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The ESSKA Pediatric Anterior Cruciate Ligament Monitoring Initiative

INTRODUCTION

Instability and functional impairments following ACL tears in skeletally immature children have been increasingly recognized, and there have been an increasing number of publications on treatment of pediatric ACL injuries through the past decade [4,7,26,34]. Intrasubstance ACL ruptures are worrisome leading to impaired participation in desired activities, and the potential long term health effects of early osteoarthritis [28]. Recent literature suggests an increased incidence of ACL injuries in children, and that the perceived increased occurrence may be due to higher participation and early specialization in sports [1,28]. However, no epidemiological studies are available with historical or new data to support the perceived increased incidence of pediatric ACL injuries and, thus, it may just as well be caused by increased awareness and advances in diagnostic methods.

The open growth plates on both sides of the knee joint warrant particular caution before surgical interventions with ACL reconstruction are performed in children [3,23]. Treatment algorithms for ACL ruptures in skeletally immature children varies around the world and the optimal treatment of these injuries are still debated [6,17,40,45]. Consequently, one of three different treatment algorithms is traditionally recommended to skeletally immature children after ACL injury [12,22,33]; a transphyseal surgical reconstruction, a physeal-sparing ACL reconstruction, or non-operative treatment with active rehabilitation and a possible delayed ACL reconstruction. Unfortunately, the methodological quality in research on treatment of ACL injuries in the younger populations has been documented to be poor with low Coleman Methodology scores, without adequately sized studies and use of prospective study designs [35]. Specific decision criteria to advise which of the algorithms a child should be recommended have not been established, and treatment decisions are traditionally based on the experiences and practice of the individual orthopedic surgeon or institution.

The development of new surgical techniques with assumed lower risk of idiopatic growth disturbances has prompted many orthopedic surgeons to advocate early ACL reconstructions also in children with open growth plates [1,29]. However, there is still a concern that surgical interventions with drilling through and/or near the epiphyseal growth plates may injure the physis and result in growth disturbances. Previous publications have described several cases following different surgical techniques [5,23,42]. Furthermore, the maturation and adaptation of the graft within the growing knee is uncertain and concerns have been raised proposing an increased risk of graft rupture in adulthood due to thinner and weaker grafts [4,39]. Additionally, the incidence of secondary meniscus injuries following non-operative treatment is proposed to be high in children [1,17,28], although it

has not been established whether early or delayed surgical intervention affect the total number of meniscus injuries [13,36].

To provide updated knowledge on the current treatments for pediatric ACL injuries, the purpose of this study was to survey and describe the treatment of pediatric ACL injuries performed by orthopedic surgeons affiliated with the European Society for Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA).

MATERIALS AND METHODS

A closed e-survey was submitted to all registered members and affiliates of ESSKA at July 1, 2013. All recipients were invited through their registered e-mail address to participate in the survey by answering 34 questions in an online survey. The list of potential respondents was extracted from the ESSKA office database in Luxembourg. One reminder was sent July 15, 2013 to the respondents who had not submitted their answer following the first invitation. The survey did not collect sensitive data and no approval from the medical ethical committee was needed.

The online registration was carried out using an online survey tool (Questback V. 9.6, Questback AS, Oslo, Norway). The survey tool had previously been successfully used by our research group [16,34], and the project manager (HM) had experience with the method. The invitation e-mail included information about the purpose of the study and a link to the closed online registration form where the responses were entered and automatically captured. The survey was voluntary and no incentives were offered for participation. All communication through the registration was encrypted. The respondents consented to participation in the study and the subsequent publication of anonymous data when they followed the link into the online registration tool. Each invitation was unique and the investigation closed for the unique link when the answers were submitted to prevent multiple entries from the same individual. All responses were automatically registered in a secure database linked to each respondents e-mail address, and they were accessible only for the project manager who extracted the data anonymously for analysis.

The survey content was developed by the project group (HM, LE, and RS), and the checklist for reporting results of internet e-surveys (CHERRIES) [10] was consulted during the development phase. The questions were tested for content validity and refined in a meeting with an invited expert group of orthopedic surgeons with extensive experience in treatment of pediatric ACL injuries at the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) conference in Toronto, Canada in May 2013. The survey included 30 items (Appendix A) and adaptive

questioning was used to reduce the number and complexity of the questions. Thus, a respondent within the target population of surgeons involved in treatment of pediatric ACL injuries would need 10-15 minutes to fulfill the questionnaire, while a respondent without involvement in pediatric ACLs would finish in 1 minute. The possibility of reviewing and changing answers was available with a Back button, however the link and questionnaire was closed and no changes were possible after submission. The questions were related to the respondents' professional experience with treatments and results from pediatric ACL injuries, preferred treatment algorithms, details on surgical preferences and technique, rehabilitation, and follow-up procedures. The specific questions (Appendix A) and the distribution of responses (Appendix B) are available in online appendix'. Data analysis was performed on descriptive parameters extracted from the online data repository.

RESULTS

An invitation to participate in the study was sent to 2236 ESSKA members and affiliates, and received 491 (22%) unique responses. Fourteen (0.01%) invitees declined participation. Forty-five percent of the responses (221 out of 491) were registered following the initial invitation. Among the respondents 445 (91%) were orthopedic surgeons, with 354 (72%) stating that they were involved in treatment of pediatric ACL injuries. The experience of the orthopedic surgeons performing adult ACL reconstructions was high with 398 (89%) doing more than 10 per year. An overview of the respondent demographics is provided in Table 1.

Among the respondents involved in treatment of pediatric ACL injuries 192 (54%) reported that they had seen more than six injuries during 2012. In total the number of pediatric ACL injuries seen by study participants in 2012 was at least 1923.

The majority (59%) of participants stated that they preferred a surgical treatment algorithm for pediatric ACL injuries, and hamstring tendon autograft was the preferred choice for 91% of the surgeons performing pediatric ACL reconstructions. Transphyseal surgical techniques were most commonly reported for both the femoral (67%) and tibial (91%) approach. A majority (62%) preferred drilling of the femoral tunnel through an anteromedial portal. Extracortical graft fixation with a button was most common on the femoral side (78%), while the fixation techniques were more varied on the tibial side (Figure 1).

Forty-eight (14%) participants reported to have seen clinical relevant growth disturbances after pediatric ACL reconstructions in the past, giving a total number of observed growth disturbances of at least 102. Corresponding numbers for non-clinical relevant growth disturbances were minimum

196 observations. About half of the participants (53%) reported that they performed skeletal age determinations before deciding on performing surgical treatment. Forty-two percent administered long standing radiographs to evaluate skeletal growth after surgical treatment, while 36% used other methods and 21% did not perform post-surgical measures of skeletal growth. The majority (83%) recommended rehabilitation before surgical treatment, usually supervised by a physiotherapist. Post-surgical restrictions with bracing was recommended by 55%.

The most common reasons reported for graft failures were new trauma (49%), tunnel positioning (28%), and stretching of the graft (14%). Fifty-one percent of the surgeons did not follow up their operated patients until the end of bone growth; 6% ended the follow up after 6 months, 4% after 9 months, 29% after 1 year and 12% at the time of return to sports.

All participants used patient reported outcome measures (PROMs) to evaluate knee function, and the new child friendly questionnaires Knee injury and Osteoarthritis Outcome Score for Children (KOOS-Child) [37] and the pediatric International Knee Documentation Committee Subjective Knee Form (Pedi-IKDC) [24] were used by 14% and 15%, respectively. The three most important criteria for success after surgical treatment were reported to be the Lachman test (83%), the Pivot shift test (79%), and returning to sport (74%), while corresponding criteria for non-operative treatment were absence of giving way episodes (81%), returning to sport (62%), and PROMs (53%). The three most important criteria for allowing return to sport were clinical examination (87%), time from surgery/injury (75%), and muscle strength measurements (68%).

DISCUSSION

The most important finding of the present study were that there are substantial differences with regard to preferred treatment algorithms and long-term follow-up procedures among orthopedic surgeons regarding the treatment of pediatric ACL injuries. Half of the respondents performed assessment of skeletal age prior to surgical treatment, and only 43% reported follow-up until skeletal maturity. The results describe the current practice for treatment of ACL injuries in skeletally immature children among members and affiliates of ESSKA. Further, the summed estimate of children with ACL injury seen by the responders in 2012 were high (n=1923), and the registration of minimum 102 clinically relevant post-operative growth disturbances is worrying.

A considerable strength of the survey is the unique contribution from 354 individuals who are active health care providers for this population. Among these, 304 reported to perform pediatric ACL reconstructions on a regular basis. Kocher et al [23] performed a comparable survey in 2002, in

which they surveyed members of The Herodicus Society and The ACL Study Group regarding their experience with the management and complications of pediatric ACL injuries. Among 170 invited orthopedic surgeons 122 responded that they were treating pediatric ACL injured patients. The results of the present survey indicate that the proportion of surgeons who advocate initial operative treatment is near doubled since 2002 (59% versus 34%). Reasons for this increase may be the refinement of surgical techniques and a stronger belief in beneficial results from surgical treatments. However, we are not aware of any studies that have compared the outcomes of surgical treatment between the past and the present. Likewise, no studies with reasonable methodological quality have investigated the outcomes of surgical versus non-operative treatment in the pediatric population [33,35]. However, primary active rehabilitation without surgical reconstruction has been documented to give favorable functional outcomes for a majority of children who have undergone supervised active rehabilitation programs [34]. None of the surveys probed the rationale for choice of treatment, and other reasons such as increased availability through health care systems and insurance, patient and parent expectations, and surgeon experience may perhaps be influential factors. In other words, the line of distinction between surgically and non-operatively treated children with ACL injuries will need to be refined in the future.

The present survey documents a strong preference (91%) of the hamstring tendon autograft for pediatric ACL reconstructions, which is probably due to previous reports of a lower risk of growth disturbances using soft tissue grafts [23]. Kocher et al also reported a majority of hamstring autograft (70%), but they also identified placement of the bone plug of the bone-patellar-tendon-bone (BPTB) graft across the physis as the most common reason for the 15 growth disturbances reported in the survey. This finding is probably one of the main reasons for the abandonment of the BPTB graft in pediatric ACL reconstructive surgery as only 2 (0.01%) out of 304 surgeons in the present study reported preference of the BPTB graft. A limitation regarding the question of BPTP graft use was related to the fact that the questionnaire did not specify whether patellar tendon grafts were used with or without bone blocks as specified in the so-called Clocheville technique [41]. Interestingly, the use of allograft appears to have increased as 5% reported this to be their preferred graft in 2012 compared to 1% in 2002, despite the fact that allografts have shown inferior results in terms of re-tear rates in young patients [18,21]. The quadriceps tendon (1.6%) plays only a minor role in the graft choice of primary pediatric ACL reconstruction [14].

Surgical reconstruction of the ACL in a skeletally immature patient is advocated to provide ligamentous knee joint stability, and to potentially protect the menisci from subsequent injury. However, surgical treatment may also damage the epiphyseal growth plates and result in various growth disturbances [3,5,23]. Thus, different approaches and techniques for tunnel drilling and graft

fixation have been proposed to decrease the risk of idiopathic growth disturbances. In the tibia the transphyseal drilling technique was reported to be favored by 91% of the surgeons, which is somewhat higher than reported by Kocher et al (79%). The proportion of surgeons who preferred transphyseal drilling in the femur was lower (67%) compared to the tibia, and similar to the 2002 survey (68%). The majority (62%) of respondents reported that they drill the femoral tunnel through an anteromedial portal, and the results suggest that extracortical fixation with button was the preferred fixation method (78%) on the femoral side of the knee joint. The tibial side graft fixation techniques were more diverse, although the design of the present survey does not detect the reasons for this diversity. Despite the fact that physeal sparing drilling techniques have been developed with the intention of reducing the risk of growth disturbances a meta-analysis by Frosch et al. [12] found that the rate of growth disturbances was higher in series using physeal sparing reconstructions compared to studies using transphyseal reconstructions. The reasons for this finding are not clear, but it may be related to a greater level of difficulty of the physeal-sparing procedure requiring precise fluoroscopy-guided tunnel drilling as well as the greater potential risk of the eccentrically placed femoral tunnel as compared to the tibial tunnel which crosses the physeal plate in its center [43].

Fifty-three percent reported that they performed systematic skeletal age determination measures before deciding on surgical treatment for kids with ACL injury, with radiograph of the wrist (38%) and radiograph of the knee (37%) as the most common methods used (Appendix B). The reasons for not performing skeletal age determinations were not questioned in the survey; however, we find this result alarming due to the known risks related to surgical interventions through and nearby epiphyseal growth plates. Additionally, if the skeletal integrity is not documented prior to surgery the possibility of accurate long-term assessment of malalignment is severely compromised. Further, almost one in five surgeons used MRI of the knee to evaluate skeletal age, although this method has not been validated for this purpose [9]. In 2012 Moksnes et al [35] found that half of the included studies in a systematic review reported using standing longitudinal radiographs to evaluate lower limb alignment at skeletal maturity. This method is a requirement for the assessment of growth disturbances [44], and the proportion of respondents who reported adequate radiological follow-up of skeletal growth in the survey was as low as 42%. Furthermore, only 49% reported that they followed up operated children until the end of bone growth. The respondents of the survey reported to have seen a minimum of 102 clinically relevant growth disturbances, which is the highest number reported in the literature so far. However, the limit for what degree of frontal plane axial deformity that should be regarded clinically relevant has not previously been defined. The results of the present

survey show that 85% of the respondents regard a deviation of < 3° as clinically non-relevant, although this should be investigated further in a designated study.

When surgical treatment of pediatric ACL injuries is performed, it is essential that suitable measures of skeletal development are included in both pre-surgical and post-surgical assessments. Furthermore, maturation and adaptation of the graft during the remaining skeletal growth is still unknown, and different authors have discussed the possibility of an increased risk of re-injuries in adulthood due to impaired biomechanical properties [2,7,30]. Park et al [39] have suggested that the youngest patients are likely to have a graft with a smaller diameter in adulthood, and even though longitudinal growth of the graft has been demonstrated, the lack of increase in the width may be problematic in the long term [2]. Two recent publications from Calvo et al [4] and Demange et al [7] with long-term follow-up of transphyseal and non-anatomical ACL reconstructions, respectively reported high incidences (15% and 25%) of graft ruptures. Traumatic events were identified in three of four graft ruptures that correspond well to the experiences of the majority of respondents in the survey. High activity levels and early specialization may predispose children and adolescents to early failure [27,32]. Thus, one must consider the possibility that a thinner graft through adolescent into adulthood may predispose young patients to re-injuries following lower energy traumas than adult graft sizes.

The importance of structured rehabilitation following an ACL injury or ACL reconstruction is undisputed [15,25]. Pre-operative rehabilitation has become the norm to optimize the possibility of a successful outcome after ACL reconstructions [8], and high-quality studies suggest that performing structured post-injury rehabilitation will reduce the need for surgical interventions for a substantial number of ACL injured patients [11]. The results from the present survey show that the majority (83%) of respondents encourage and perform pre-operative rehabilitation on a structured basis. The content of the rehabilitation protocols was beyond the scope of this survey, although interesting diversity was reported regarding post-operative immobilization with a knee brace. Bracing was recommended by 55% of the surgeons who performed pediatric ACL reconstructions, although there was no consensus with regard to immobilization time. No studies have evaluated the effect of bracing on re-injuries in skeletally immature ACL reconstructed patients.

In order to assess knee function and facilitate safe return to sport, it is paramount that functional testing with valid and reliable outcome measures is performed. There is consensus that multi-dimensional test batteries which evaluate the different levels of function should be used [19,31]. The present survey identified giving way episodes, return to sport, and a high score on PROMs as success factors following non-operative treatment. Additionally, clinical tests were identified as important

after ACL reconstruction. Interestingly, clinical examination, time from injury/surgery, and muscle strength measurements were highlighted as the most important factors for advice on returning to sport. Thus, functional test batteries does not seem to be regarded essential for the assessment of knee function by orthopedic surgeons involved in the treatment of pediatric ACL injuries.

Comparably, Lynch et al [31] investigated expert consensus of measures that define successful outcomes 1 and 2 years after adult ACL injury or reconstruction among 1779 members of international sports medicine associations. They identified five measures important for successful outcome after ACL injury or reconstruction: effusion, giving way, muscle strength, PROMs, and return to sport.

Traditionally, adult PROMs such as Lysholm score with Tegner acitivity level, IKDC, and KOOS have been used to assess knee function in pediatric patients. These questionnaires have been shown to be poorly understood by children and adolescents [20,38], and should not be used to assess knee function in this population. Adapted questionnaires (KOOS-Child and Pedi-IKDC) with satisfactory psychometric properties have been developed, and the survey reveal a positive trend because approximately 15% of the respondents report that they are currently using the child friendly questionnaires. This proportion may rise substantially in both the clinical setting and research due to increased familiarity in the near future.

The limitations of the present survey is related to the method of online e-surveys that often are subject to bias due to the possibility of a non-representative population of respondents. The identification and targeted invitation of ESSKA members and affiliates optimized the representative proportion in the present survey. Further, we did not implement any measures of quality assurance related to the data submitted by the respondents. This could have been done through an investigation of hospital records; however, this was beyond limits of the present project. Additionally, a test-retest reliability study providing the respondents with an identical survey would have increased the reliability of responses.

The clinical relevance of this study is foremost to increase the awareness on the diversity in the treatment of pediatric ACL injuries. Increased awareness should lead orthopedic surgeons, physicians, and physiotherapists to evaluate their clinical practice and seek evidence based algorithms in future cases. Additionally, we hope that the survey can serve as a catalyst to future multicenter international clinical collaborations aimed at establishing evidence to develop guidelines for individualized treatment decisions.

CONCLUSION

The present survey documents that the incidences of pediatric ACL injuries and idiopathic growth disturbances may be higher than previously estimated. Treatment algorithms and surgical techniques are highly diverse and consensus could not be identified. It is worrying that only half the surgeons reported to follow up children until skeletal maturity after surgical treatment. The results of this survey highlight the importance of international multicenter studies on pediatric ACL treatment and the development of an outcome registry to enable prospective data collections. These findings may serve as a background and catalyst of future high-quality studies with adequate size, predefined treatment decision criteria and valid outcome measures.

