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ACL Study Group presents the global trends in ACL reconstruction: biennial survey of the ACL Study Group

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ABSTRACT

Objectives The primary objective of this survey was to gauge the current global trends in anterior cruciate ligament reconstruction (ACLR) as reported by the members of the Anterior Cruciate Ligament (ACL) Study Group (SG).

Methods A survey was created and distributed among the members of the ACL SG consisting of 87 questions and 16 categories related to ACLR, including member demographics, preoperative management, primary ACLR techniques and graft choice, use of concomitant procedures and biological augmentation, postoperative rehabilitation, and more.

Results The survey was completed by the 140 members of the ACL SG. Fifty per cent of members are from Europe, 29% from the USA, 15% from the Asia-Pacific and the remaining 6% are from Latin America, the Middle East, New Zealand and Africa. Most (92%) do not believe there is a role for non-operative management of ACL tears in higher level athletes; conversely, most agree there is a role for non-operative management in lower impact athletes (92%). A single-bundle (90%) technique with hamstring autograft (53%) were most common for primary ACLR. Tunnel position varied among respondents. Sixty-one per cent do not use allograft for primary ACLR. Fifty per cent of respondents use cortical suspensory fixation on the femur, with variable responses on the tibia. Most (79%) do not use biologics in primary ACLR, while 83% think there is a selective role for extra-articular augmentation in primary ACLR. Fifty per cent prefer bone-tendon-bone autograft for revision ACLR and extra-articular augmentation is more commonly used (13% always, 26% often) than in primary ACLR (0% always, 15% often). A majority (53%) use a brace after primary ACLR. The most common responses for minimal time to return to play after primary ACLR were 6–8 months (44%) and 8–12 months (41%).

Conclusion We presented the thoughts and preferences of the ACL SG on the management of ACL injuries. This survey will help to facilitate an ongoing discussion with regard to ACLR by providing global insights into the current surgical trends in ACLR.

Level of evidence Level V, Expert Opinion.

What are the new findings

- The vast majority of the Anterior Cruciate Ligament (ACL) Study Group (SG) (90%) used a single-bundle technique for anterior cruciate ligament reconstruction (ACLR) and over 50% chose hamstring autograft as their primary ACL graft of choice.
- Over 80% of ACL SG members believe that there is a selective role for extra-articular augmentation in primary ACLR.
- Fifty per cent of ACL SG members prefer bone-tendon-bone autograft for revision ACLR and extra-articular augmentation is more commonly used in revision ACLR than in primary ACLR.
- More than 50% of the ACL SG routinely use a brace after ACLR and the most common minimal times to return to play after primary ACLR were 6–8 months (44%) and 8–12 months (41%).

INTRODUCTION

Anterior cruciate ligament (ACL) reconstruction (ACLR) is one of the most common orthopaedic sports medicine procedures performed worldwide. Each year, more than 200 000 ACL injuries occur in the USA alone at an estimated annual cost (both direct and indirect) of $7 billion.[1 2] Furthermore, ACLR appears to be on the rise in both adults and adolescents worldwide.[3–8] As ACL injuries increase in incidence and thus overall cost, and with evidence that many athletes fail to return to their preinjury level of activity post-ACLR,[9–13] while many develop post-traumatic osteoarthritis,[14–16] research is ongoing to optimise surgical techniques, fixation devices, graft options and postoperative rehabilitation protocols.

In an effort to continuously evaluate and improve on outcomes in ACLR, the ACL Study Group (SG) was founded over 50 years ago with a mission 'to advance the art and science of knee soft tissue surgery, rehabilitation, and injury prevention through the exchange of scientific information and debate'. This mission began circa 1967, when John Feagin, MD, held a discussion at West Point prior to the American Orthopaedic Society for Sports Medicine meeting in Lake Placid, New York, USA.

Since that initial meeting, biennial ACL SG meetings have encouraged the continued exchange of information related to ACLR among a growing group of experts. Prior to the recent ACL SG meeting, a structured survey was sent out to the members in order to get a better overview about current global trends in ACLR. The first ACL SG survey was performed in 1980.[17] Our objective here is to present the results of the most recent ACL SG survey that was distributed prior to the January 2020 meeting.

