Consensus-Based Guidelines for Management of First-Time Patellar Dislocation in Adolescents

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Background: The management of first-time patellar dislocation remains variable, with limited evidence to support or compare different operative and nonoperative modalities. The primary aim was to establish consensus-based guidelines for different components of nonoperative treatment following a first-time patellar dislocation. The secondary aim was to develop guidelines related to management after failed nonoperative treatment. The tertiary aim was to establish consensus-based guidelines for the management of first-time patellar dislocation with a concomitant osteochondral fracture.

Methods: A 29-question, multiple-choice, case-based survey was developed by 20 members of the Patellofemoral Research Interest Group of the Pediatric Research in Sports Medicine Society. The survey consisted of questions related to demographic information, management of first-time patellar dislocation without an osteochondral fracture, and management of first-time patellar dislocation with a 2 cm osteochondral fracture. The survey underwent 2 rounds of iterations by Patellofemoral Research Interest Group members and the final survey was administered to Pediatric Research in Sports Medicine members, using REDCap. Consensus-based guidelines were generated when more than 66% of respondents chose the same answer.

Results: Seventy-nine of 157 (50%) eligible members responded. Sixty-one were orthopaedic surgeons and 18 were primary sports medicine physicians. Eleven consensus-based guidelines were generated based on survey responses. Those that met the criteria for consensus included initial knee radiographs (99% consensus), nonoperative treatment for first-time patellar dislocation without an osteochondral fracture (99%), physical therapy starting within the first month postinjury (99%), with return to sport after 2 to 4 months (68%) with a brace (75%) and further follow-up as needed (75%). Surgical treatment was recommended if there were patellar subluxation episodes after 6 months of nonoperative treatment (84%). Patellar stabilization should be considered for a first-time dislocation with an osteochondral fracture (81.5%).

Conclusion: Consensus-based guidelines offer recommendations for the management of first-time patellar dislocation with or without an osteochondral fracture. Several changing trends and areas of disagreement were noted in clinical practice.

Clinical Relevance: In the absence of high-level evidence, consensus-based guidelines may aid in clinical decision-making when treating patients following a first-time patellar dislocation. These guidelines highlight the evolving trends in clinical practice for the management of first-time patellar dislocation. Areas not reaching consensus serve as topics for future research.

Key Words: patellar instability, first-time patellar dislocation, consensus, guidelines, discordance, medial patellofemoral ligament

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Often occurring in adolescence, patellofemoral instability (PFI) is a spectrum ranging from subluxation-relocation events to frank dislocation requiring reduction and the potential for devastating long-term effects.[1,2] The diagnosis of PFI can frequently be established based on history and physical examination. However, in an acute setting, a focused knee exam may be limited. Therefore, knee radiographs and advanced imaging, including magnetic resonance imaging (MRI) or computed tomography scan, may aid in establishing the diagnosis and evaluating for any underlying anatomic risk factors that may predispose one to recurrent PFI.[3,4] Nonoperative treatment is often used for those who sus-

tain a first-time (primary) patellar dislocation event.[5,6] However, there is no validated protocol for what constitutes a well-rounded, comprehensive treatment plan.[7] The type of initial immobilization (if any), weight-bearing status, physical therapy, patellar-stabilizing brace, and time to return to sports are variably reported in the literature and are largely based on treating physician preferences.[8–11] The results of nonoperative conservative treatment for first-time patellar dislocation have been variable and can be summarized into 3 groups. One-third of patients following a first-time dislocation do well and return to their preinjury level of function without limitations. Another one-third have recurrent PFI. The last subset does not sustain recurrent dislocations but continues to have persistent symptoms, including pain, swelling, apprehension, subluxation episodes, and the inability to return to preinjury level of function.[1,8]

Another subset of patients with first-time patellar dislocation have significant effusion and an intra-articular osteochondral fracture, commonly occurring at the inferomedial aspect of the patella and/or the lateral femoral condyle.[12] In the presence of such a fracture, nonoperative treatment may not be the best treatment option.[10] There are controversies related to this approach, including the need for an MRI, the type of fixation of the fracture, and the indications for a concomitant patellar stabilization procedure.