References

1. Anderson AF, Anderson CN (2015) Correlation of meniscal and articular cartilage injuries in children and adolescents with timing of anterior cruciate ligament reconstruction. Am J Sport Med 43 (2):275-281
2. Bollen S, Pease F, Ehrenraich A, Church S, Skinner J, Williams A (2008) Changes in the four-strand hamstring graft in anterior cruciate ligament reconstruction in the skeletally-immature knee. J Bone Joint Surg Br 90 (4):455-459
3. Caine D, DiFiori J, Maffulli N (2006) Physeal injuries in children's and youth sports: reasons for concern? Br J Sport Med 40 (9):749-760
4. Calvo R, Figueroa D, Gili F, Vaisman A, Mococain P, Espinosa M, Leon A, Arellano S (2015) Transphyseal Anterior Cruciate Ligament Reconstruction in Patients With Open Physes: 10-Year Follow-up Study. Am J Sport Med 43 (2):289-294
5. Chotel F, Henry J, Seil R, Chouteau J, Moyen B, Berard J (2010) Growth disturbances without growth arrest after ACL reconstruction in children. Knee Surg Sport Tr A 18 (11):1496-1500
6. Chotel F, Seil R (2013) Growth disturbances after transphyseal ACL reconstruction in skeletally immature patients: who is more at risk? Young child or adolescent? J Pediatr Orthop 33 (5):585-586
7. Demange MK, Camanho GL (2014) Nonanatomic Anterior Cruciate Ligament Reconstruction With Double-Stranded Semitendinosus Grafts in Children With Open Physes: Minimum 15-Year Follow-up. Am J Sport Med 42 (12):2926-2932
8. Eitzen I, Holm I, Risberg MA (2009) Preoperative quadriceps strength is a significant predictor of knee function two years after anterior cruciate ligament reconstruction. Br J Sport Med 43 (5):371-376
9. Engebretsen L, Steffen K, Bahr R, Broderick C, Dvorak J, Janarv PM, Johnson A, Leglise M, Mamisch TC, McKay D, Micheli L, Schamasch P, Singh GD, Stafford DE, Steen H (2010) The International Olympic Committee Consensus statement on age determination in high-level young athletes. Br J Sport Med 44 (7):476-484
10. Eysenbach G (2004) Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res 6 (3):e34
11. Frobell RB, Roos HP, Roos EM, Roemer FW, Ranstam J, Lohmander LS (2013) Treatment for acute anterior cruciate ligament tear: five year outcome of randomised trial. BMJ 346:f232
12. Frosch KH, Stengel D, Brodhun T, Stietencron I, Holsten D, Jung C, Reister D, Voigt C, Niemeyer P, Maier M, Hertel P, Jagodzinski M, Lill H (2010) Outcomes and risks of operative treatment of

rupture of the anterior cruciate ligament in children and adolescents. Arthroscopy 26 (11):1539-1550
13. Funahashi KM, Moksnes H, Maletis GB, Csintalan RP, Inacio MC, Funahashi TT (2014) Anterior cruciate ligament injuries in adolescents with open physis: effect of recurrent injury and surgical delay on meniscal and cartilage injuries. Am J Sport Med 42 (5):1068-1073
14. Granan LP, Bahr R, Steindal K, Furnes O, Engebretsen L (2008) Development of a national cruciate ligament surgery registry: the Norwegian National Knee Ligament Registry. Am J Sport Med 36 (2):308-315
15. Grindem H, Eitzen I, Engebretsen L, Snyder-Mackler L, Risberg MA (2014) Nonsurgical or Surgical Treatment of ACL Injuries: Knee Function, Sports Participation, and Knee Reinjury: The Delaware-Oslo ACL Cohort Study. J Bone Joint Surg Am 96 (15):1233-1241
16. Grindem H, Eitzen I, Snyder-Mackler L, Risberg MA (2014) Online registration of monthly sports participation after anterior cruciate ligament injury: a reliability and validity study. Br J Sport Med 48 (9):748-753
17. Henry J, Chotel F, Chouteau J, Fessy MH, Berard J, Moyen B (2009) Rupture of the anterior cruciate ligament in children: early reconstruction with open physes or delayed reconstruction to skeletal maturity? Knee Surg Sport Tr A 17 (7):748-755
18. Hettrich CM, Dunn WR, Reinke EK, Spindler KP (2013) The rate of subsequent surgery and predictors after anterior cruciate ligament reconstruction: two- and 6-year follow-up results from a multicenter cohort. Am J Sport Med 41 (7):1534-1540
19. Hildebrandt C, Muller L, Zisch B, Huber R, Fink C, Raschner C (2015) Functional assessments for decision-making regarding return to sports following ACL reconstruction. Part I: development of a new test battery. Knee Surg Sport Tr A 23 (5):1273-1281
20. Iversen MD, Lee B, Connell P, Andersen J, Anderson AF, Kocher MS (2010) Validity and comprehensibility of the International Knee Documentation Committee Subjective Knee Evaluation form in Children. Scand J Med Sci Spor 20 (1):e87-95
21. Kaeding CC, Aros B, Pedroza A, Pifel E, Amendola A, Andrish JT, Dunn WR, Marx RG, McCarty EC, Parker RD, Wright RW, Spindler KP (2011) Allograft Versus Autograft Anterior Cruciate Ligament Reconstruction: Predictors of Failure From a MOON Prospective Longitudinal Cohort. Sports Health 3 (1):73-81
22. Kaeding CC, Flanigan D, Donaldson C (2010) Surgical techniques and outcomes after anterior cruciate ligament reconstruction in preadolescent patients. Arthroscopy 26 (11):1530-1538
23. Kocher MS, Saxon HS, Hovis WD, Hawkins RJ (2002) Management and complications of anterior cruciate ligament injuries in skeletally immature patients: survey of the Herodicus Society and The ACL Study Group. J Pediatr Orthop 22 (4):452-457
24. Kocher MS, Smith JT, Iversen MD, Brustowicz K, Ogunwole O, Andersen J, Yoo WJ, McFeely ED, Anderson AF, Zurakowski D (2011) Reliability, validity, and responsiveness of a modified International Knee Documentation Committee Subjective Knee Form (Pedi-IKDC) in children with knee disorders. Am J Sport Med 39 (5):933-939
25. Kruse LM, Gray B, Wright RW (2012) Rehabilitation after anterior cruciate ligament reconstruction: a systematic review. J Bone Joint Surg Am 94 (19):1737-1748
26. Kumar S, Ahearne D, Hunt DM (2013) Transphyseal anterior cruciate ligament reconstruction in the skeletally immature: follow-up to a minimum of sixteen years of age. J Bone Joint Surg Am 95 (1):e1
27. Kvist J, Kartus J, Karlsson J, Forssblad M (2014) Results from the Swedish national anterior cruciate ligament register. Arthroscopy 30 (7):803-810
28. Lawrence JT, Argawal N, Ganley TJ (2011) Degeneration of the knee joint in skeletally immature patients with a diagnosis of an anterior cruciate ligament tear: is there harm in delay of treatment? Am J Sport Med 39 (12):2582-2587
29. Lawrence JT, Bowers AL, Belding J, Cody SR, Ganley TJ (2010) All-epiphyseal anterior cruciate ligament reconstruction in skeletally immature patients. Clin Orthop Relat Res 468 (7):1971-1977

30. Lee K, Siegel MJ, Lau DM, Hildebolt CF, Matava MJ (1999) Anterior cruciate ligament tears: MR imaging-based diagnosis in a pediatric population. Radiology 213 (3):697-704
31. Lynch AD, Logerstedt DS, Grindem H, Eitzen I, Hicks GE, Axe MJ, Engebretsen L, Risberg MA, Snyder-Mackler L (2015) Consensus criteria for defining 'successful outcome' after ACL injury and reconstruction: a Delaware-Oslo ACL cohort investigation. Br J Sport Med 49 (5):335-342
32. Magnussen RA, Trojani C, Granan LP, Neyret P, Colombet P, Engebretsen L, Wright RW, Kaeding CC, Group M, Group SFARA (2015) Patient demographics and surgical characteristics in ACL revision: a comparison of French, Norwegian, and North American cohorts. Knee Surg Sport Tr A 23 (8):2339-2348
33. Mohtadi N, Grant J (2006) Managing anterior cruciate ligament deficiency in the skeletally immature individual: a systematic review of the literature. Clin J Sport Med 16 (6):457-464
34. Moksnes H, Engebretsen L, Eitzen I, Risberg MA (2013) Functional outcomes following a non-operative treatment algorithm for anterior cruciate ligament injuries in skeletally immature children 12 years and younger. A prospective cohort with 2 years follow-up. Br J Sport Med 47 (8):488-494
35. Moksnes H, Engebretsen L, Risberg MA (2012) The current evidence for treatment of ACL injuries in children is low: a systematic review. J Bone Joint Surg Am 94 (12):1112-1119
36. Moksnes H, Engebretsen L, Risberg MA (2013) Prevalence and incidence of new meniscus and cartilage injuries after a nonoperative treatment algorithm for ACL tears in skeletally immature children: a prospective MRI study. Am J Sport Med 41 (8):1771-1779
37. Ortqvist M, Iversen MD, Janarv PM, Brostrom EW, Roos EM (2014) Psychometric properties of the Knee injury and Osteoarthritis Outcome Score for Children (KOOS-Child) in children with knee disorders. Br J Sport Med 48 (19):1437-1446
38. Ortqvist M, Roos EM, Brostrom EW, Janarv PM, Iversen MD (2012) Development of the Knee Injury and Osteoarthritis Outcome Score for children (KOOS-Child): comprehensibility and content validity. Acta Orthop 83 (6):666-673
39. Park SY, Oh H, Park S, Lee JH, Lee SH, Yoon KH (2013) Factors predicting hamstring tendon autograft diameters and resulting failure rates after anterior cruciate ligament reconstruction. Knee Surg Sport Tr A 21 (5):1111-1118
40. Reider B (2015) A matter of timing. Am J Sport Med 43 (2):273-274
41. Robert H, Bonnard C (1999) The possibilities of using the patellar tendon in the treatment of anterior cruciate ligament tears in children. Arthroscopy 15 (1):73-76
42. Robert HE, Casin C (2010) Valgus and flexion deformity after reconstruction of the anterior cruciate ligament in a skeletally immature patient. Knee Surg Sport Tr A 18 (10):1369-1373
43. Seil R, Pape D, Kohn D (2008) The risk of growth changes during transphyseal drilling in sheep with open physes. Arthroscopy 24 (7):824-833
44. Sled EA, Sheehy LM, Felson DT, Costigan PA, Lam M, Cooke TD (2011) Reliability of lower limb alignment measures using an established landmark-based method with a customized computer software program. Rheumatol Int 31 (1):71-77
45. Yoo WJ, Kocher MS, Micheli LJ (2011) Growth plate disturbance after transphyseal reconstruction of the anterior cruciate ligament in skeletally immature adolescent patients: an MR imaging study. J Pediatr Orthop 31 (6):691-696

	Yes	No
Are you an orthopedic surgeon? (n=491)	445 (91%)	46
Do you perform adult ACL reconstructions? (n=491)	426 (87%)	65
Do you treat pediatric ACL injuries? (n=491)	354 (72%)	137
Do you perform pediatric ACL reconstructions yourself? (n=354)	304 (86%)	50

Table 1. Summary describing the respondents' professional experience

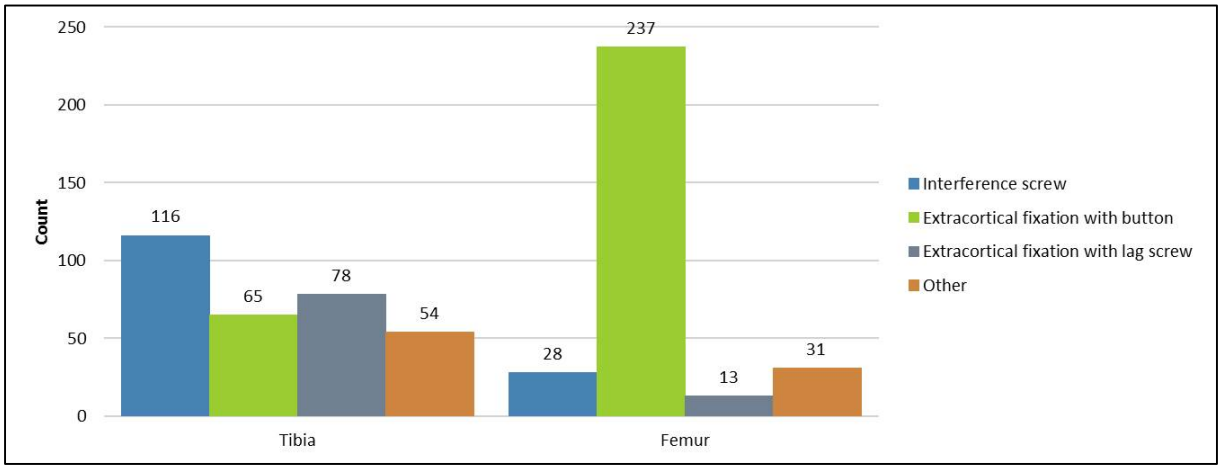

Figure 1. Distribution of participants preferred method for tibial and femoral graft fixation

APPENDIX A. The 30 questions asked in the survey

The ESSKA Pediatric Anterior Cruciate Ligament Monitoring Initiative

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1. Are you an orthopaedic surgeon?
2. Do you perform adult ACL reconstructions?
3. How many adult ACL reconstructions do you perform per year?
4. Do you treat pediatric ACL injuries?
5. How many skeletally immature children with ACL tears did you see in 2012?
6. What is your preferred treatment algorithm for pediatric ACL injuries?
7. Do you perform pediatric ACL reconstructions yourself?
8. Since you do not perform this type of surgery, what do you recommend?
9. When you perform pediatric ACL reconstructions, which is your preferred surgical treatment?
10. When you perform pediatric ACL reconstructions, which is your preferred graft?
11. When you perform pediatric ACL reconstructions, which is your preferred method of graft fixation?
12. When you perform a pediatric ACL reconstruction; which is your preferred method of femoral tunnel drilling?
13. When you perform a transphyseal technique in children; what is your maximum tunnel diameter (independent of age or size of the patient)?
14. When you perform pediatric ACL reconstructions; do you use fluoroscopy on a systematic basis?
15. If you consider surgery, do you perform systematic skeletal age determinations before deciding?
16. What is your preferred method for skeletal age determination?
17. Do you recommend rehabilitation before surgical treatment?

18. How do you organize the rehabilitation for children with ACL injuries?
19. What are your success criteria after surgical treatment (multiple options possible)?
20. What are your success criteria after non-operative treatment (multiple options available)?
21. What are your criteria before allowing return to sport (multiple options available)?
22. If you use Patient Reported Outcome Measures, which do you administer (multiple options available)?
23. How many clinically relevant growth disturbances have you experienced from pediatric ACL reconstructions in the past?
24. How many non-clinically relevant growth disturbances have you experienced from pediatric ACL reconstructions in the past?
25. What is the minimum degree of frontal plane axial deformity that you would consider clinically relevant?
26. How do you evaluate skeletal growth after surgical treatment?
27. In your experience; what is the most common reason for graft failure?
28. Do you immobilize the knee with a brace after surgical treatment of pediatric ACL reconstructions?
29. If you immobilize children postoperatively; for how long time?
30. For how long do you perform clinical follow-ups of the children after ACL reconstruction?

APPENDIX B
The ESSKA Pediatric Anterior Cruciate Ligament Monitoring Initiative
Moksnes H, Engebretsen L, Seil R

Knee Surgery, Sports Traumatology, Arthroscopy

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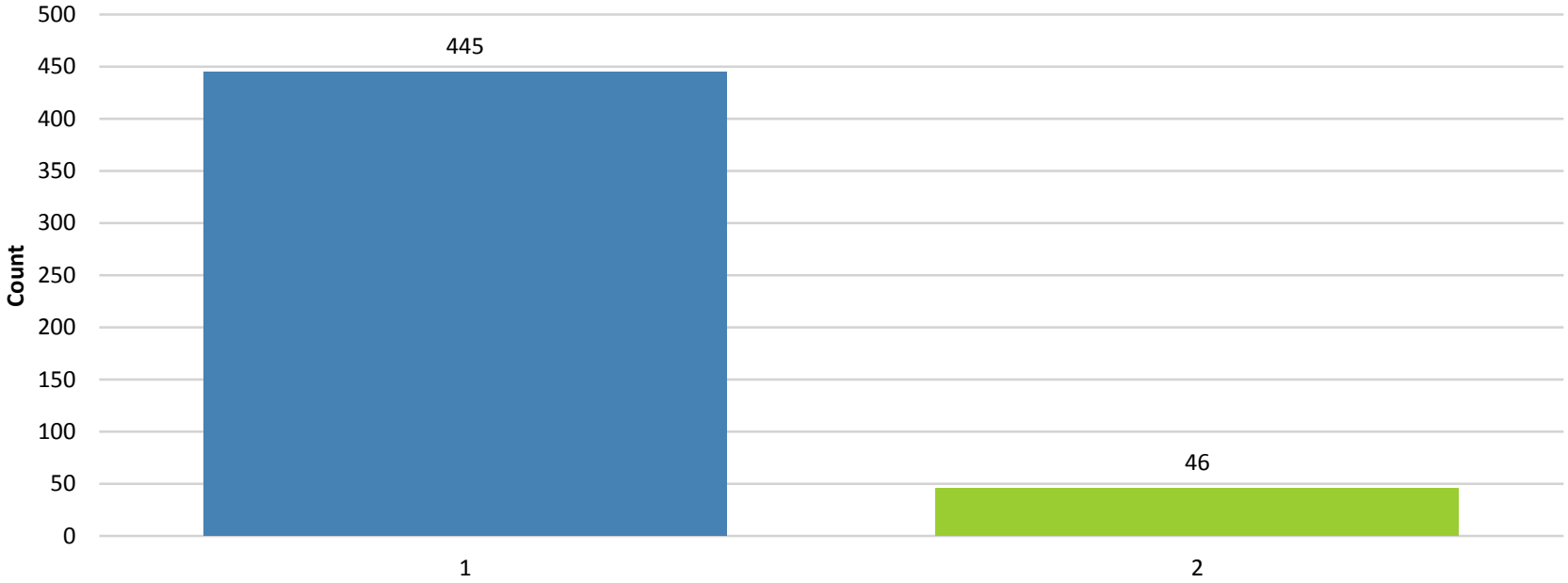
1. Are you an orthopaedic surgeon ?