METHODS

Before the January 2020 ACL SG biannual meeting in Kitzbühel, Austria, a survey was created consisting of 87 questions and 16 categories related to ACL injuries and ACLR, including member demographics, preoperative management, primary ACLR techniques and graft choice, use of concomitant

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procedures and biological augmentation and postoperative rehabilitation, among others. The survey was developed, housed and then distributed via an anonymous link (Qualtrics, Provo, Utah, USA) to the members of the ACL SG 7 days prior to the meeting. After a 7-day collection period, the data were summarised and analysed, with the responses reported as percentages of the total. For certain questions, the recipient was given the option of choosing multiple answers and in those specific questions, the total percentage may add to greater than 100%.

RESULTS

Demographics

One hundred and forty members of the ACL SG completed the survey. Approximately 50% of members of the ACL SG are from Europe, 29% are from the USA, 15% are from the Asia-Pacific and the remaining 6% are from Latin America, the Middle East, New Zealand and Africa. Thirty-five per cent of respondents work in an academic practice setting, 37% private practice, 24% mixed practice and 4% are retired.

Preoperative management

Regarding surgical timing, 65% of respondents cited the importance of patient-specific factors such as range of motion, effusion, pain and gait rather than a specific timeframe. Ninety per cent of respondents do not routinely aspirate a knee hemarthrosis within a few days of ACL injury. The majority (51%) of respondents routinely instruct patients to use crutches until they can ambulate without pain, compared with 43% who do not recommend crutch use prior to ACLR. Eighty per cent of respondents do not routinely brace patients prior to ACL surgery, while 14% brace until adequate quadriceps control and 6% brace until the ACLR procedure. Finally, most respondents do not have a rigid upper (93%) or lower (71%) patient age limit with regards to performing ACLR.

A vast majority of respondents (94%) routinely obtain preoperative MRI, while 80% also obtain preoperative plain X-rays. When asked if they obtain other routine preoperative imaging, 96% reported 'no', while 4% reported 'yes' (40% of which obtain CT scans and the remainder obtain ultrasounds).

Non-operative treatment in athletes

A brief section of the survey was dedicated to the role of non-operative treatment of ACL tears in athletes. For higher level athletes (Tegner 8–10), 92% of respondents said there is not a role for non-operative treatment. For moderate level athletes (Tegner 6–7), responses were split with 54% responding that there is a role for non-operative treatment in this demographic and 46% stating that there is not. Finally, with lower impact athletes (Tegner 3–5), 92% of respondents state that there is a role for non-operative treatment of ACL injuries (figure 1).

Primary ACLR

Ninety per cent of respondents perform a single-bundle ACLR greater than 90% of the time, while only 7% of respondents typically perform a double-bundle ACLR. The most common primary graft choices were hamstring tendon (HT) autograft (53%) and bone-tendon-bone (BTB) autograft (36%) (figure 2). The most common secondary graft choices were as follows: BTB autograft (37%), HT autograft (26%) and quadriceps tendon (QT) autograft with bone (13%). The respondents were then asked to predict the graft choice used most commonly 10 years from now, 40% said HT autograft, 33% BTB autograft and 10% QT autograft without bone.

Several questions targeted intraoperative techniques. With regard to peripheral nerve blocks during surgery, 50% of members stated they do not routinely use a block, while 40% routinely use nerve blocks (femoral and adductor each 20%). The use of tourniquet for the duration of the case is routinely done by the 70% of respondents. Members were asked, with regard to adult single-bundle ACLR, where they prefer to place the femoral tunnel: 33% reported centrally at the footprint, 32% reported more anteromedial (AM) bundle than posterolateral (PL) bundle and 23% reported AM bundle (figure 3). The most popular means of finding the femoral footprint of the ACL included bony landmarks (78%) and soft tissue remnant preservation (59%). Notably, 56% of respondents stated that remnant preservation is important. When referencing off of the anterior horn of the lateral meniscus, 61% reported placing the