In the absence of evidence, the current study has 3 aims. The primary aim of the current study was to establish consensus-based guidelines for different components of nonoperative treatment. The secondary aim was to develop guidelines related to management after failed nonoperative treatment. The tertiary aim was to establish consensus-based guidelines for the management of first-time patellar dislocation with a concomitant osteochondral fracture.

METHODS

A 29-question, multiple-choice, case-based survey was developed by 20 members of the Patellofemoral Research Interest Group of the Pediatric Research in Sports Medicine (PRISM) society. IRB approval was not required as there were no human subjects involved. The case scenarios were hypothetical, and the study design was a survey. Standardized guidelines for reporting surveys using the CHERRIES (Checklist for Reporting Results of Internet E-Surveys) checklist was utilized.[13] The survey consisted of questions related to the demographic information of the respondents (5 questions), management of first-time patellar dislocation without an osteochondral fracture (17 questions), and management of first-time patellar dislocation with an osteochondral fracture (7 questions). The survey underwent 2 rounds of iterations to format the survey questions and answer choices, to analyze free text responses, and to condense and develop a final survey (Supplemental File—Survey Instrument, Supplemental Digital Content 1, http://links.lww.com/BPO/A703). The survey was divided into 2 parts: the first 22 questions (part I) were to be answered by orthopaedic surgeons and primary sports medicine physicians; the remaining 7 questions were related to surgical preferences (part II) and were to be answered by orthopaedic surgeons only. The survey was built and distributed in REDCap (Research Electronic Data Capture: Vanderbilt University, Nashville, TN), which is a secure, web-based software platform designed to support data capture for research studies.

The survey was administered to all orthopaedic surgeons and primary sports medicine physicians of PRISM society membership. An email was sent to eligible members with a link to the survey. A reminder e-mail was sent 9 days later. REDCap survey data was exported into an Excel spreadsheet (Microsoft Excel 2013: Microsoft, Redmond, WA USA), and analyses were performed using descriptive statistics by one of the authors, who was blinded to the identity of the respondents. Responses to survey questions were reported as frequencies and percentages. Greater than two-thirds (66%) of respondents selecting the same answer was defined as consensus.[14] Areas meeting and lacking consensus were defined. The demographic data was further analyzed to study the preferences based on years in practice (less or more than 10 y).

RESULTS

Of the 276 PRISM members, 157 were eligible to participate in part I of the survey and 102 were eligible to participate in part II of the survey. A total of 79 of 157 (50%) eligible members completed part I of the survey, and 61 of 102 (60%) eligible members completed part II of the survey. Sixty-one were orthopaedic surgeons and 18 were primary sports medicine physicians. Of the 61 orthopaedic surgeons, 48 (79%) were pediatric orthopaedic fellowship-trained surgeons, 40 (66%) were orthopaedic sports medicine surgeons, and 9 (15%) were dual fellowship-trained. Of all respondents, 45 (57%) had been in practice for <10 years, and 20 (25%) had been in practice for over 15 years. There were 34 (43%) respondents who treated between 25 and 50 patellar instability cases per year; 36 respondents (46%) treated more than 50 cases per year. Sixty-nine (87%) respondents were involved in academic practice, and there was an almost equal distribution of practice location between the West Coast, East Coast, Midwest, and Southern United States.

Case 1 involved a 12.5-year-old girl who sustained a first-time patellar dislocation while playing soccer. The patella spontaneously reduced, and there was no effusion. For the workup of this child, 78 of the 79 (99%) respondents agreed to obtain anteroposterior, lateral, and patellar axial view (Merchant) knee radiographs. Left-hand radiographs for bone age (9%) and full-length (hip to ankle) standing radiographs (28%) were not obtained routinely unless clinically indicated. In the absence of effusion and with normal radiographs, there was no consensus on the routine need for an MRI, although 51% of respondents would get an MRI to evaluate for cartilage

damage. In the absence of an osteochondral fracture, there was a 99% consensus to treat the patient nonoperatively.