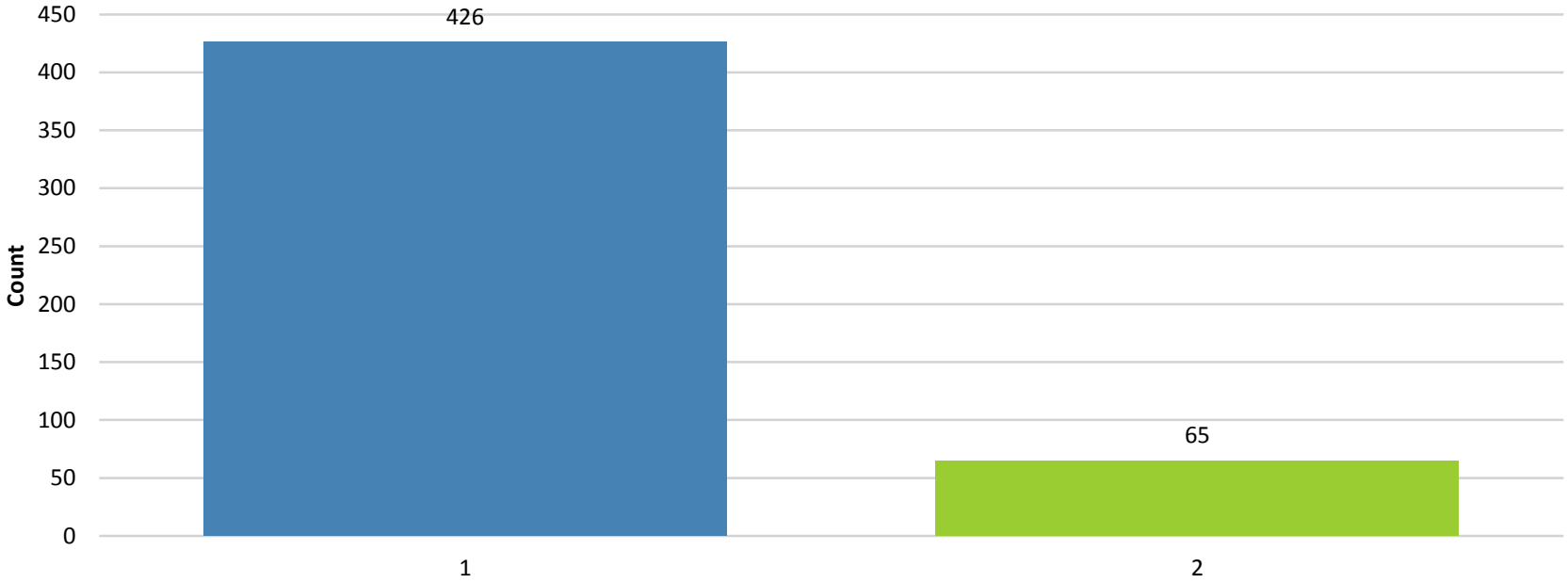
	Name
1	Yes
2	Other

1. Are you an orthopaedic surgeon ?

Name	Count
Yes	445
Other	46
N	491

Other:	
Physiotherapist	n=20
Trauma surgeon	n=5
Sports clinician	n=2
Biomechanics, Scientist, Engineer, Epidemiologist	n=6
Unknown	n=13

