairs to 80-100% meniscectomies	21-40% meniscus repairs to 79-60% meniscectomies	41-60% meniscus repairs to 40-59% meniscectomies	61-80% meniscus repairs to 20-39% meniscectomies	>80% meniscus repairs to <20% meniscectomies	
When repairing a medial meniscus tear please select one or more of the following that best describes your approach to visualization	I never pie crust the MCL	I pie crust the medial collateral ligament to improve visualization seldomly < 20 % of cases	I pie crust the medial collateral ligament to improve visualization often > 50 % of cases	Other - [Please write in comment]		
After completion of an isolated meniscus repair please select as many of the following choices that you perform intra-operatively	Marrow venting with a drill or awl	Injection of autologous conditioned plasma / platelet rich plasma	Injection of bone marrow aspirate concentrate	Fenestrate the meniscal-capsular junction with a rasp / needle	I do not perform any of the above	Other - [Please write in comment]

Table 1. The first six general questions of the survey. Questions are listed in the far left column and the options (a-f) are listed in the corresponding rows

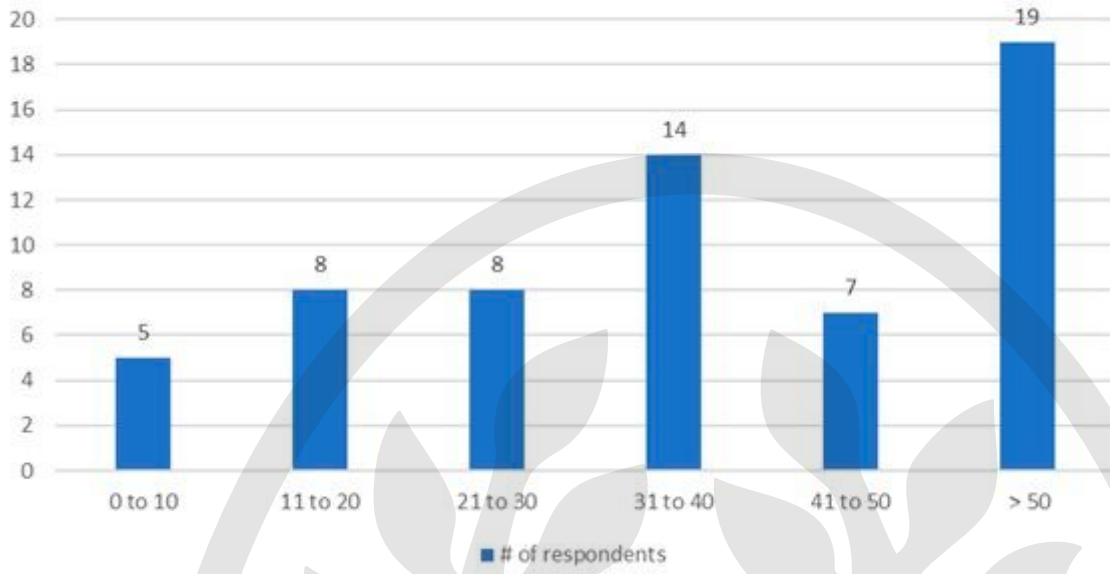
Years in Practice



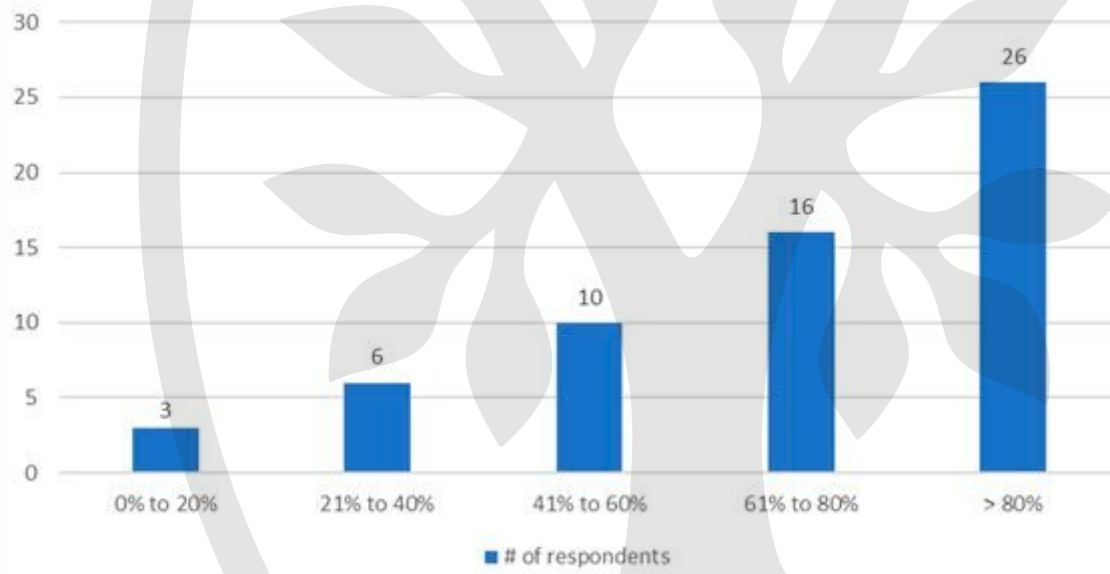
Type of Fellowship Training



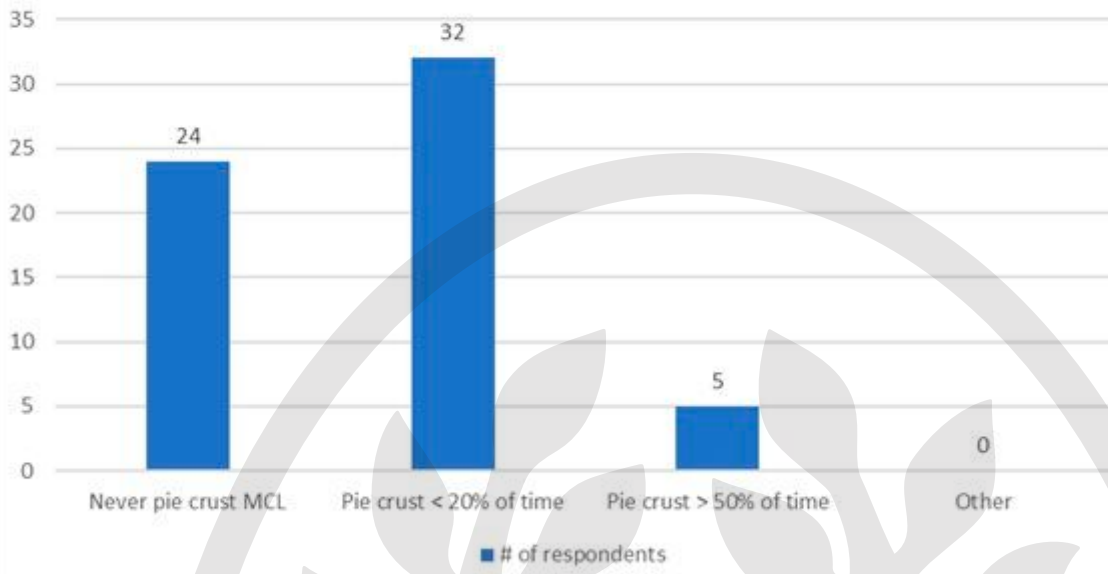
Meniscus repairs per year



% Meniscus repair compared to meniscectomy/year



Frequency of MCL Pie Crusting



Biologic Adjunctive Measures