When nonoperative treatment was recommended, a knee immobilizer (52%), or patellar stabilizing brace (34%), would be utilized for up to 2 weeks (57%), or 3 to 4 weeks (24%), with weight bearing as tolerated (97%), and crutches as needed (70%). After an initial phase of immobilization, a patellar stabilizing brace (82%) and physical therapy (97%) were recommended. There was no agreement on the duration of brace wear, with 40% recommending brace for 1 to 3 months and 26% for 3 to 6 months. Physical therapy was recommended to start within the first month postinjury once acute symptoms had resolved (88%) and continue for 1 to 4 months (97%). Return to sports was allowed after 2 to 4 months (68%) with a brace (73%), and further follow-up was on an as-needed basis (76%).

If, after 6 months of nonoperative treatment for a first-time patellar dislocation, the child had persistent or recurrent symptoms, then the treatment approach was based on symptoms. Surgical treatment was recommended if there were recurrent patellar subluxation episodes (84%), or in the case of another episode of frank dislocation (95%). Surgical treatment was not recommended for continued patellofemoral pain (87%), even in the presence of a positive apprehension sign. If the child was unable to return to sports after 6 months of nonoperative treatment, there was no agreement between continuing nonoperative treatment (43%) or surgery (53%).

Case 2 involved a 12.5-year-old girl who sustained a first-time patellar dislocation-relocation episode while playing soccer and demonstrated a moderate knee effusion. Knee radiographs and an MRI confirmed an osteochondral fragment measuring 2×1.5 cm from the inferomedial aspect of the patella. There was mild trochlear dysplasia (Dejour type A), a TT-TG distance of 15 mm, a 10-degree patellar tilt, and open physis.

For this scenario, 59/61 respondents (97%) would surgically address the patellar instability at the time of surgery for the osteochondral fragment. Even though there was a consensus about addressing the osteochondral fracture fragment, there was no consensus among fixation devices for the osteochondral fracture; responses included a biodegradable screw (36%), a biodegradable nail (34%), metal screws (30%), or suture fixation (10%). Patellar stabilization was considered by 97% of respondents, though there was no consensus between medial-sided repair (30%) and medial patellofemoral ligament (MPFL) reconstruction (51%). The decision about surgery was not influenced by the patient's age (77%) or MPFL tear pattern (84%). There was no consensus on whether the fracture fixation and patellar stabilization should be performed simultaneously (54%) or staged (44%). Simultaneous guided growth for the genu valgum in skeletally immature patients undergoing patellar stabilization surgery was recommended (98%), using a tension-band plate (82%).

There was no consensus between nonoperative treatment (60%) and surgical treatment (41%), for a first-time contralateral patellar dislocation. On the basis of these results, consensus-based guidelines and areas of disagreement were established (Table 1).

When the responses were further analyzed based on years of practice, 45 (57%) responses were from those <10 years in practice, and 34 (43%) responses were from those more than 10 years in practice. There were no differences in consensus or discordance between these 2 subgroups for all survey questions except for the following 3 domains. Those with <10 years of practice had a consensus to start physical therapy in the first 2 weeks following first-time dislocation (71%), to allow return to sports after 2 to 4 months following dislocation (71%), and that age did not influence the surgical decision-making process for stabilization after first-time dislocation (91%). Responses to these 3 questions did not reach consensus for those with more than 10 years of practice.

DISCUSSION

The optimal management of first-time patellar dislocation is controversial. While some randomized controlled trials have shown decreased re-dislocation rates after surgical stabilization of the patella, others have shown no significant functional differences between surgical and nonsurgical treatment for first-time patellar dislocations.[15,16] Part of the discrepancy is due to variation in surgical techniques, as several older studies are based on medial-sided repair or imbrication and not MPFL reconstruction. In the absence of high-level evidence, nonoperative treatment has continued to be the standard of care, as suggested by 99% of survey participants. However, there is a paucity of literature on the specific components of a nonoperative management protocol.[17] The current survey was designed to identify the treatment approach for a young patient with a first-time patellar dislocation, with or without an osteochondral fracture, based on the preferences of sports physicians who routinely treat pediatric and adolescent sports injuries.