2. Do you perform adult ACL reconstructions ?

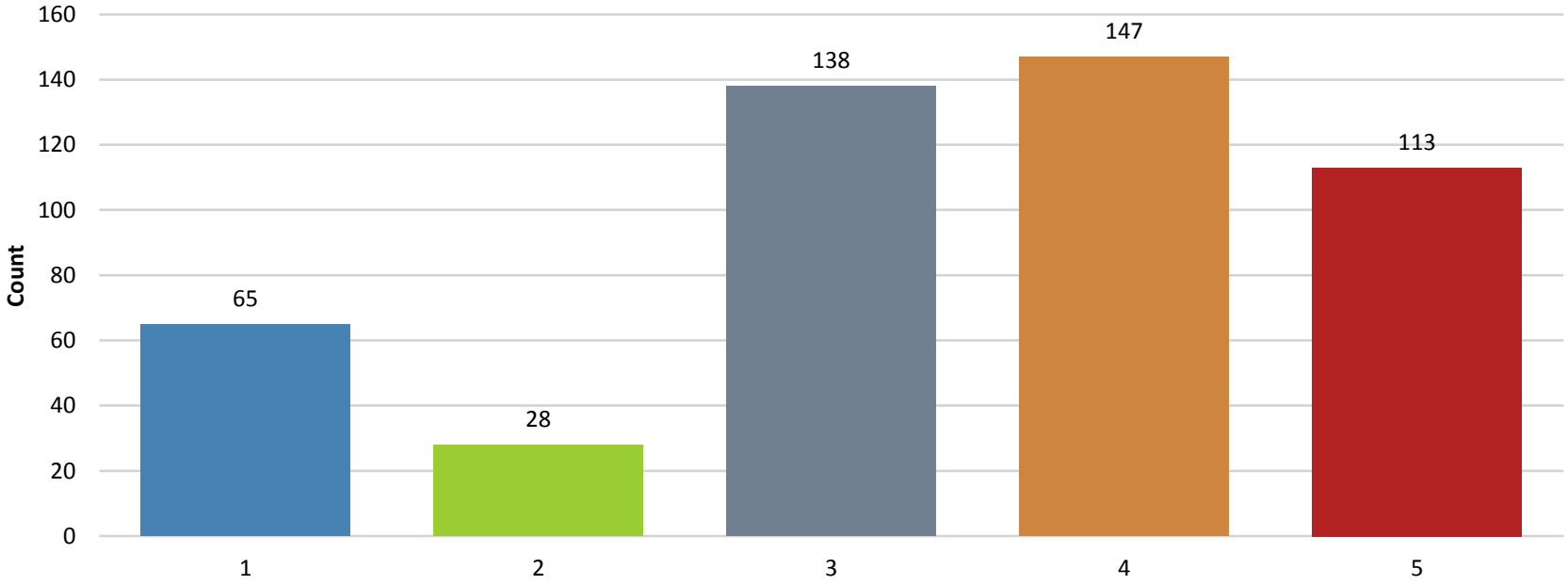


	Name
1	Yes
2	No

2. Do you perform adult ACL reconstructions ?

Name	Count
Yes	426
No	65
N	491

3. How many adult ACL reconstructions do you perform per year ?

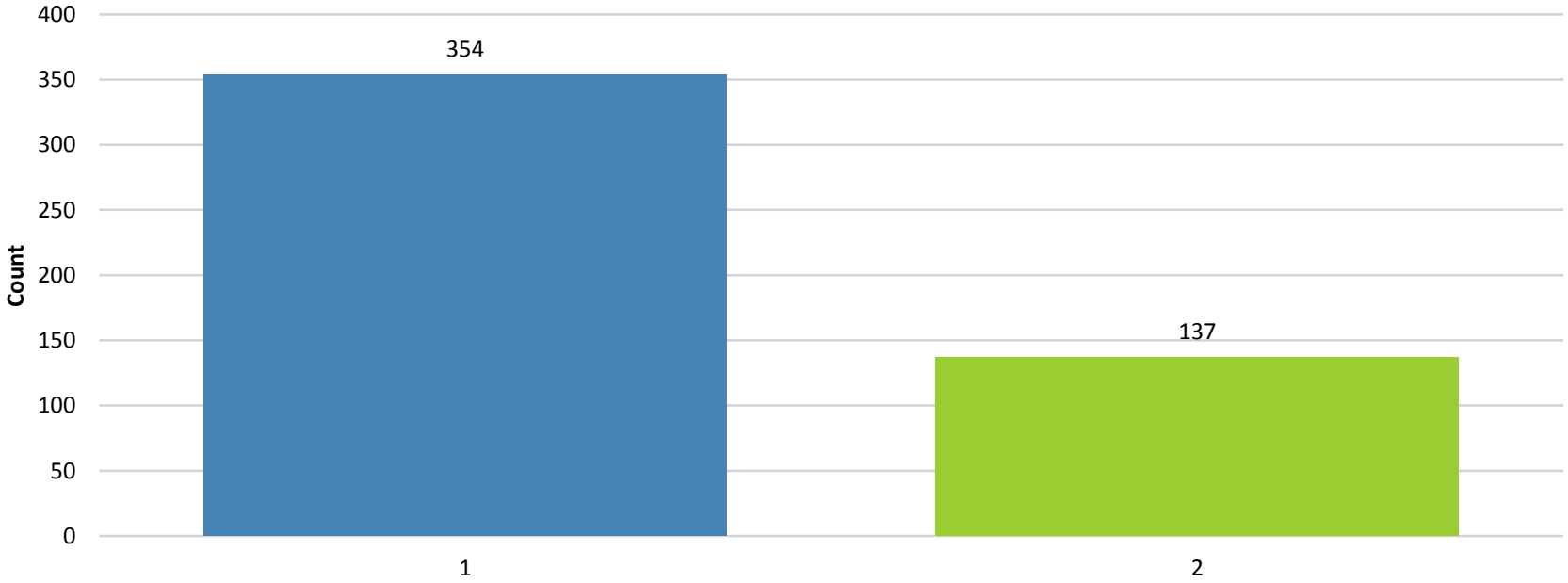


	Name
1	0
2	< 10
3	11-50
4	51-100
5	> 100

3. How many adult ACL reconstructions do you perform per year ?

Name	Count
0	65
< 10	28
11-50	138
51-100	147
> 100	113
N	491

4. Do you treat pediatric ACL injuries ?

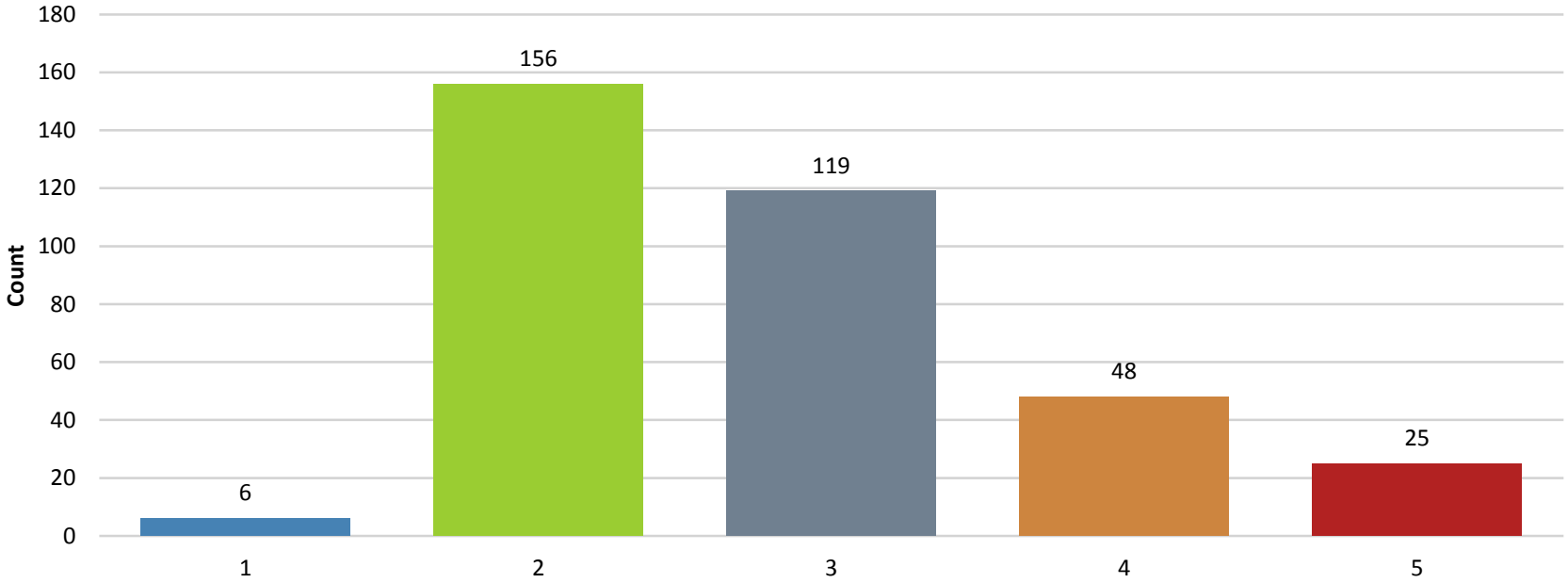


	Name
1	Yes
2	No

4. Do you treat pediatric ACL injuries ?

Name	Count
Yes	354
No	137
N	491

5. How many skeletally immature children with ACL tears did you see in 2012?

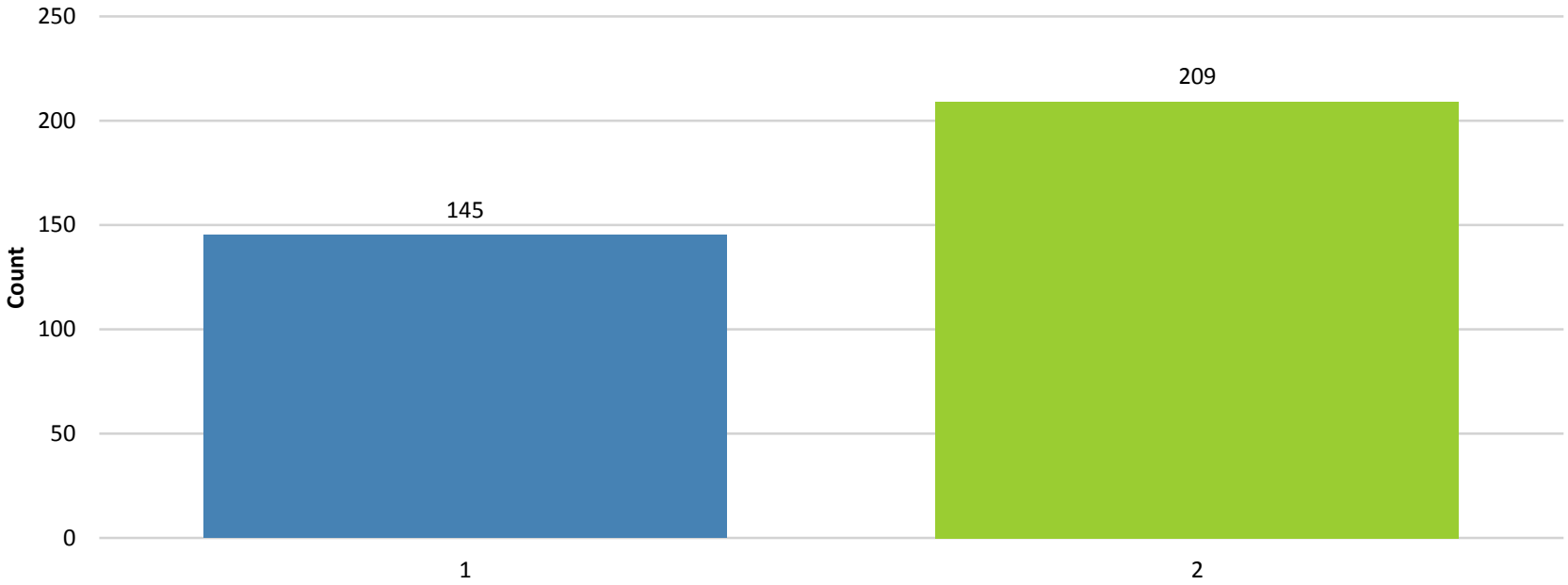


	Name
1	0
2	1-5
3	6-10
4	11-20
5	>20

5. How many skeletally immature children with ACL tears did you see in 2012?

Name	Count
0	6
1-5	156
6-10	119
11-20	48
>20	25
N	354

6. What is your preferred treatment algorithm for pediatric ACL injuries?

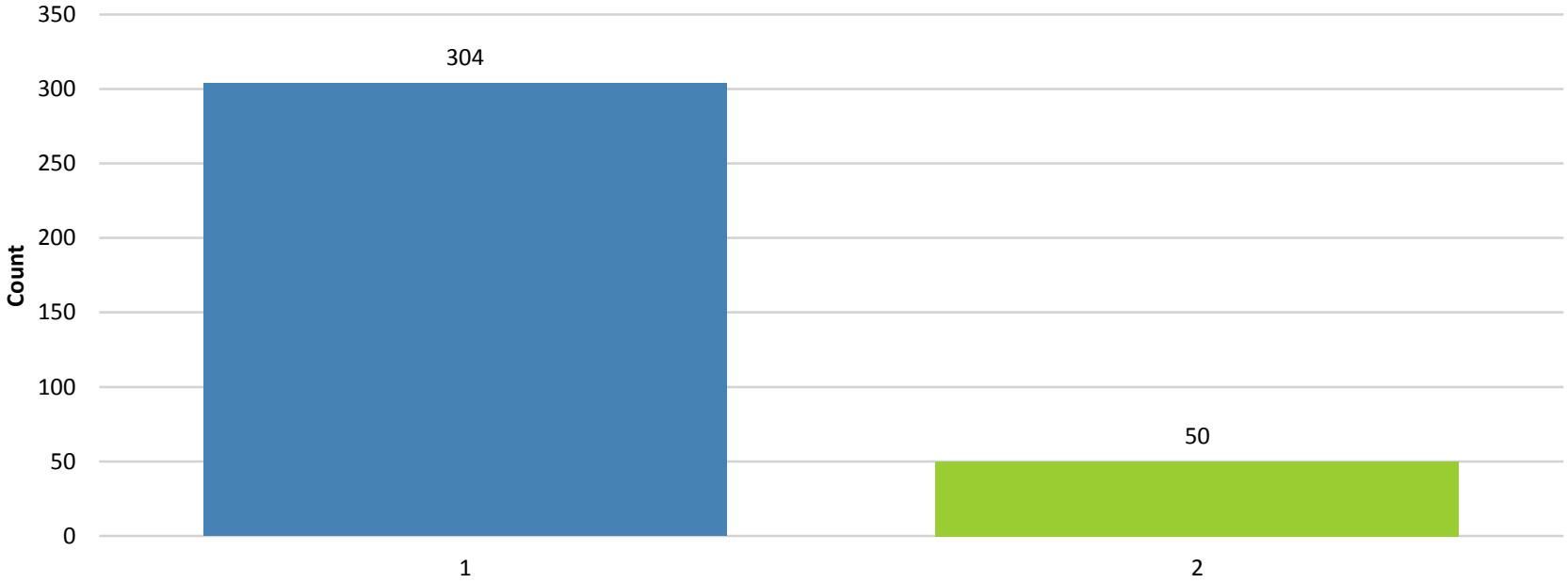


	Name
1	Non-operative
2	Surgery

6. What is your preferred treatment algorithm for pediatric ACL injuries?

Name	Count
Non-operative	145
Surgery	209
N	354

7. Do you perform pediatric ACL reconstructions yourself ?

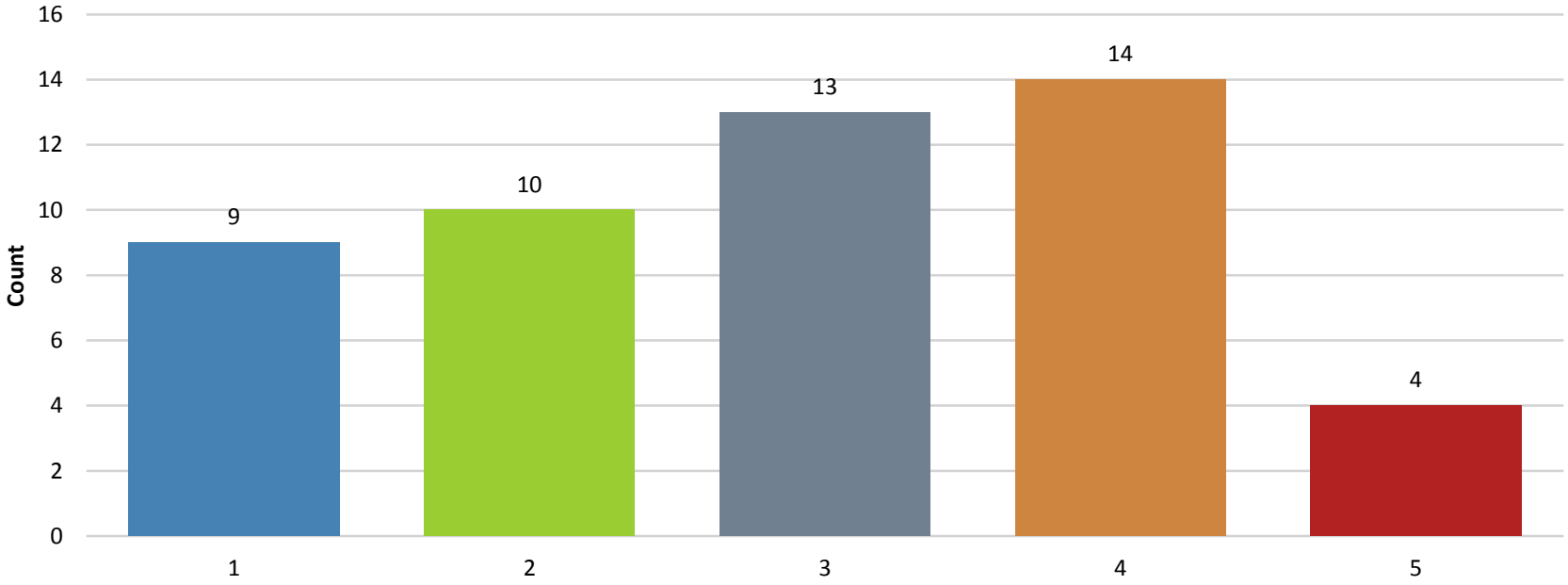


	Name
1	Yes
2	No

7. Do you perform pediatric ACL reconstructions yourself ?

Name	Count
Yes	304
No	50
N	354

8. Since you do not perform this type of surgery, what do you recommend ?



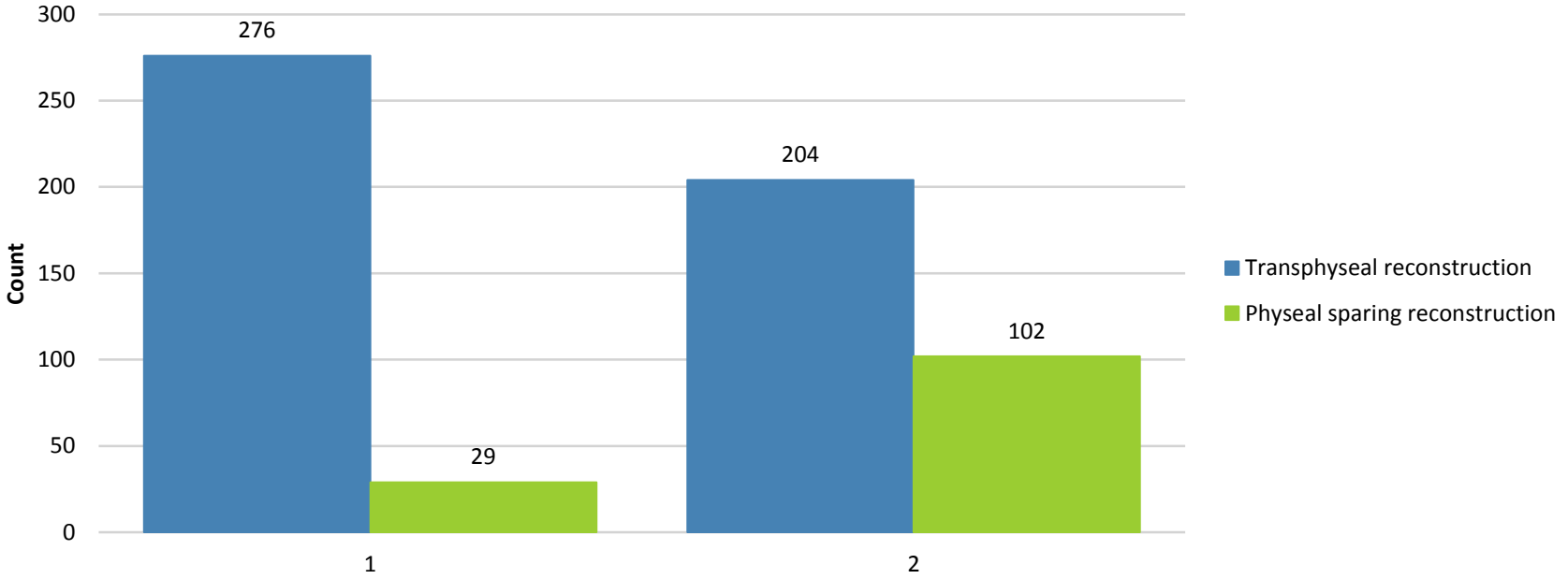
	Name
1	Referral to pediatric orthopaedic surgeon for surgery
2	Referral to adult knee surgeon for surgery
3	Treat nonoperatively on your own
4	Referral to physiotherapy
5	Other

8. Since you do not perform this type of surgery, what do you recommend ?

Name	Count
Referral to pediatric orthopaedic surgeon for surgery	9
Referral to adult knee surgeon for surgery	10
Treat nonoperatively on your own	13
Referral to physiotherapy	14
Other	4
N	50

Other:
Refer to established knee surgeon who knows what he is doing regardless of patient age
pediatric knee surgeon
First referral to physiotherapist for rehabilitation. If problems with instability can not be restored, referral to pediatric orthopaedic surgeon for consultation about surgery
Unknown

9. When you perform pediatric ACL reconstructions, which is your preferred surgical treatment ?

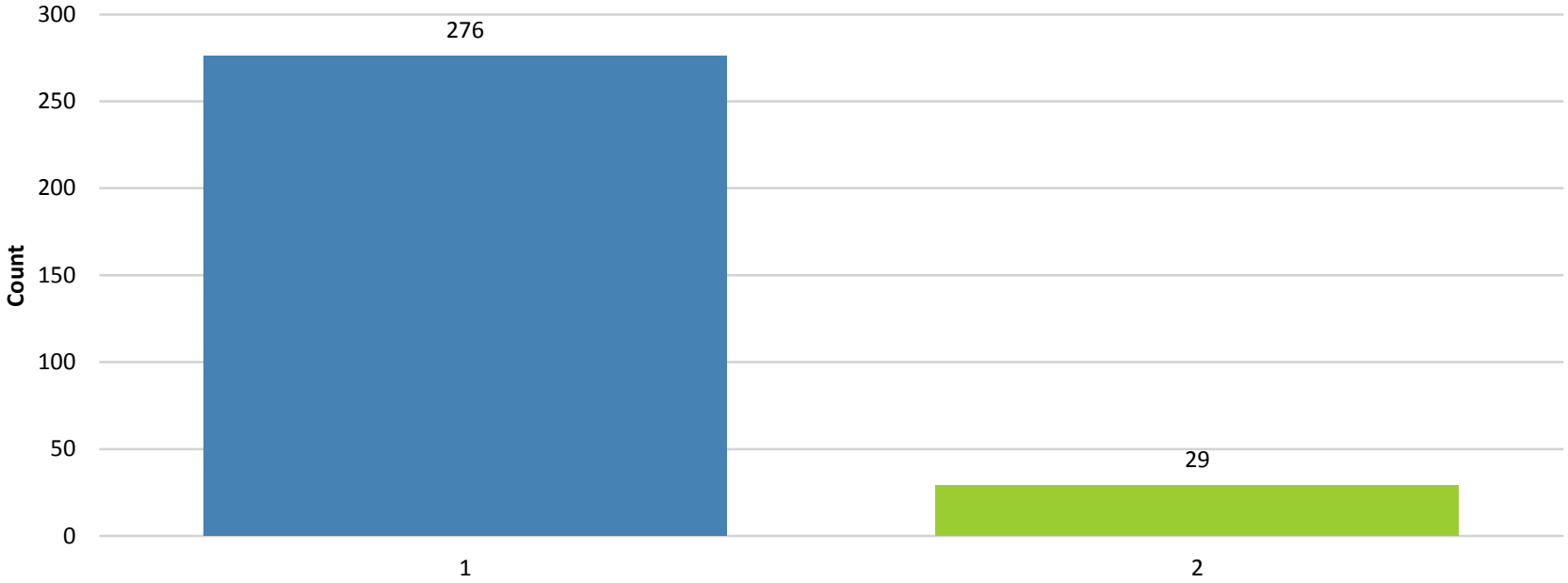


	Name
1	Tibia
2	Femur

9. When you perform pediatric ACL reconstructions, which is your preferred surgical treatment ?

	Transphyseal reconstruction	Physeal sparing reconstruction	N
Tibia	276	29	304
Femur	204	102	304

10. Tibia

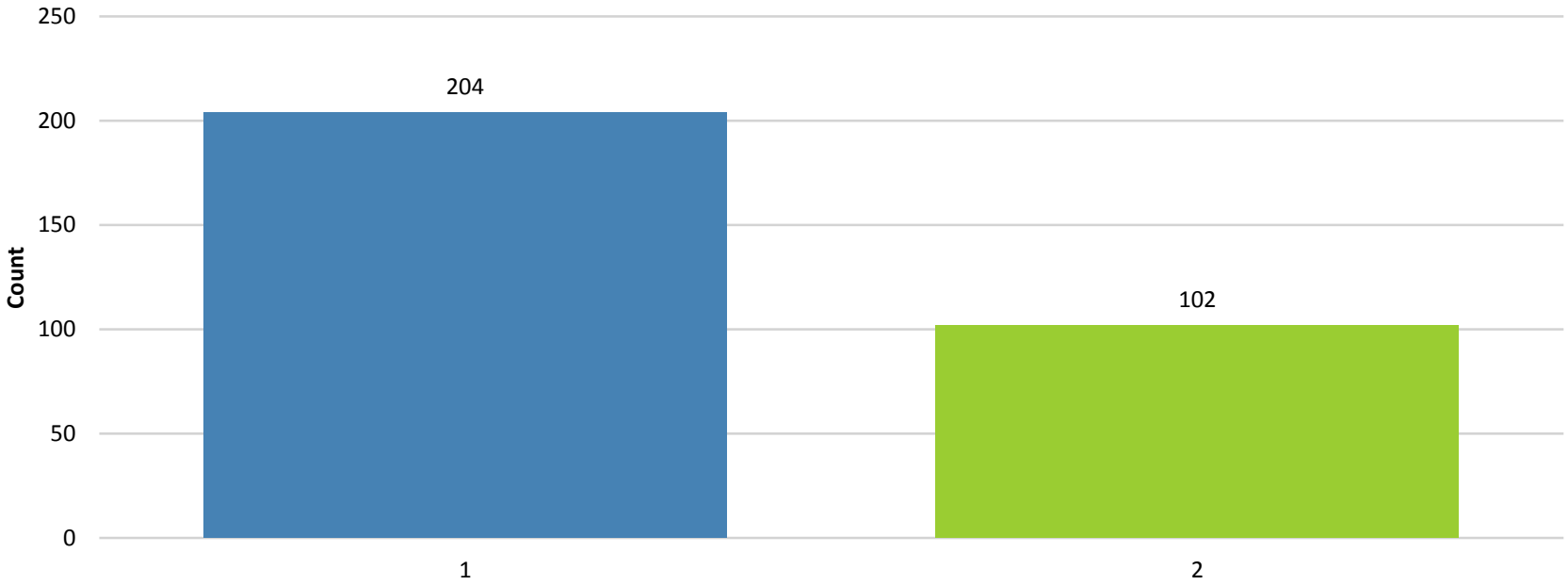


	Name
1	Transphyseal reconstruction
2	Physeal sparing reconstruction

10. Tibia

Name	Count
Transphyseal reconstruction	276
Physeal sparing reconstruction	29
N	304

11. Femur

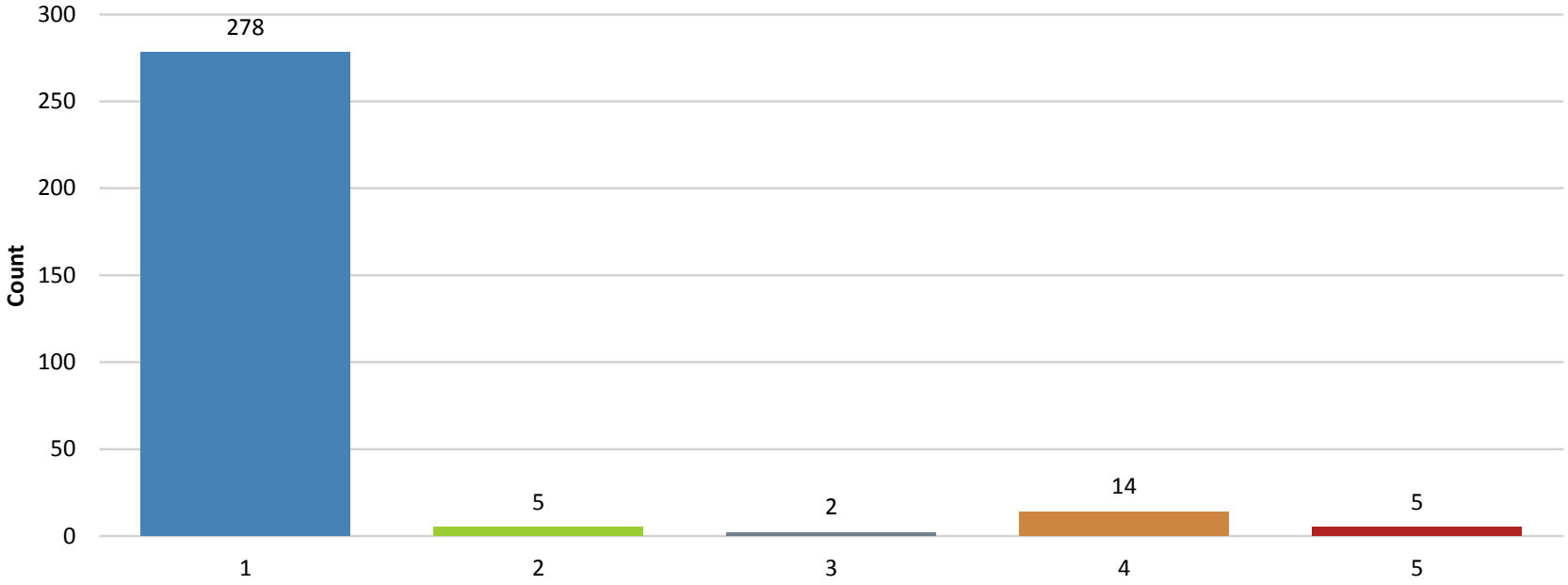


	Name
1	Transphyseal reconstruction
2	Physeal sparing reconstruction

11. Femur

Name	Count
Transphyseal reconstruction	204
Physeal sparing reconstruction	102
N	304

12. When you perform pediatric ACL reconstructions, which is your preferred graft ?



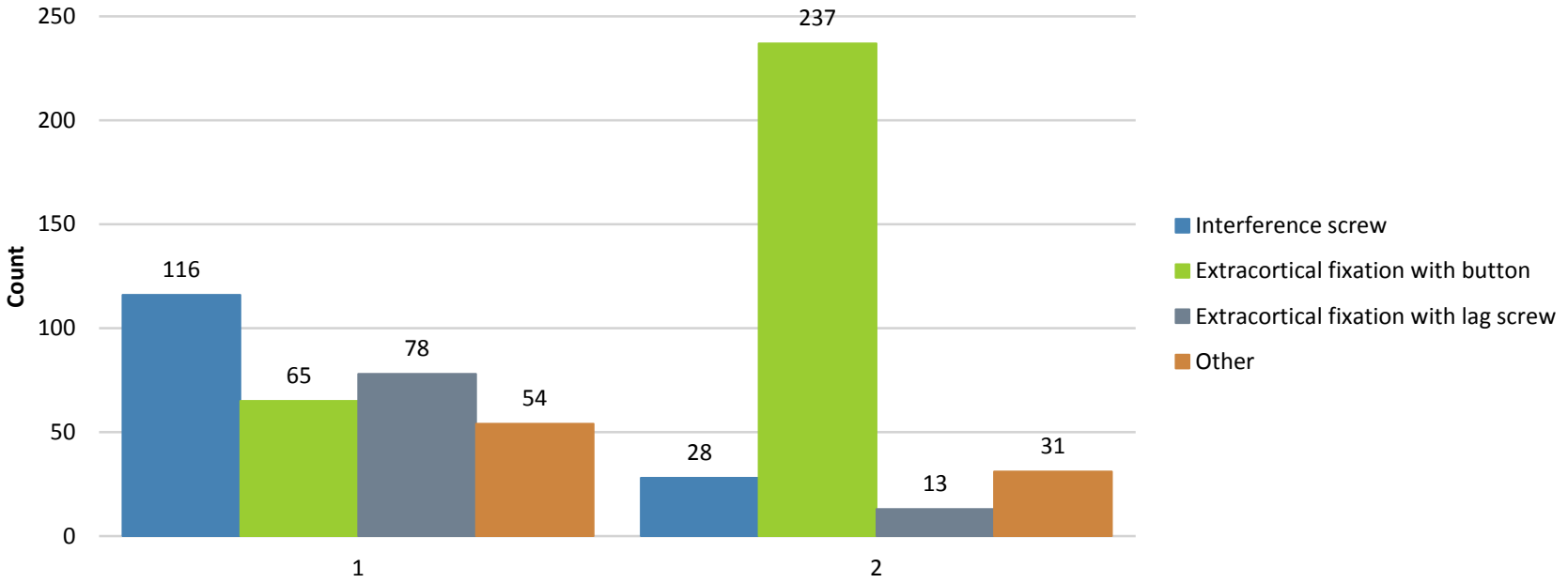
	Name
1	Hamstring
2	Quadriceps
3	BPTB
4	Allograft
5	Other