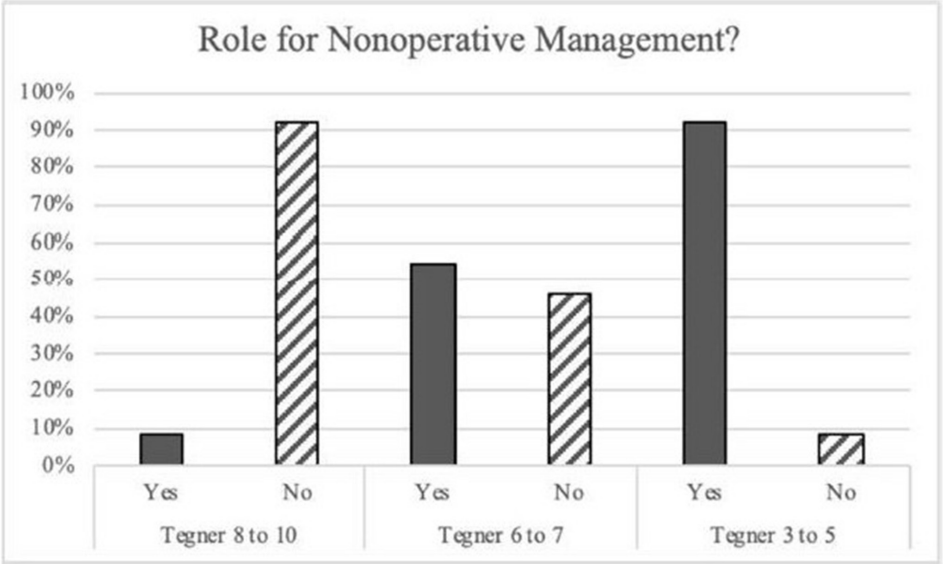

Figure 1 Is there a role for non-operative treatment of ACL injuries in higher level athletes (Tegner 8–10; ie, competitive basketball, soccer, football)? Moderate level athletes (Tegner 6–7, ie, competitive racquet sports, recreational skiing)? Lower impact athletes (Tegner 3–5, ie, bikers, joggers, swimmers)?

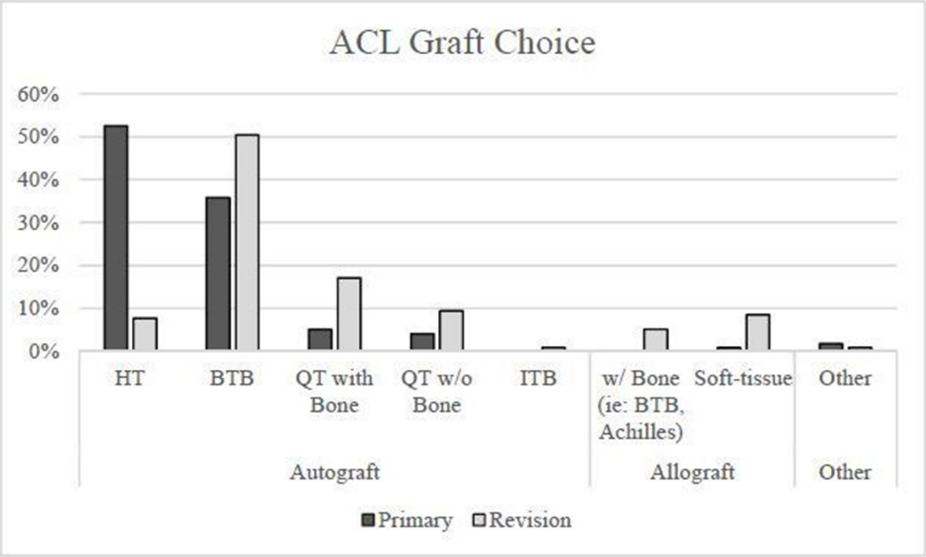

Figure 2 What is your most common graft choice for primary or revision ACLR? ACLR, anterior cruciate ligament reconstruction; BTB, bone-tendon-bone; HT, hamstring tendon; ITB, iliotibial band; QT, quadriceps tendon.

tibial tunnel in line with the lateral meniscus, 20% posterior and 12% anterior.

Members most commonly prefer drilling their femoral tunnel from the AM portal (73%), while 13% prefer an outside-in approach . Femoral tunnel fixation preference was variable; however, the most common choice was cortical suspensory fixation (50%) (figure 4). The tibial tunnel is most commonly drilled anterograde (94%), with variable methods of fixation—most commonly, absorbable interference screw (28%) and metal interference screw (22%). Preferences for graft tensioning prior to fixation were mixed: maximum manual pull at 15°–30° of flexion (35%), maximum manual pull at 0° (17%), submaximal manual pull at 15°–30° (13%) and maximum manual pull at full hyperextension (10%).