After an acute episode of first-time patellar dislocation, routine knee radiographs (anteroposterior, lateral, and Merchant views) were obtained by 99% of participants to identify any fractures and to evaluate anatomic risk factors and the status of the physis. Though skeletal immaturity is considered a risk factor for recurrence, routine skeletal age determination using hand radiographs was only considered by 11% of participants. Similarly, routine full-length, hip-to-ankle, standing radiographs for evaluation of coronal plane alignment (especially knee valgus) and limb length discrepancy were recommended by 34% of participants only when indicated by clinical exam. Both hand bone age and full-length radiographs are probably more important if surgical treatment and/or growth modulation are to be considered in the skeletally immature. About 50% of participants would routinely obtain an MRI, even in the absence of a knee effusion, as in Case 1. MRI can help to evaluate chondral injuries, MPFL tear pattern, bone bruises, and anatomic risk factors for recurrence, but its role in guiding nonoperative treatment is controversial.[3,4] In the presence of

TABLE 1. Consensus-Based Guidelines (% Agreement) and Areas of Disagreement

1	Initial imaging studies should include knee radiographs (99% consensus) but bone age (11%), full-length radiographs (34%), and MRI (51%) are not required unless clinically indicated
2	For first-time patellar dislocation without an osteochondral fracture, nonoperative treatment is recommended (99%)
3	For immediate treatment, a knee immobilizer (52%) or patellar stabilizing brace (34%) is used for up to 2 weeks (57%) or 3-4 weeks (24%), and the patient is weight bearing as tolerated (96%) with crutches as needed (70%). Subsequently a patellar stabilizing brace is recommended (82%) though the duration for brace wear is variable (1-6 mo)
4	Physical therapy is recommended (99%) starting within the first month postinjury once acute symptoms subside (91%) and continued for 1-4 months (97%)
5	Return to sports is allowed after 2-4 months (68%) with a brace (75%) and further follow-up is on an as needed basis (75%)
6	Surgical treatment is recommended if there are patellar subluxation episodes after 6 months of nonoperative treatment (84%) or in case of another episode of frank dislocation (95%). Surgical treatment is not recommended for continued patellofemoral pain (87.5%)
7	For first-time dislocation with an osteochondral fracture, patellar stabilization should be considered (81.5%) though there was no consensus between medial-sided repair (29%) and MPFL reconstruction (52.5%). The decision about surgery was not influenced by age of the patient (77%) or MPFL tear pattern (86%)
8	There was no consensus between fixation devices for osteochondral fracture; biodegradable implant (60%), metal screws (30%), or suture fixation (10%)
9	There was no consensus on performing fracture fixation and patellar stabilization simultaneously (55%) or in a staged manner (45%)
10	Simultaneous guided-growth for genu valgum in skeletally immature patients undergoing patellar stabilization surgery is recommended (98%) using tension-band plate (82%)
11	There was no consensus between nonoperative treatment (60%) or surgical treatment (40%) for first-time contralateral patellar dislocation

MPFL indicates medial patellofemoral ligament; MRI, magnetic resonance imaging.

traumatic hemarthrosis of the knee, an MRI evaluation is justified to evaluate for osteochondral fractures and associated injuries. Though a computed tomography scan is an option for assessment, it is not recommended in the pediatric population due to the increased risk of radiation, inferior soft tissue contrast, and limited additional information compared with an MRI.[18,11]