12. When you perform pediatric ACL reconstructions, which is your preferred graft ?

Name	Count
Hamstring	278
Quadriceps	5
BPTB	2
Allograft	14
Other	5
N	304

Other:
ITB strip-kocher procedure, only when really immature, for >14y boys and >12Y girls transphyseal
fascia lata
parent"s hamstring
Unknown, n=2

13. When you perform pediatric ACL reconstructions, which is your preferred method of graft fixation ?

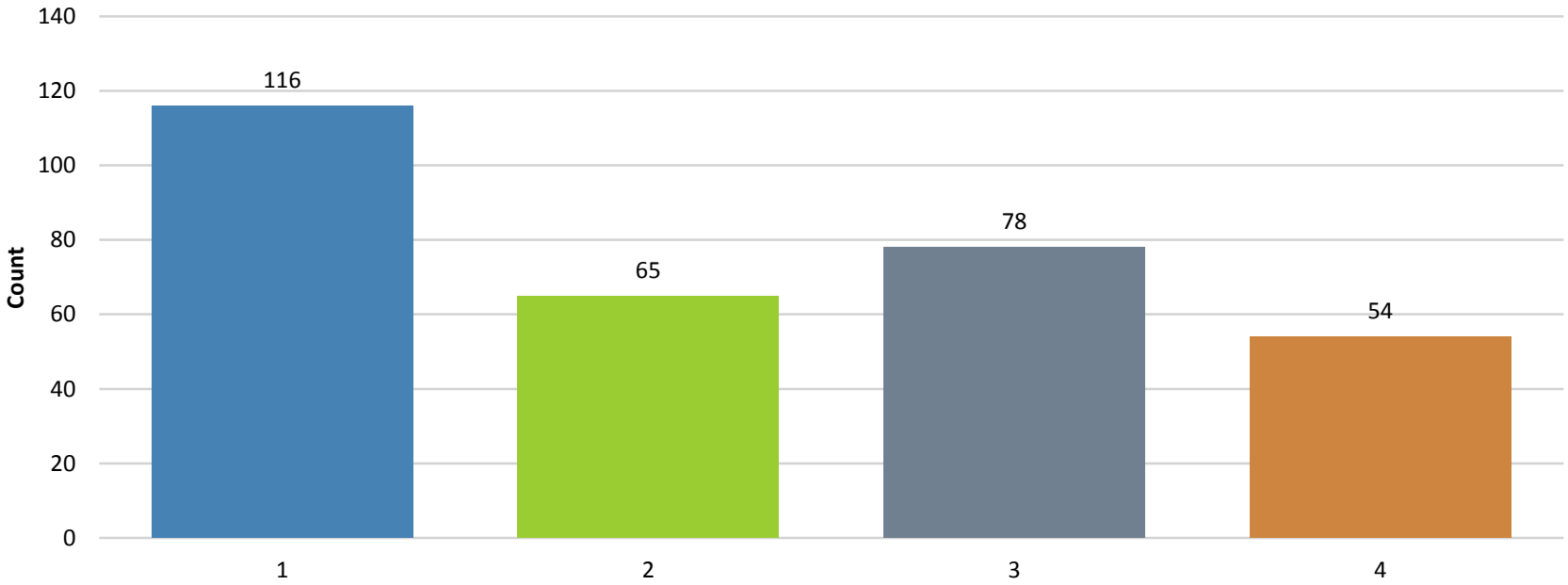


	Name
1	Tibia
2	Femur

13. When you perform pediatric ACL reconstructions, which is your preferred method of graft fixation ?

	Interference screw	Extracortical fixation with button	Extracortical fixation with lag screw	Other	N
Tibia	116	65	78	54	304
Femur	28	237	13	31	304

14. Tibia



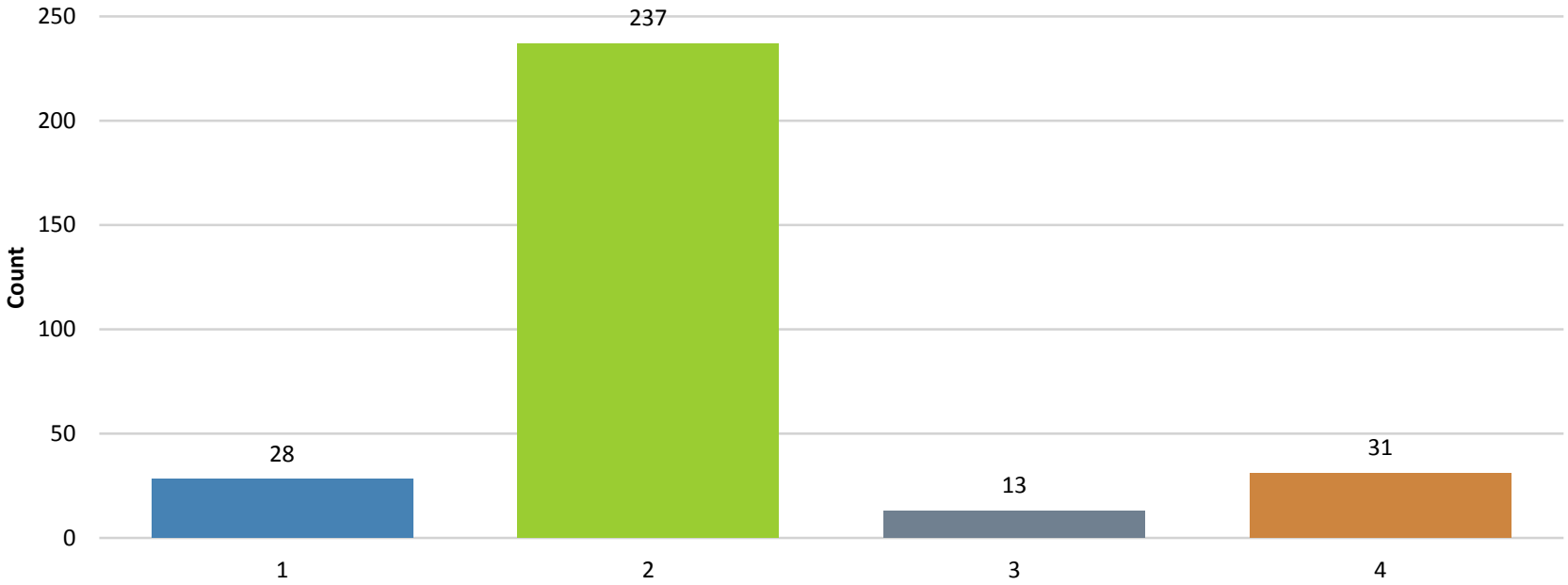
	Name
1	Interference screw
2	Extracortical fixation with button
3	Extracortical fixation with lag screw
4	Other

14. Tibia

Name	Count
Interference screw	116
Extracortical fixation with button	65
Extracortical fixation with lag screw	78
Other	54
N	304

Other	
Staple	n=9
hamstrings left attached at their insertion	n=6
Washer	n=3
Post-fixation	n=3
Rigid Fix	n=3
TLS	n=2
Tightrope	n=2
button	n=1
double spike plate	n=1
retrodrill technique all inside	n=1
extracortical with tibial hook	n=1
bone plug press fit fixation	n=1
pull out technique	n=1
suture to periosteum	n=1
unknown	n=19

15. Femur



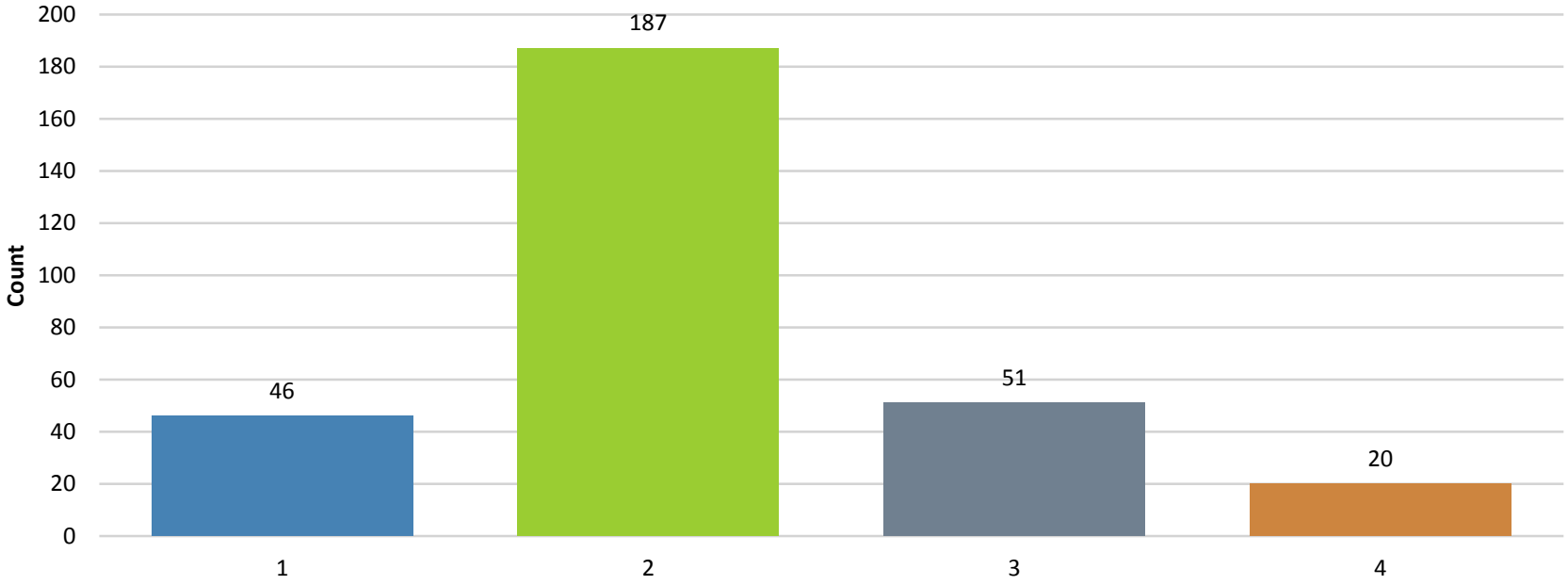
	Name
1	Interference screw
2	Extracortical fixation with button
3	Extracortical fixation with lag screw
4	Other

15. Femur

Name	Count
Interference screw	28
Extracortical fixation with button	237
Extracortical fixation with lag screw	13
Other	31
N	304

Other	
Pressfit	n=4
Staples	n=4
Bioabsorbable pins	n=4
Rigid Fix	n=4
Endobutton	n=2
TLS	n=2
soft tissue	n=1
Post screw	n=1
fixation by sutures at the level of fascia lata (extra-articular tenodesis)	n=1
exracortical with screw and washer	n=1
no femoral fixation (Mc Intosh technique)	n=1
flip cutter technique all inside	n=1
suture to periosteum	n=1
tightrope RT	n=1
Unknown	n=3

16. When you perform pediatric ACL reconstructions; which is your preferred method of femoral tunnel drilling?



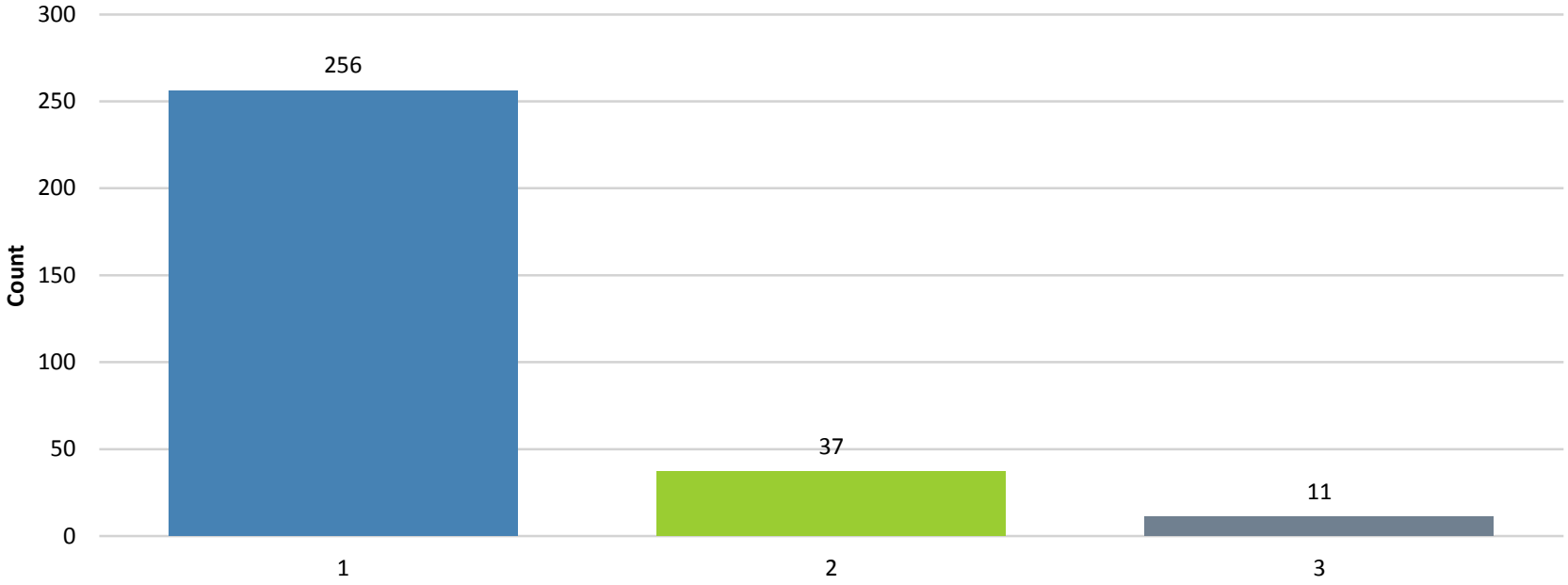
	Name
1	Transtibial
2	From anteromedial portal
3	Outside in intraepiphyseal (distal of femoral physics)
4	Other

16. When you perform pediatric ACL reconstructions; which is your preferred method of femoral tunnel drilling?

Name	Count
Transtibial	46
From anteromedial portal	187
Outside in intraepiphyseal (distal of femoral physics)	51
Other	20
N	304

Other	
Over the top	n=6
Retrodrill	n=3
All inside	n=3
indside out retrograd drilling with flipcutter	n=1
outside in transphyseal	n=1
transtbial with smaller drill in femur twice greating and oval drill hole	n=1
Unknown	n=5

17. When you perform a transhyseal technique in children; what is your maximum tunnel diameter (independent of age or size of the patient)?

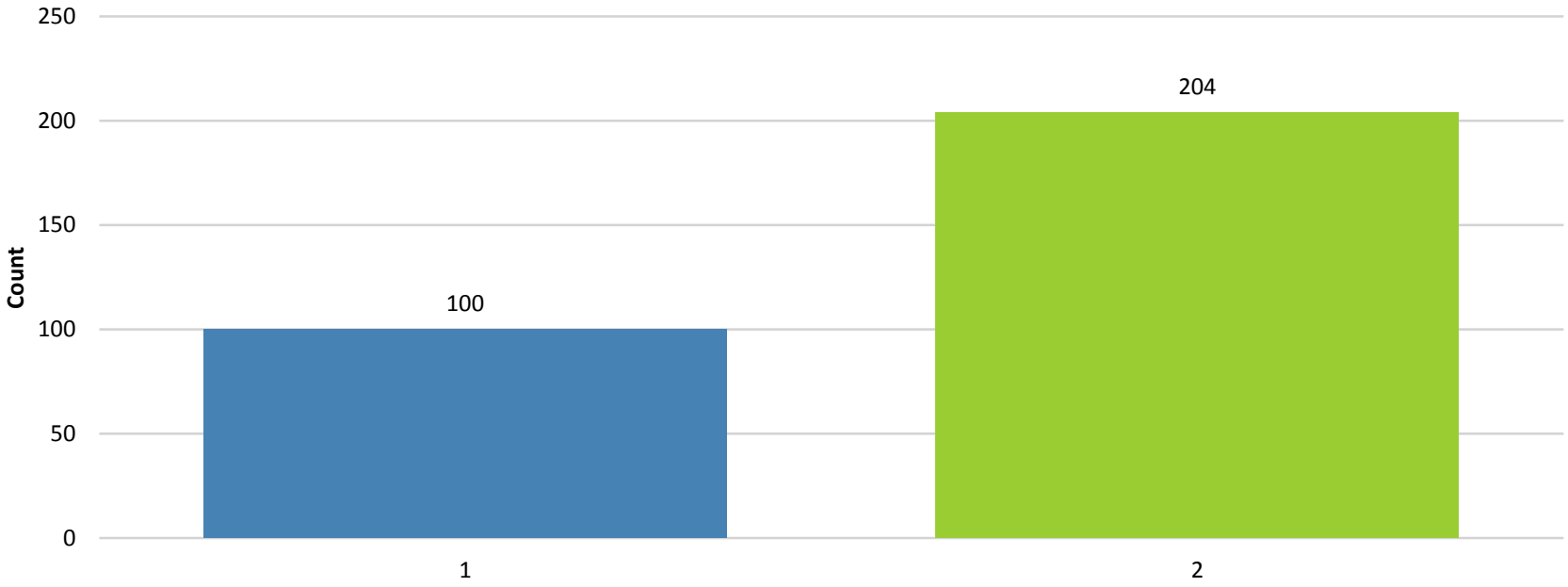


	Name
1	<9 mm
2	9 mm
3	>9 mm

17. When you perform a transhyseal technique in children; what is your maximum tunnel diameter (independent of age or size of the patient)?