After primary ACLR, a majority of respondents (58%) check the pivot shift in the operating room. Most (79%) stated they never use biologics, such as platelet-rich plasma (PRP) or bone marrow aspirate concentrate (BMAC), during primary ACLR.

Most respondents (83%) think that there is a selective role for extra-articular augmentation in primary ACLR. Fifteen per cent report that they often use it (none responded always), 31% sometimes, 35% rarely and 19% never use extra-articular augmentation during primary ACLR (figure 5). When asked about technique preferred for lateral extra-articular augmentation, 70% of respondents agree that it is important to pass the graft underneath the lateral collateral ligament (LCL) and 85% think the best location for fixation into the femur is posterior/proximal to the LCL. Regarding location of tibial fixation, members were nearly split between Gerdy's tubercle (51%) (whether iliotibial band (ITB) was left attached distally or allograft was used) and midway between the fibular head and Gerdy's tubercle (42%).

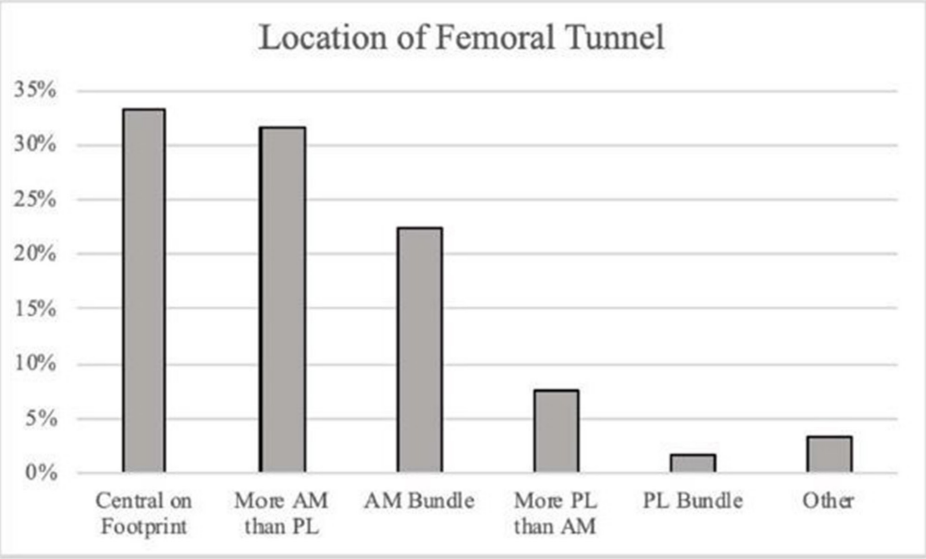

Figure 3 Regarding adult single-bundle ACLR, where do you prefer to place your femoral tunnel? ACLR, anterior cruciate ligament reconstruction; AM, anteromedial; PL, posterolateral.

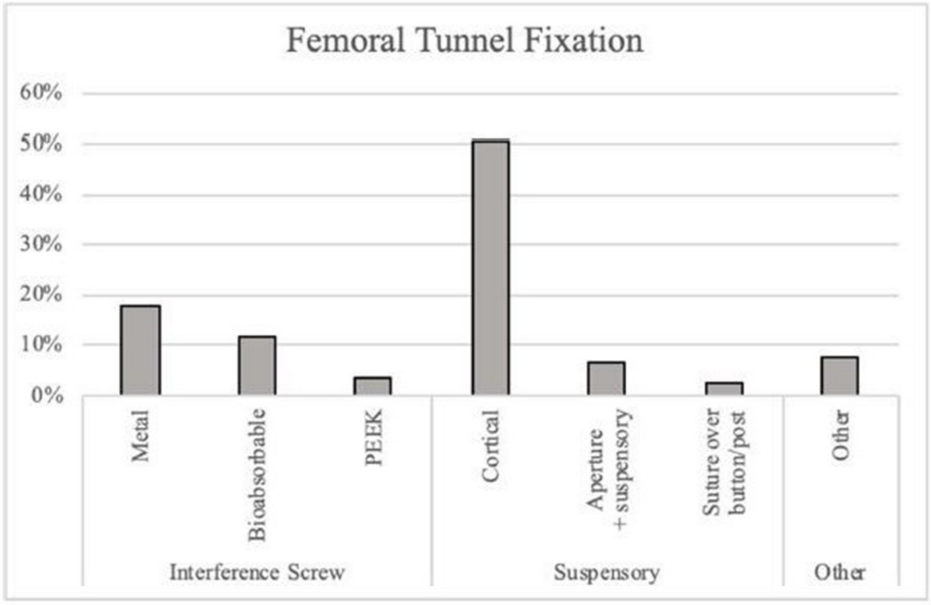

Figure 4 How do you prefer to fix your femoral tunnel? PEEK, polyetheretherketone.