After an acute episode of first-time patellar dislocation, the type and duration of immobilization is controversial.[9,10,17,19] Rigid and long-term immobilization can allow injured tissues to heal but can lead to muscle atrophy, joint stiffness, and cartilage degeneration.[20] There is a paucity of studies comparing methods of initial immobilization and their outcomes. Mäenpää and Lehto[8] compared 3 types of immobilizations (knee brace, cylinder cast in extension, and posterior splint in extension) after a first-time patellar dislocation and showed that posterior splint immobilization for 3 weeks decreased re-dislocation rates. Cylinder cast had the worst results and led to knee stiffness, increased patellofemoral crepitus, and higher re-dislocation rates. However, this study had significant limitations, including a small sample size, a varied duration of immobilization (2 wk in brace vs. 4 wk in cast) and old-style braces. In another study, 47 patients with the first patellar dislocation who had a rigid plaster sleeve for 3 weeks were compared with 30 patients who had a semiflexible bandage for 3 weeks. At 1-year follow-up, there was no difference in the redislocation rate (21%) between groups, but the sick leave was shorter in patients treated with semiflexible bandage.[21] In a prospective randomized control study, Honkonen and colleagues compared clinical outcomes after treatment with and without knee immobilization after the first patellar dislocation in 64 patients. Immobilization in near extension (0° to 30°) using a patella-stabilizing, hinged knee brace did not prevent recurrent instability when compared with immediate range of motion using a nonhinged, nonstabilizing neoprene knee brace but led to more stiffness and knee pain.[22] For the duration of initial immobilization, Kaewkongnok et al[19] found no differences in the redislocation rate when comparing 0, 2, 4, and 6 weeks of brace wear after dislocation. The void in the literature reflects the current survey results, where there was no consensus related to initial treatment or duration of treatment. The choices were to use either a knee immobilizer or patellar stabilizing brace for 2 or 4 weeks or till acute symptoms subside.

Irrespective of the type of initial immobilization, weight-bearing is allowed with the help of crutches. The acute phase would typically last for 1 through 4 weeks. Once the acute symptoms of pain, swelling, and limp subsided, there was a consensus to initiate physical therapy. The goal of physical therapy is to further reduce pain and swelling, regain range of motion, strengthen the core, hip, and lower extremity muscles, and help with patellar stabilization exercises. However, there is no study comparing different physical therapy or rehabilitation protocols for the first patellar dislocation.[7] On the basis of the current survey, physical therapy is continued for 1 through 4 months, and a return to sports is allowed after 2 to 4 months. A patellar stabilizing brace is typically recommended during sports and high-risk activities. While natural history studies have shown that 30% to 50% of patients may continue to have some symptoms at 1-year follow-up, 75% of respondents would see a patient back only as needed following a return to sports.[23]

For patients who continue to experience subluxation episodes following 6 months of nonoperative management, surgical stabilization of the patella would be recommended (84% consensus). Similarly, there was a 95% consensus to consider surgical stabilization of the patella if there were a second episode of patellar dislocation. Following a second episode of patellar dislocation, the likelihood of recurrent dislocation is $>50\%$. Thus, a second dislocation episode is considered the most significant risk factor for recurrent PFI.[1]

For those who continue to experience patellofemoral pain after 6 months of nonoperative treatment, a significant majority (87.5%) would not consider patellar stabilization. Patellofemoral pain may be related to a variety of causes, including initial or new chondral injuries, patellofemoral maltracking, instability, limb deconditioning, and muscle weakness, an early degenerative process, or decreased joint proprioception and may not directly benefit from patellar stabilization alone.

For a first-time patellar dislocation with knee effusion, an osteochondral fracture should be suspected. A small sliver of bone on a radiograph frequently represents a larger osteochondral fragment that may be better evaluated on an MRI. The presence of a large chondral or osteochondral fragment in the joint is an indication for surgical treatment. Smaller fragments may be neglected or excised, but attempts should be made to salvage and fix larger (>15 mm) fragments.[24] There was no consensus between bioabsorbable implants (60%), metal screws (30%), or sutures (10%) for the fixation of these fragments.