Name	Count
<9 mm	256
9 mm	37
>9 mm	11
N	304

18. When you perform pediatric ACL reconstructions; do you use fluoroscopy on a systematic basis?

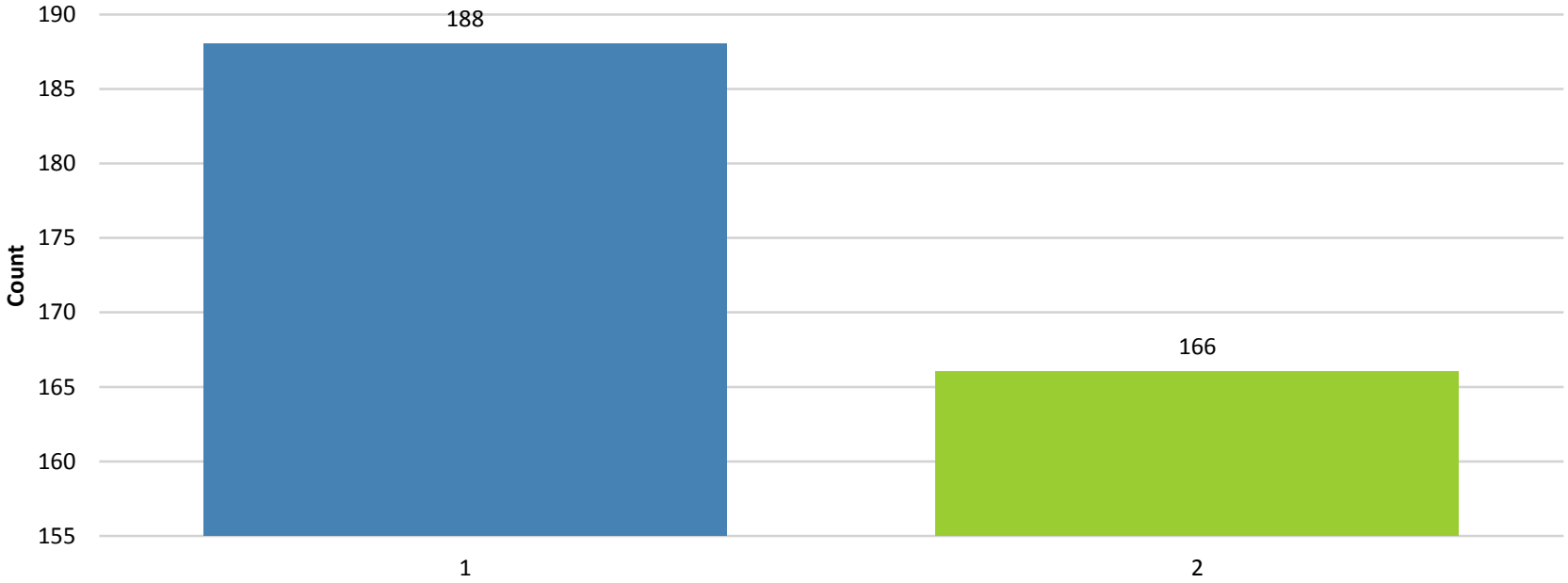


	Name
1	Yes
2	No

18. When you perform pediatric ACL reconstructions; do you use fluoroscopy on a systematic basis?

Name	Count
Yes	100
No	204
N	304

19. If you consider surgery, do you perform systematic skeletal age determinations before deciding?

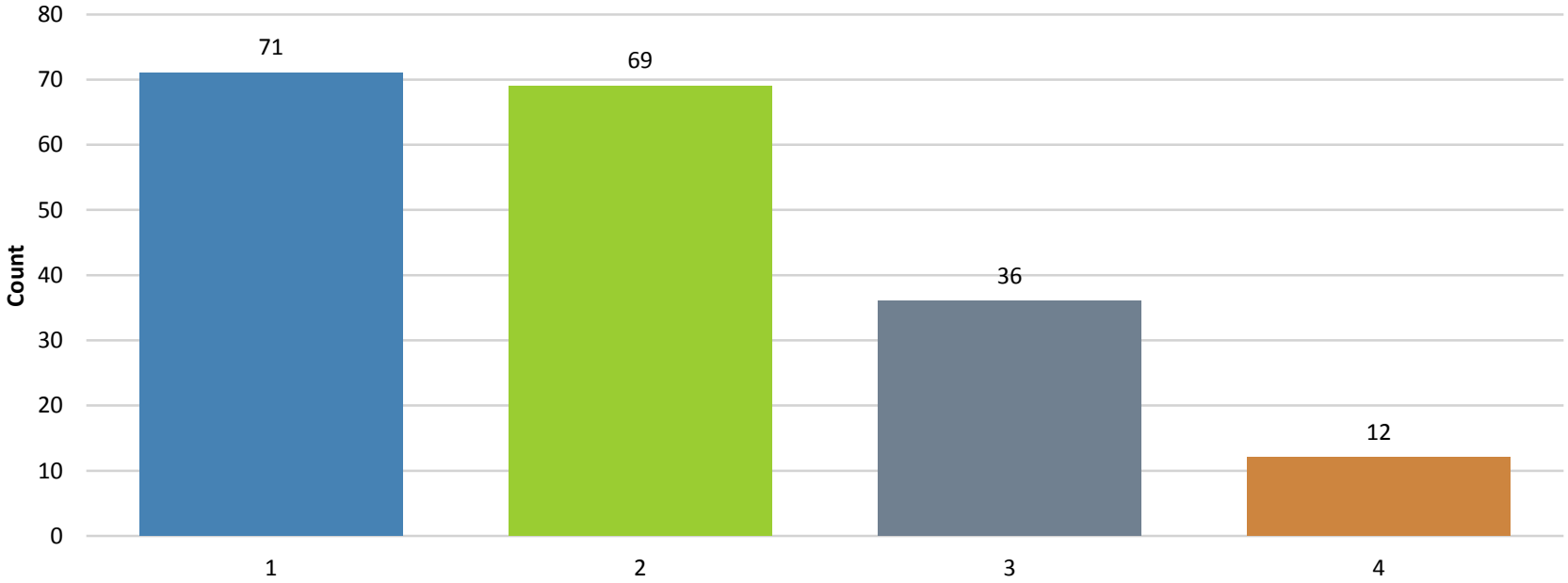


	Name
1	Yes
2	No

19. If you consider surgery, do you perform systematic skeletal age determinations before deciding?

Name	Count
Yes	188
No	166
N	354

20. What is your preferred method for skeletal age determination?



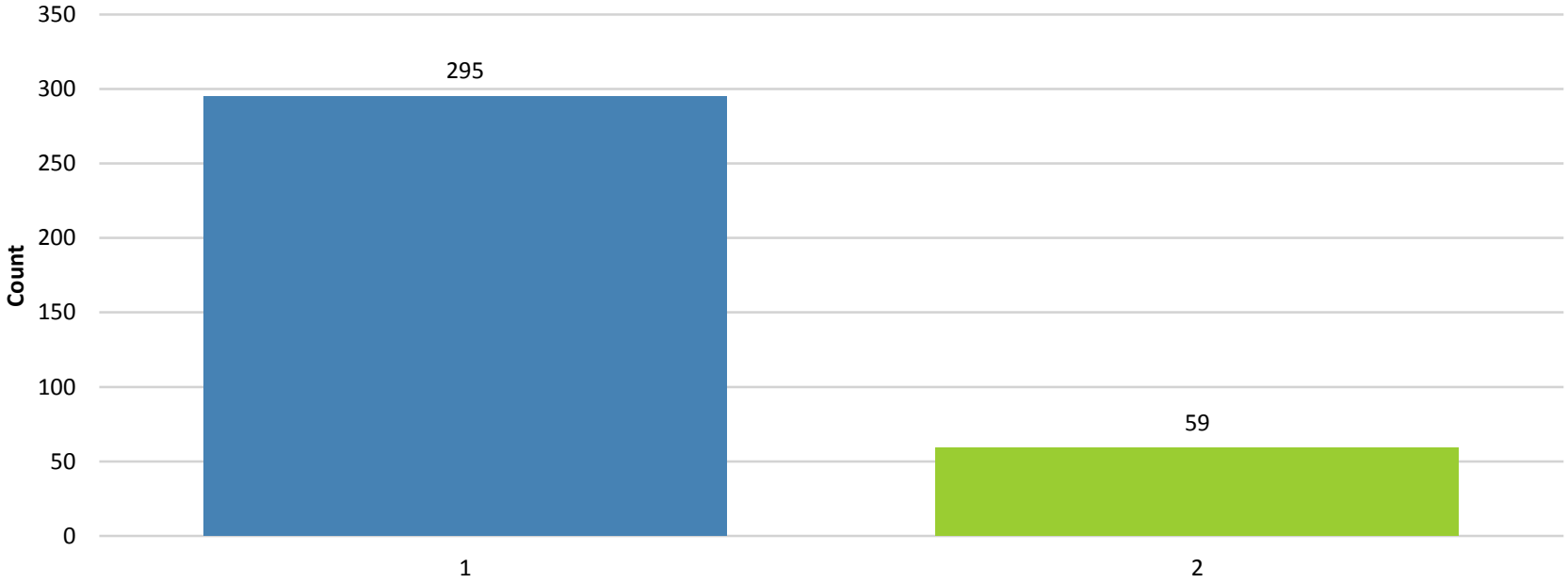
	Name
1	x-ray of wrist
2	x-ray of knee
3	MRI
4	Other

20. What is your preferred method for skeletal age determination?

Name	Count
x-ray of wrist	71
x-ray of knee	69
MRI	36
Other	12
N	188

Other	
x-ray pelvis	n=1
Tanner Scale	n=1
right elbow	n=1
age and Tanner score	n=1
X-ray of pelvis and knee	n=1
anthropometry	n=1
Unknown	n=6

21. Do you recommend rehabilitation before surgical treatment?

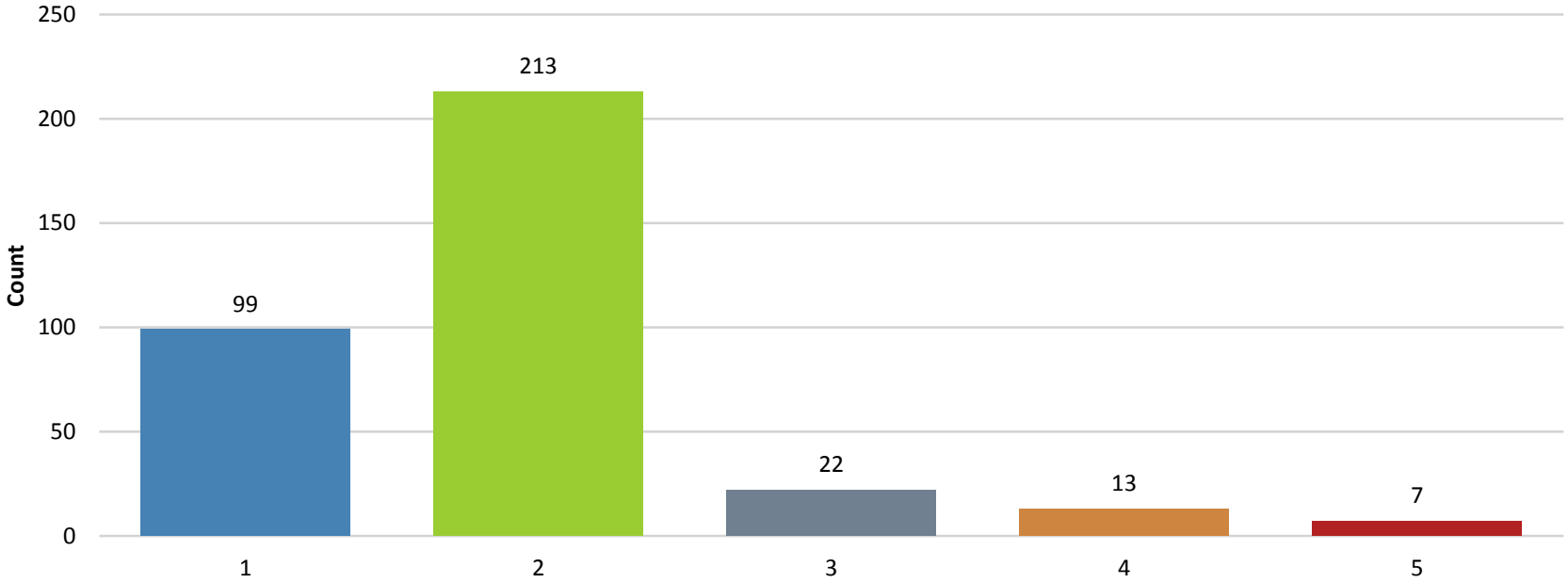


	Name
1	Yes
2	No

21. Do you recommend rehabilitation before surgical treatment?

Name	Count
Yes	295
No	59
N	354

22. How do you organize the rehabilitation for children with ACL injuries?



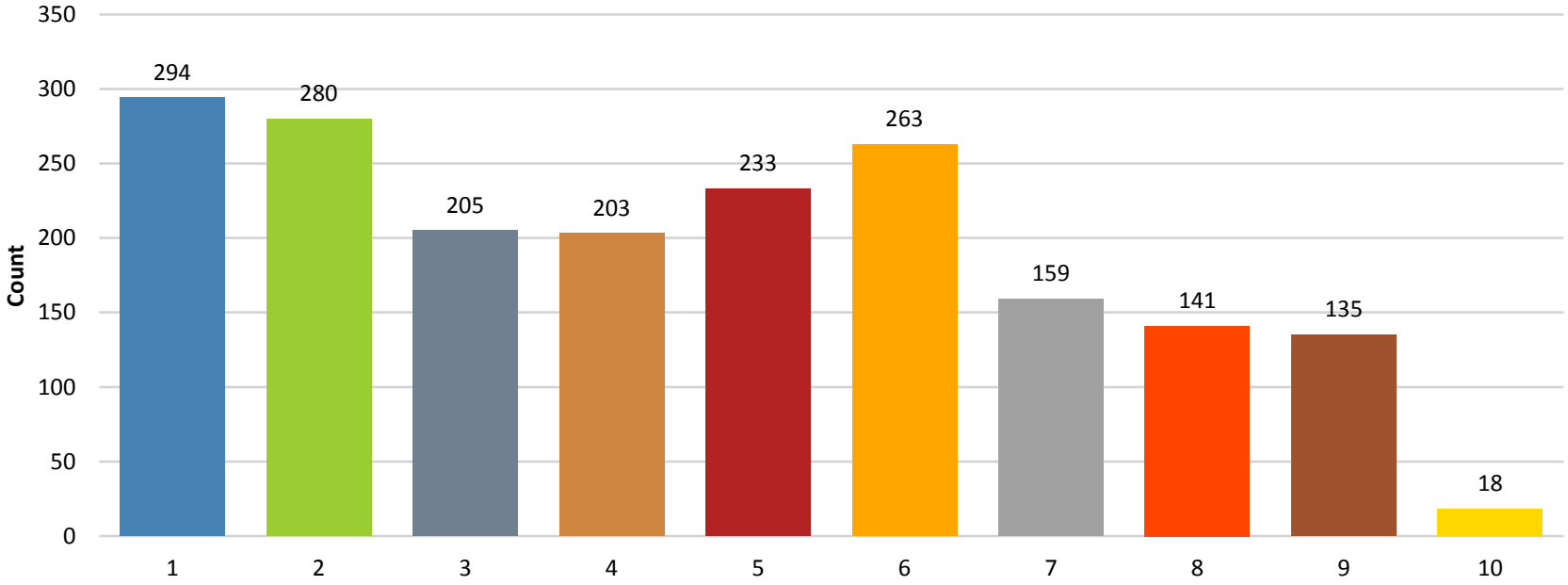
	Name
1	Standardized written protocol
2	Referral to Physiotherapist
3	Outpatient clinic in hospital
4	Home exercises
5	Other

22. How do you organize the rehabilitation for children with ACL injuries?

Name	Count
Standardized written protocol	99
Referral to Physiotherapist	213
Outpatient clinic in hospital	22
Home exercises	13
Other	7
N	354

Other	
Reffereal to physio, and pre and posttest.	n=1
ensure specialist rehab with good understanding	n=1
brace	n=1
straight to surgery	n=1
parental advice	n=1
Phisio/home exercises, depending on patient location and availability	n=1
Unknown	n=1

23. What are your success criteria after surgical treatment (multiple options possible)?



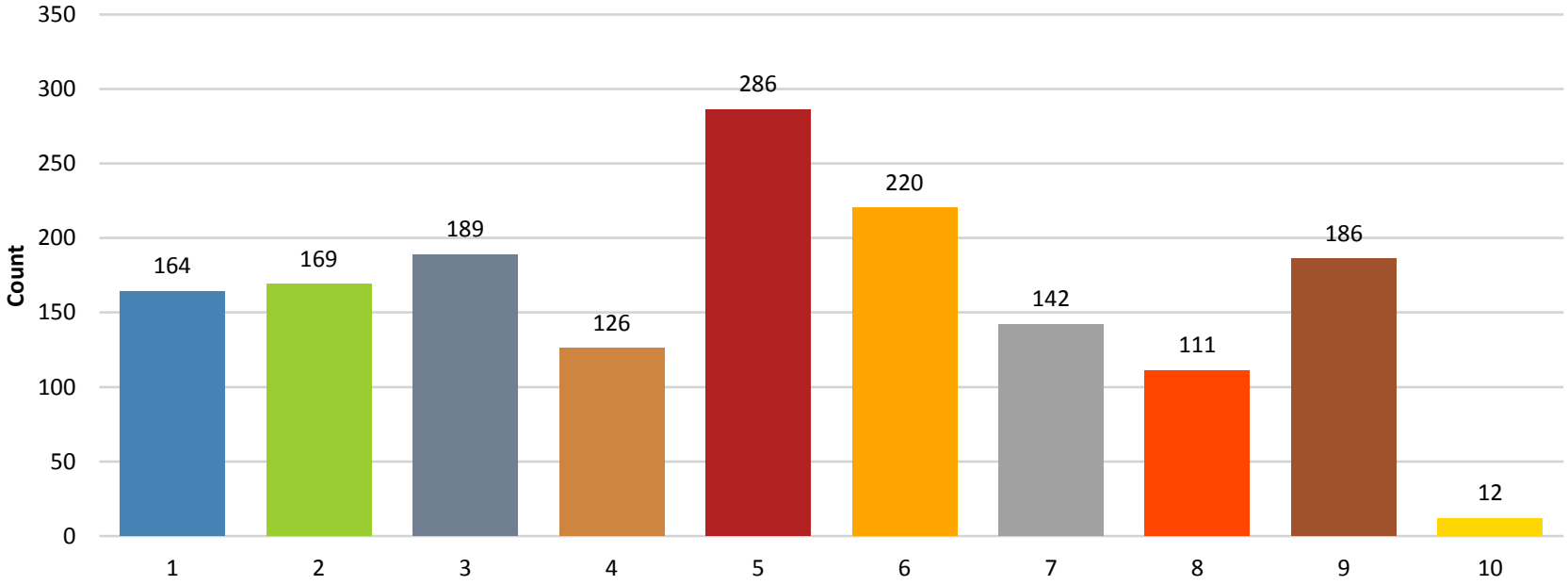
	Name
1	Lachmans test
2	Pivot shift test
3	Patient Reported Outcome Measures
4	Range of Motion
5	Giving way episodes
6	Return to Sport
7	Muscle strength
8	Hop test performance
9	Absence of secondary injuries
10	Other