Allograft

Sixty-one per cent of respondents do not use allograft for primary ACLR. Nearly all respondents (97%) agreed that non-irradiated, age-matched allograft for ACLR does not perform comparably to autograft in high-level athletes under the age of 21. Alternatively, 48% of respondents agree that a non-irradiated age-matched allograft ACLR performs similarly to autograft in the 40 years or older recreational athlete.

Revision ACL

For revision ACLR, 92% of members perform a single-bundle technique greater than 90% of the time. The most common graft choice for revision ACLR was BTB autograft (50%), followed by QT autograft with bone (17%) (figure 2). Additionally, 89% of respondents report that they believe there is a selective role for extra-articular augmentation during revision ACLR. There was no clear consensus on how frequently members use extra-articular augmentation during revision ACLR: 13% reported always, 26% often, 29% sometimes, 20% rarely and 12% never (figure 5).

Paediatric ACL

Most respondents (79%) agreed there is a role for delayed surgical treatment of ACL injuries in children. When asked about the graft of choice for primary ACLR in a 10-year-old, the most common answer was HT autograft (75%), followed by QT autograft without bone (11%). Several respondents noted that they do not treat paediatric patients in their practice. ACLR surgical technique used most commonly in a 10-year-old are as follows: 34% transphyseal on both, 23% partial transphyseal (femur all-epiphysial or over-the-top, tibia transphyseal), 19% all-epiphysial physeal-sparing fixation on the femur and tibia

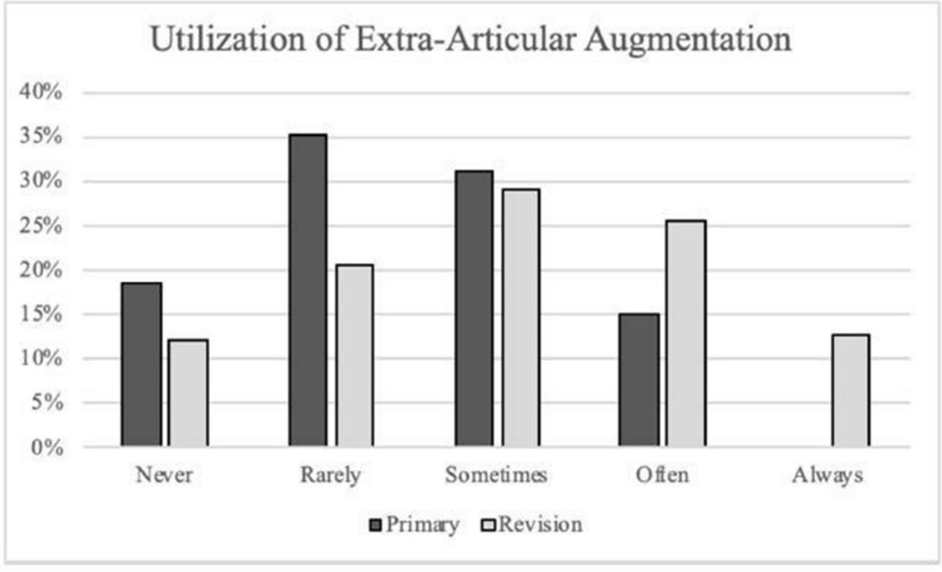

Figure 5 How often do you use extra-articular augmentation (ie, anterolateral reconstruction or lateral extra-articular tenodesis) during primary or revision ACLR? ACLR, anterior cruciate ligament reconstruction.

and 15% physeal-sparing over-the-top femur and tibia. The respondents were asked the same questions for a 13-year-old man. Most common graft choice remained hamstring autograft (72%). For surgical technique, transphyseal was again the most common choice (53%) followed by partial transphyseal (femur all-epiphysial or over-the-top, tibia transphyseal, 29%).