There was consensus (81.5%) on performing patellar stabilization surgery in conjunction with surgery to address the osteochondral fracture. A majority (52.5%) would consider MPFL reconstruction, and 21.5% would consider medial-sided repair. This reflects the current practice trend and literature favoring MPFL reconstruction over MPFL repair.[25] Pedowitz et al[26] reported a 61% recurrent instability rate when the MPFL was not reconstructed during index surgery to address the osteochondral fracture. Furthermore, MPFL repair did not reduce the rate of recurrent instability. In a subsequent study by Gurusamy et al,[27] adolescents treated with MPFL reconstruction for acute first-time patellar dislocation with associated loose bodies found that MPFL reconstruction was associated with less recurrent instability (10.0% vs. 58.7%; $P<0.001$), fewer secondary procedures (6.7% vs. 47.8%; $P<0.001$), and a more frequent return to sports (66.7% vs. 39.1%; $P=0.003$). Several randomized prospective trials comparing medial-sided repair with nonoperative treatment have shown no significant differences in short-term and medium-term outcomes of the 2 treatment groups.[16] In contrast, studies have shown significantly decreased re-dislocation rates and better clinical outcomes after MPFL reconstruction compared with nonoperative treatment.[26,28] There was no consensus on whether fracture fixation and patellar stabilization procedures should be performed simultaneously (55%) or in a staged (45%) manner. In a typical 2-stage surgical approach, fracture fixation is performed initially, and MPFL reconstruction is subsequently performed after the patient regains knee range of motion or when implant removal is planned.

In addition to patella stabilization, other anatomic risk factors for recurrent instability, such as genu valgum, may be indicated for concomitant surgical treatment. In skeletally immature patients with sufficient growth remaining, correction of genu valgum may be achieved through an implant-mediated guided growth procedure, which is less invasive and morbid than the osteotomies that may be required in a skeletally mature individual. In agreement with the available literature, there was a 98% consensus to perform a concomitant guided growth procedure at the time of patellar stabilization in individuals with sufficient growth remaining.[29] The implant of choice for such growth modulation has been the tension-band plate (82%), though transphyseal screws are also used for a quicker correction of deformity and do not interfere with medial-sided surgery.[29]

Contralateral patellar dislocation is another significant risk factor for patellar instability.[30] However, there was no consensus between operative (40%) and nonoperative (60%) treatment for first-time contralateral dislocation. There were no differences in consensus or discordance for most of the survey responses when divided based on respondents' years of practice. The only differences were that those with <10 years in practice had a consensus to initiate physical therapy in the first 2 weeks following the dislocation and that return to sports was allowed between 2 and 4 months following dislocation. This reflects a slightly accelerated rehabilitation protocol favored by those in early practice compared with those in practice for more than 10 years.

A significant limitation of a survey is the finite number of responses, forcing physicians to pick a choice that may not completely represent their response. Two rounds of iterations were performed amongst the Patellofemoral Research Interest Group members to minimize this limitation. As with any survey study, there is a risk of response bias. The response rate for the current survey was 50% for part I and 60% for part II; though limited, the response rate was better than most published Pediatric Orthopaedic surveys.[31] Another limitation of this study is its applicability to all patella dislocation situations. Only 2 scenarios were presented in the current survey. In clinical practice, patients with patella dislocation may have varied demographics, concomitant injuries, comorbidities, coronal or rotational limb malalignment, and/or anatomic risk factors of the knee that may influence management. For example, patients with significant risk factors (trochlear dysplasia, patella alta, skeletal immaturity, and history of contralateral dislocation) have been shown to have a predicted recurrence rate of more than 85% after first-time patellar dislocation.[30] These patients may be candidates for surgical stabilization without an initial trial of conservative treatment. Our goal was to establish consensus-based guidelines to serve as a framework for the management of first-time patellar dislocation with and without osteochondral fracture. Areas of concordance could be validated in the future by an audit of clinical practice, and areas of discordance would serve as topics for future research.

In conclusion, following a first-time patellar dislocation without an osteochondral fracture, there was 99% agreement by respondents to treat nonoperatively. After failed nonoperative treatment, respondents recommended surgical treatment if there were patellar subluxation episodes after 6 months of nonoperative treatment (84%) or in the case of another episode of frank dislocation (95%). For a first-time dislocation with an osteochondral fracture, 81.5% of respondents agreed that patellar stabilization should be considered. Such guidelines could help standardize care for patients with first-time patellar dislocation. Standardization of care would optimize clinical

care and preserve health-related resources. These guidelines highlight the evolving trends in clinical practice for the management of first-time patellar dislocation.

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