23. What are your success criteria after surgical treatment (multiple options possible)?

Name	Count
Lachmans test	294
Pivot shift test	280
Patient Reported Outcome Measures	205
Range of Motion	203
Giving way episodes	233
Return to Sport	263
Muscle strength	159
Hop test performance	141
Absence of secondary injuries	135
Other	18
N	354

Other	
KT 1000/2000 6	n=6
Telos 2	n=2
Meniscal status or healing after surgery	n=1
Avoidance of injury to opposite knee	n=1
MRI	n=1
Gauntlet of functional challenges arranged in association with primary sport of interest	n=1
in vivo kinematics	n=1
muscle coordination	n=1
Lysholm, Tegner	n=1
optimal funtional in daily life and sports after <12 months depends of the age	n=1
Individually based depending on the patients goal	n=1
Unknown	n=1

24. What are your success criteria after non-operative treatment (multiple options available)?



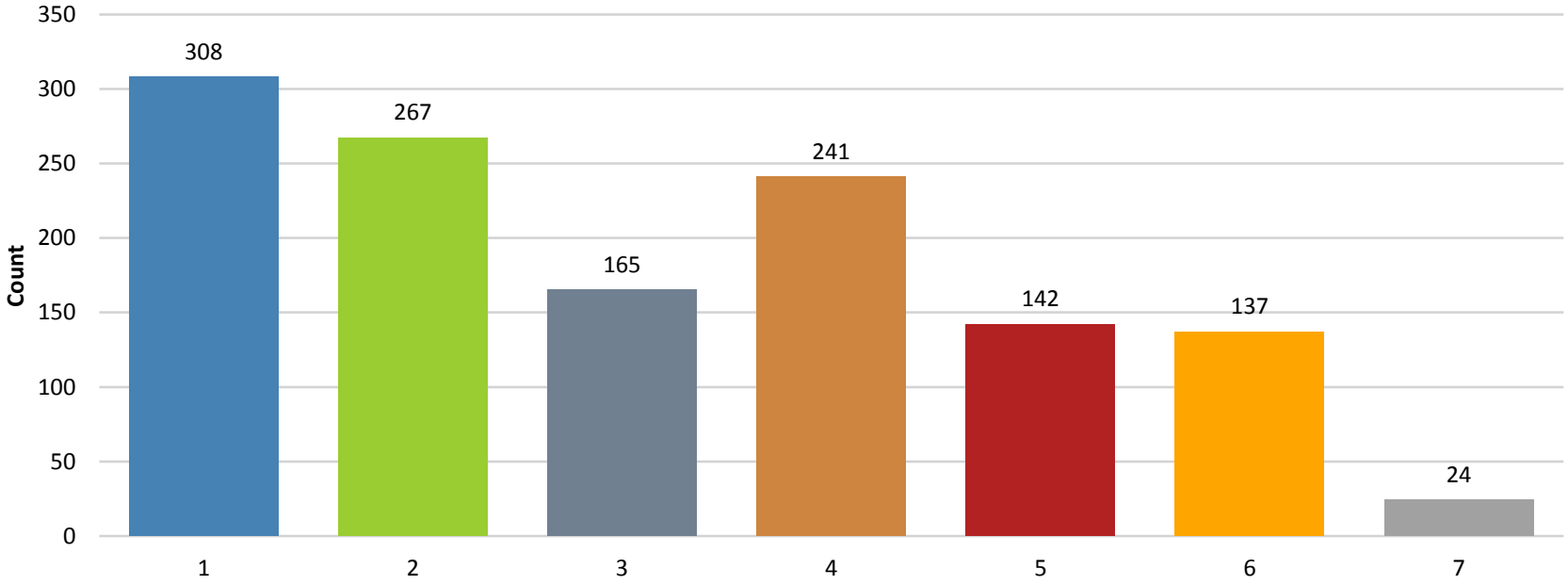
	Name
1	Lachmans test
2	Pivot shift test
3	Patient Reported Outcome Measures
4	Range of Motion
5	Giving way episodes
6	Return to Sport
7	Muscle strength
8	Hop test performance
9	Absence of secondary injuries
10	Other

24. What are your success criteria after non-operative treatment (multiple options available)?

Name	Count
Lachmans test	164
Pivot shift test	169
Patient Reported Outcome Measures	189
Range of Motion	126
Giving way episodes	286
Return to Sport	220
Muscle strength	142
Hop test performance	111
Absence of secondary injuries	186
Other	12
N	354

Other	
Non-operative is not an option	n=3
patient wishes	n=1
kt 1000 tests	n=1
stress x ray	n=1
muscle coordination	n=1
Lysholm, Tegner	n=1
normal daily life activities.With pivot >1 no pivoting sports Patient should be happy and satisfied and accept the little inconvenience	n=1
Individually based depending on the patients goal	n=1
Unknown	n=2

25. What are your criteria before allowing return to sport (multiple options available)?



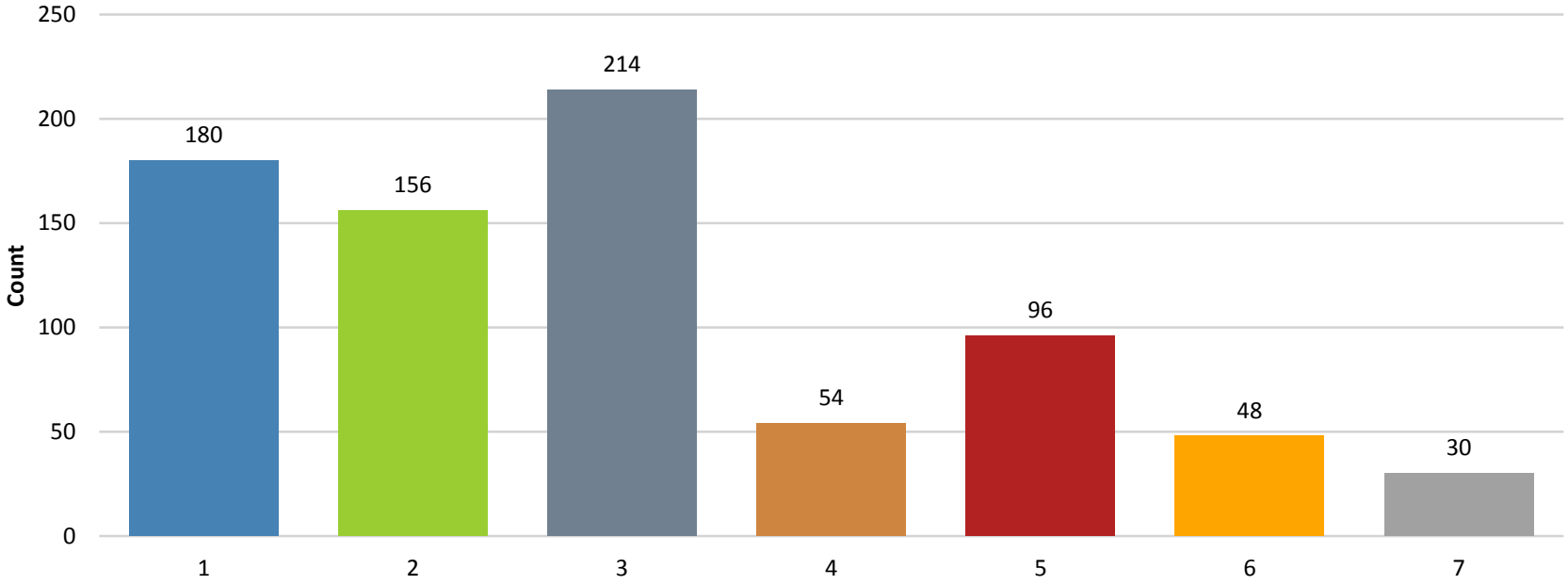
	Name
1	Clinical examination
2	Time from surgery/injury
3	Hop tests
4	Muscle strength measurements
5	Patient Reported Outcome Measures
6	Statement from Physiotherapist
7	Other

25. What are your criteria before allowing return to sport (multiple options available)?

Name	Count
Clinical examination	308
Time from surgery/injury	267
Hop tests	165
Muscle strength measurements	241
Patient Reported Outcome Measures	142
Statement from Physiotherapist	137
Other	24
N	354

Other	
Return to Sport test	n=7
MRI	n=5
No giving way	n=2
Careful discussion with the child and parents to ensure that they fully understand the risks of reinjury and performance in sport	n=1
ROM	n=1
KT-1000	n=1
self reported activity level and function (not necessarily a PROM)	n=1
SPECIF MUSCUL AND PROPRIO PERFORM TESTS	n=1
KOS sports activity scale, bilaterally equivalent single leg press 8-rep max, full pain-free ROM, pass 5 criteria with 5-6 functional tasks within each criteria	n=1
muscle coordination	n=1
patient´s confidence	n=1
Ability to performe tasks within the sport without symptoms such as giving way, efusion, pain	n=1
sport specific movements has to be optimal	n=1

26. If you use Patient Reported Outcome Measures, which do you administer (multiple options available)?



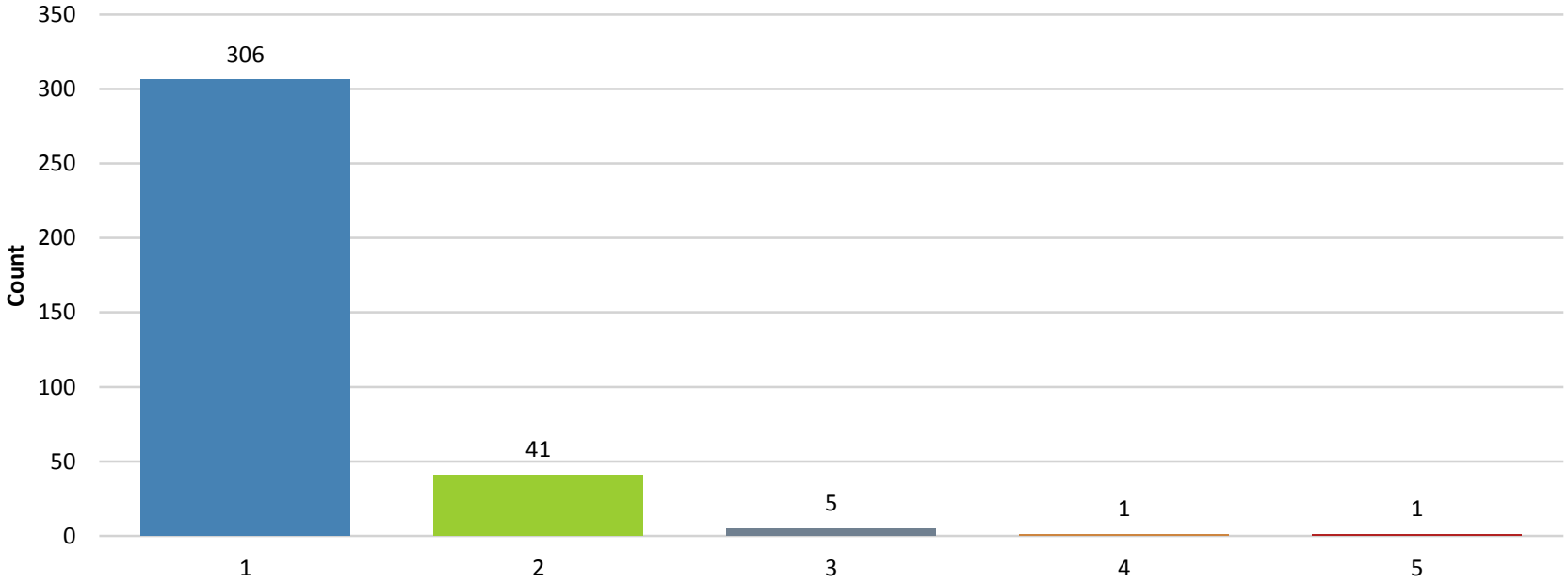
	Name
1	Lysholm
2	Tegner
3	IKDC
4	Pedi-IKDC
5	KOOS
6	KOOS-child
7	Other

26. If you use Patient Reported Outcome Measures, which do you administer (multiple options available)?

Name	Count
Lysholm	180
Tegner	156
IKDC	214
Pedi-IKDC	54
KOOS	96
KOOS-child	48
Other	30
N	354

Other	
No PROMs	n=8
3 assessments: Dr Happy (stable knee, full R-O-M,no physial changes) 2.Patient Happy (functionally back to level of pre injury activity...or can do what they want. 3) Knee Happy: No effusions, no radiologic changes.	n=1
jump tests	n=1
isokinetic test	n=1
IKDC systematic but taken into account only for clinical studies	n=1
Kujala	n=1
KOS-SAS	n=1
HSS	n=1
Registration of type and frequency of organized sports	n=1
KOS-ADLS, KOS-SAS, Marx, ACL-RSI, TSK-11	n=1
ACL-QOL	n=1
Our own additional questions	n=1
EQ-5D	n=1
Unknown	n=10

27. How many clinically relevant growth disturbances have you experienced from pediatric ACL reconstructions in the past?

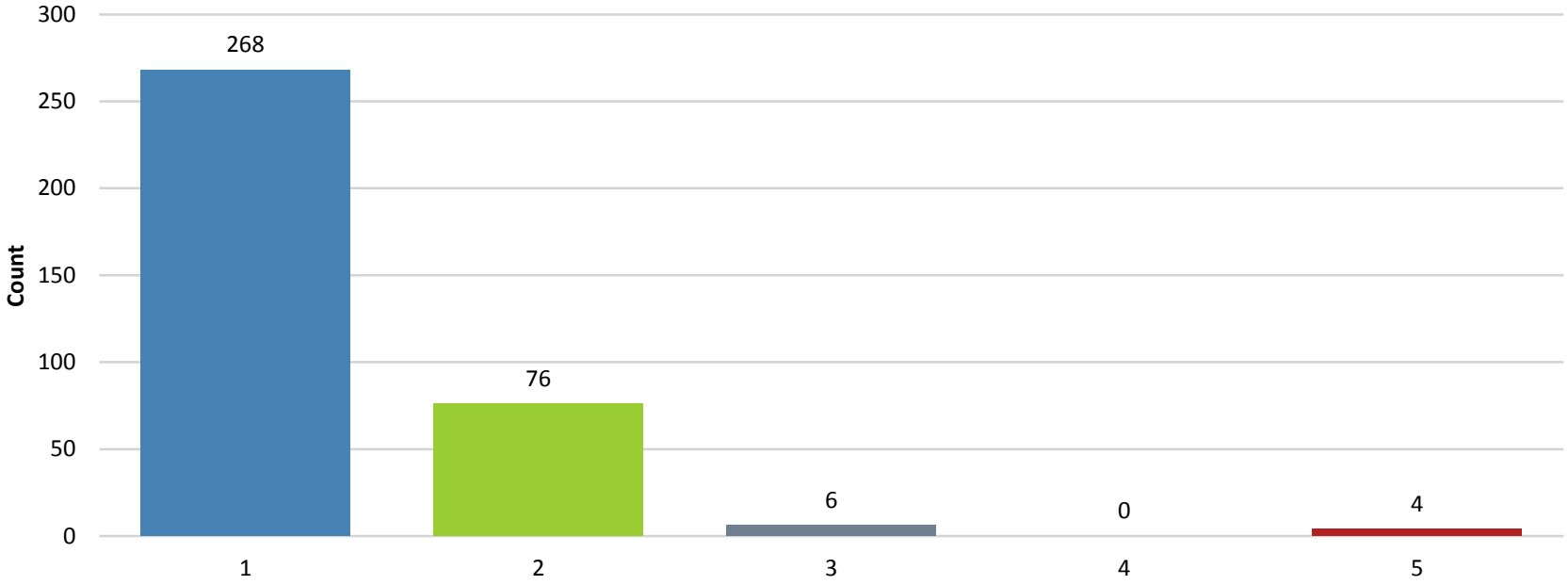


	Name
1	0
2	1-5
3	6-10
4	11-20
5	>20

27. How many clinically relevant growth disturbances have you experienced from pediatric ACL reconstructions in the past?

Name	Count
0	306
1-5	41
6-10	5
11-20	1
>20	1
N	354

28. How many non-clinically relevant growth disturbances have you experienced from pediatric ACL reconstructions in the past?

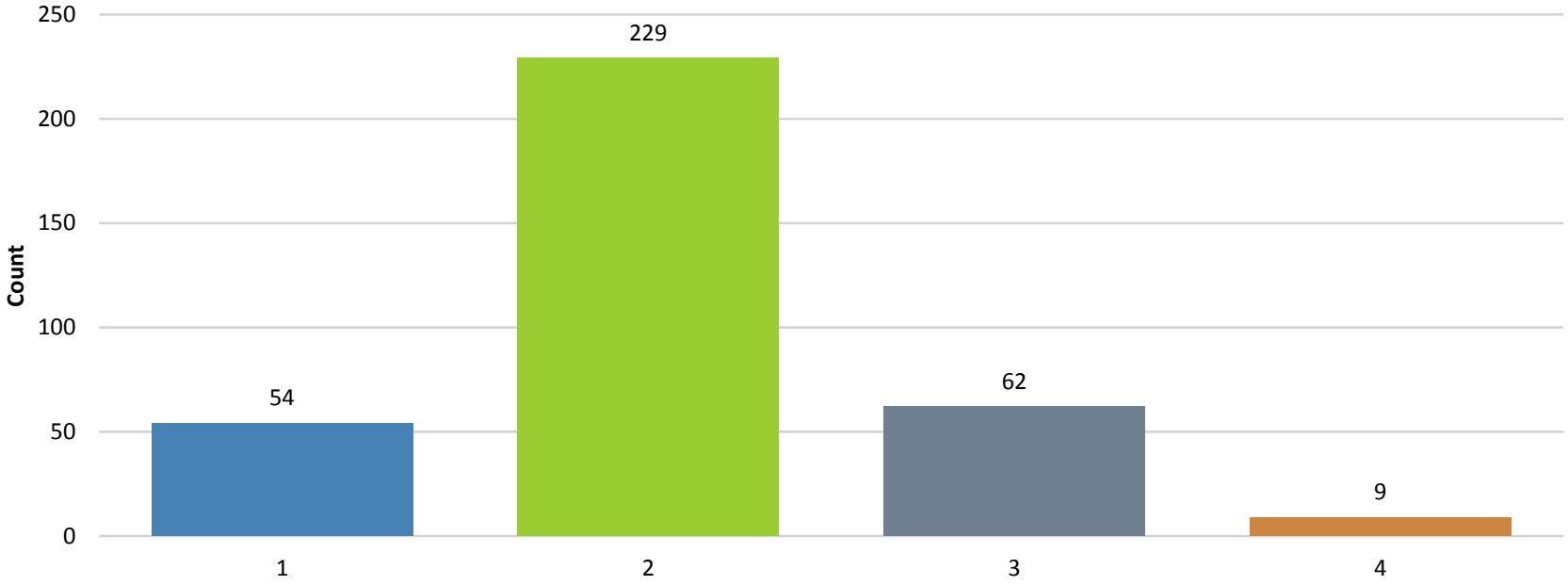


	Name
1	0
2	1-5
3	6-10
4	11-20
5	>20

28. How many non-clinically relevant growth disturbances have you experienced from pediatric ACL reconstructions in the past?