Postsurgery

Fifty-three per cent of respondents use a brace following primary ACLR. Regarding the initiation of a stationary bike after primary ACLR, 11% start under 2 weeks, 45% between 2 and 4 weeks postoperatively, 34% between 4 and 6 weeks and 10% at greater than 6 weeks. The majority of respondents (70%) do not initiate jogging until 3–5 months after primary ACLR. Timing for initiation of lateral movements and agility training are as follows: 5% initiate at 6 weeks to 3 months, 22% at 3–4 months, 49% at 4–6 months and 24% at greater than 6 months. Eighty-three per cent do not use a functional brace before initiating lateral movements. Determination of return-to-play is most commonly (71%) done using minimum time criteria and functional assessment. The most common responses for minimal time to return-to-play after primary ACLR were 6–8 months (44%) and 8–12 months (41%).

Meniscus tear

Preferred management of concomitant meniscus tears at the time of ACLR in a competitive athlete are as follows: all-inside meniscus repair for a 1.5 cm unstable red-white medial meniscus tear (56%); all-inside meniscus repair for a 1.5 cm unstable red-white lateral meniscus tear (67%); hybrid all-inside/inside-outside/outside-in meniscus repair (42%) versus all-inside meniscus repair (33%) of a red-red zone bucket-handle medial meniscus tear; hybrid all-inside/inside-out/outside-in meniscus repair (41%) versus all-inside meniscus repair (40%) of a red-red zone bucket-handle lateral meniscus tear.

When asked how often meniscus root tears are encountered in the setting of primary ACLR, 54% answered sometimes and 29% rarely. Transosseous root repair was the most commonly chosen technique (89%). The frequency of encountering meniscus ramp tears in the setting of primary ACLR is 50% sometimes and 38% rarely. Repair of meniscus ramp lesions using all-inside devices through the medial compartment (55%) is the most common treatment of choice when encountering a meniscus ramp tear in primary ACLR.

Ninety-two per cent of respondents agreed that medial and/or lateral meniscus deficiency plays an important role in failure of primary ACLR. Finally, the majority of respondents (59%) have not performed either a meniscus substitution (ie, collagen meniscus implant (CMI), Actifit) or meniscus allograft transplantation procedure in the past 2 years.

Concomitant procedures

Most members (82%) do not think that routine coronal plane alignment correction (ie, osteotomy) is important during primary ACLR. When asked how often they perform alignment correction during primary ACLR, 43% reported rarely and 46% never. However, most members (72%) think coronal plane alignment correction (ie, high-tibial osteotomy (HTO) or distal femoral osteotomy) is important during revision ACLR. In one example, the favoured approach in the setting of symptomatic moderate to severe medial arthritis, varus malalignment, and ACL insufficiency was simultaneous HTO plus ACLR (48%), followed by HTO alone (biplanar as indicated) (27%).

Most members (89%) agree that increased tibial slope plays an important role in the failure of primary ACLR. When asked if they have performed a slope decreasing tibial osteotomy in the past 2 years, 43% reported 'no', 39% 'yes' and 18% only as part of a biplanar HTO.

Ninety-one per cent of respondents agreed that unrecognised or untreated posteromedial/posterolateral corner laxity is a cause of failure in primary ACLR. Regarding returning an athlete to impact sports after combined cartilage restoration and ACLR procedures, 73% responded that they would. In terms of returning an athlete to impact sports after combined ACLR and meniscus transplant, 63% of respondents would not. Last, members were asked about their treatment of choice for a 16 mm (2 cm^2) grade IV cartilage defect of the femoral condyle identified during primary ACLR, and the results are as follows: 32% responded microfracture, 19% benign neglect and 14% osteochondral autograft transplantation/mosaicplasty.

Osteoarthritis

Sixty-five per cent of respondents believe ACLR reduces the risk of knee osteoarthritis. When asked what factors are the most important contributors to osteoarthritis following ACL injury and surgery (respondents were able to select up to two options), the two most common responses were status of the menisci (86%) and status of the cartilage (66%) at the time of ACLR. Finally, respondents reported how often they use biologics (ie, PRP, BMAC) in the office setting following ACLR; a majority reported never (68%) and 25% rarely.