Name	Count
0	268
1-5	76
6-10	6
11-20	0
>20	4
N	354

29. What is the minimum degrees of frontal plane axial deformity that you would consider clinically relevant?

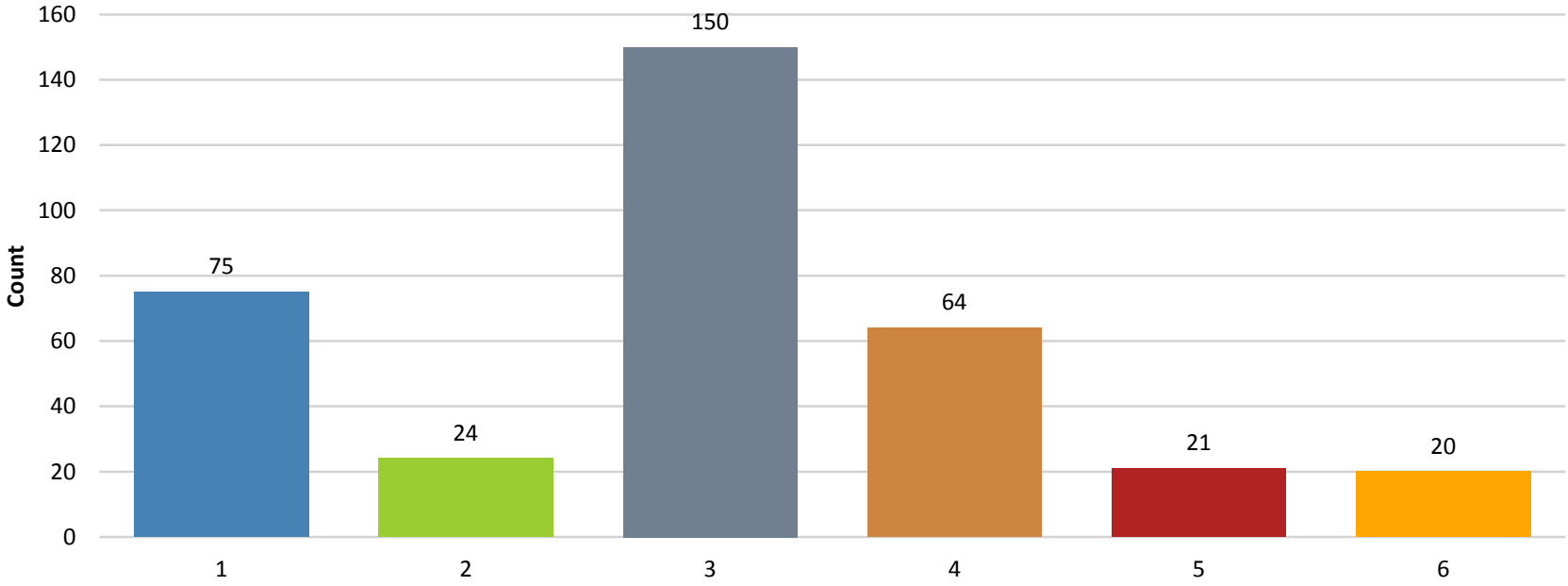


	Name
1	1-2°
2	3-5°
3	6-10°
4	>10°

29. What is the minimum degrees of frontal plane axial deformity that you would consider clinically relevant?

Name	Count
1-2°	54
3-5°	229
6-10°	62
>10°	9
N	354

30. How do you evaluate skeletal growth after surgical treatment?



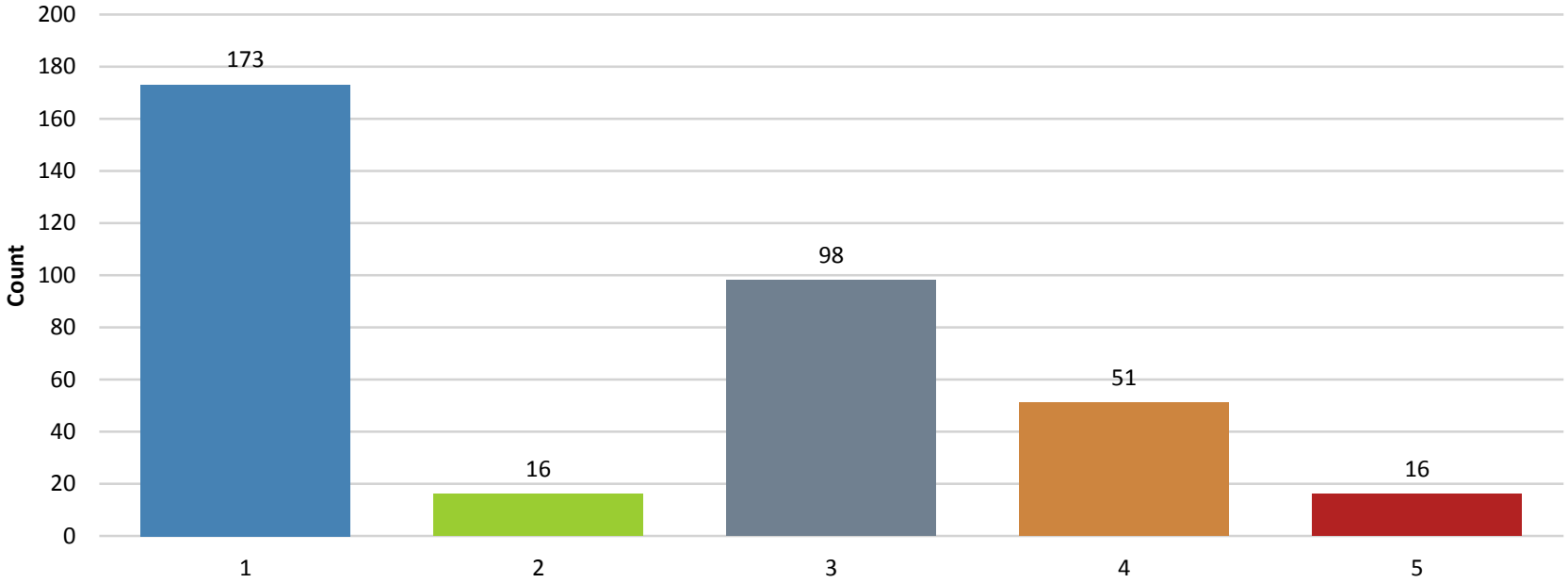
	Name
1	Do not evaluate
2	MRI
3	Long standing x-rays
4	Standard x-rays
5	Measure body longitudinal growth
6	Other

30. How do you evaluate skeletal growth after surgical treatment?

Name	Count
Do not evaluate	75
MRI	24
Long standing x-rays	150
Standard x-rays	64
Measure body longitudinal growth	21
Other	20
N	354

Other	
Clinical exam	n=9
long follow up - 2 years	n=1
only in selected cases	n=1
Standing x rays both knees.	n=1
scanogram if indicated	n=1
CT scanogram	n=1
ct	n=1
EOS IMAGING	n=1
body long grow and longstanding Xrays.If neccesary mri	n=1
Unknown	n=3

31. In your experience; what is the most common reason for graft failure?



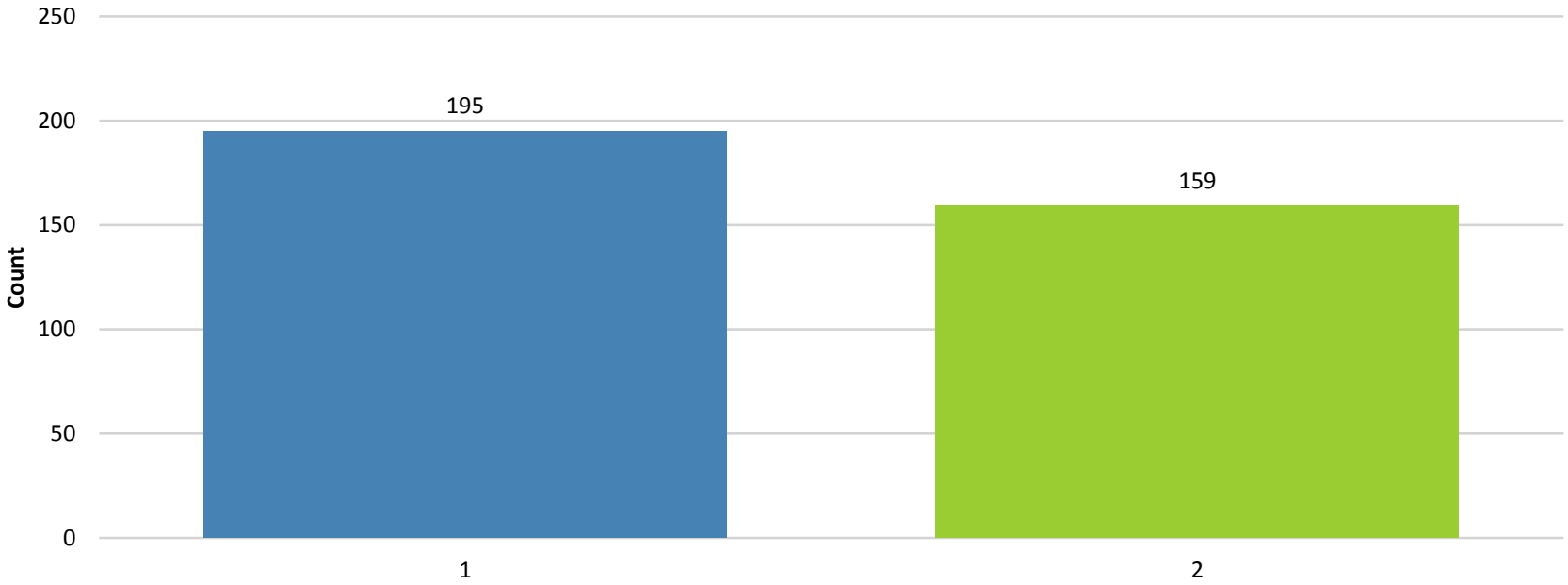
	Name
1	New trauma
2	Fixation failure
3	Tunnel positioning
4	Stretching (the graft becomes longer)
5	Other

31. In your experience; what is the most common reason for graft failure?

Name	Count
New trauma	173
Fixation failure	16
Tunnel positioning	98
Stretching (the graft becomes longer)	51
Other	16
N	354

Other	
Laxity of children And muscular immaturity	n=1
Maybe insuff graft	n=1
wrong rehabilitation, no proprioception	n=1
non integration	n=1
less compliant group - new trauma as kids never do as they are told in my experience!!	n=1
these knees are predisposed to ACL tears	n=1
to aggressive rehab and to soon return to sports	n=1
inappropriate return to play timing, impaired secondary stabilizers such as MCL	n=1
patient compliance	n=1
Combination	n=1
too early recovery of sport activity	n=1
Bad surgical technique: fixation failure, tunnel positioning	n=1
unknown	n=1
mostly new adequate trauma.But the serie of really pediatric acl is small.	n=1
rehab failure	n=1
combination of things	n=1

32. Do you immobilize the knee with a brace after surgical treatment of pediatric ACL reconstructions ?

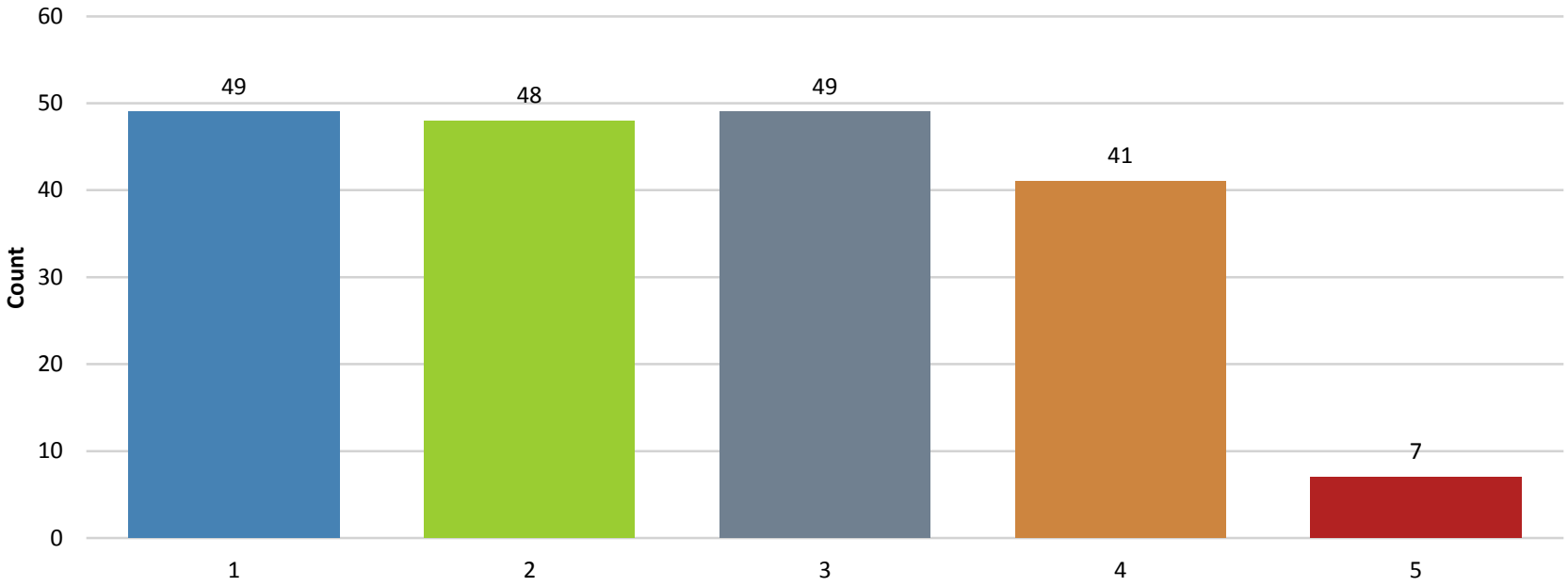


	Name
1	Yes
2	No

32. Do you immobilize the knee with a brace after surgical treatment of pediatric ACL reconstructions ?

Name	Count
Yes	195
No	159
N	354

33. If you immobilize children postoperatively; for how long time?

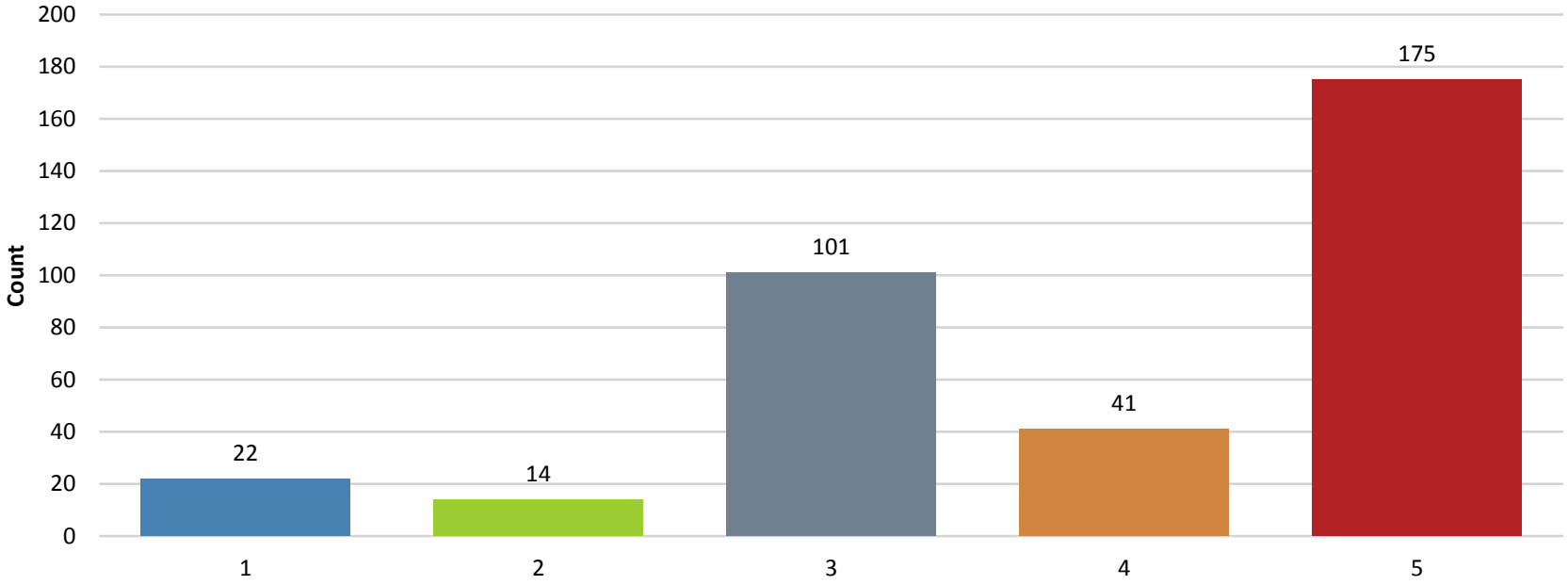


	Name
1	< 2 weeks
2	2 weeks
3	4 weeks
4	6 weeks
5	> 6 weeks

33. If you immobilize children postoperatively; for how long time?

Name	Count
< 2 weeks	49
2 weeks	48
4 weeks	49
6 weeks	41
> 6 weeks	7
N	194

34. For how long do you perform clinical follow-ups of the children after ACL reconstruction?



	Name
1	6 months
2	9 months
3	1 year
4	Until return to sports
5	Until the end of bone growth

34. For how long do you perform clinical follow-ups of the children after ACL reconstruction?

Name	Count
6 months	22
9 months	14
1 year	101
Until return to sports	41
Until the end of bone growth	175
N	353