DISCUSSION

In this manuscript, we present the thoughts and preferences of the ACL SG on the management of ACL injuries. There are numerous precipitating factors and subsequent decisions that go into the management of ACL tears, including the preoperative diagnosis and initial treatment, graft choice, tunnel position, method of fixation, concomitant procedures and postoperative rehabilitation and return to activities. This survey set out to gauge current opinions and trends among an international group of world experts who routinely perform high volume ACLR.

While the timing of ACLR after initial injury is an important and often debated factor, the majority of respondents in the ACL SG pointed towards approaching each case individually, taking into account the patient's range of motion, presence of an effusion, pain and gait instead of having a specific timeline, while approximately one-third of respondents specified that they prefer to operate within 6 weeks. Previous studies have demonstrated better outcomes with less complications and no significant increase in postoperative stiffness with earlier ACLR.[18–20] Anderson *et al* reported a higher rate of secondary meniscal and chondral injuries with delayed ACLR in children and adolescents.[18] Similarly, Brambilla *et al* found that the risk of cartilage and medial meniscus injuries increase an average of 0.6% with each month that ACLR is delayed.[19]

A vast majority of respondents stated that there is potentially a role for non-operative management of an ACL tear in lower impact athletes (Tegner 3–5), while over half stated that non-operative management may have a role in the treatment of moderate level athletes (Tegner 6–7). The literature addressing the natural history of an ACL deficient knee has demonstrated higher rates of arthritis, meniscus tears and progression to knee arthroplasty in knees with an ACL tear compared with both healthy controls and to patients who underwent ACLR.[21 22] Hence, it is important to note that the survey question in the

present study specifically asks if there a role for non-operative treatment in these patients and not if the respondent would necessarily treat patients in these categories non-operatively.

In both primary and revision ACLR, graft choice is one of the most important shared-decisions made by the surgeon and patient. The preferred graft of choice of the ACL SG differs slightly between primary and revision cases but both heavily favour autograft and nearly all prefer autograft for primary ACLR. While more than half of the respondents prefer HT autograft in primary ACLR, less than 10% chose HT autograft for a revision case. Greater than 85% of respondents chose some type of autograft in revision cases, with autograft with bone, including BTB autograft and QT autograft with bone, as the most common graft choices. This trend coincides with what is reported in the literature, as autograft demonstrates better patient-reported outcomes and a lower failure rate in both primary and revision ACLR, thus leading to the more common utilisation of autograft in ACLR, especially in young, active patients.[23–26]

Questions regarding tunnel position and fixation methods showed that 90% of respondents prefer the single-bundle technique, 88% favour positioning their femoral tunnel either centrally or shifting towards the AM bundle and 50% prefer cortical suspensory fixation on the femur. Both single-bundle and double-bundle ACLR have demonstrated positive clinical outcomes in the literature, with some studies suggesting lower retear rates and reduced laxity using the double-bundle technique.[27–30] Correct tunnel placement both on the tibia and femur are paramount to a successful stable knee after ACLR. Previous studies on single-bundle ACLR have demonstrated translational and rotational control restored closer to that of the native ACL when the femoral tunnel is drilled centrally or towards the AM bundle,[31–34] which were favoured in our survey. However, it is important to mention that there is often disagreement among surgeons on the exact location of the central footprint and AM and PL bundles.

The ACL SG reports supplementing ACLR with extra-articular augmentation more commonly in revision cases, with nearly 13% stating that they always perform extra-articular augmentation for revision ACLR. For many surgeons, extra-articular augmentation has a role in primary ACLR in specific patient populations. The addition of extra-articular augmentation at the time of index ACLR may reduce laxity and pivot shift without an accelerated development of arthritis, although it does not reliably lead to significant improvements in clinical outcomes or decreased ACL rerupture rates.[35–40] The ACL and ITB provide the primary restraints to internal tibial rotation; thus, lateral extra-articular tenodesis (LET) may decrease rotational laxity of the knee.[41–44] Therefore, in some cases of high-grade rotatory laxity of the knee, the members of the ACL SG may use LET.

Interestingly, most members (82%) stated that they do not believe routine coronal plane alignment correction is important in primary ACLR, while 72% believe correcting coronal plane malalignment is important in revision ACLR. Additionally, most members (89%) agree that tibial slope plays an important role in the failure of primary ACLR, although 43% reported they had not performed an osteotomy to address tibial slope in the past 2 years.

Finally with regard to return to sport, nearly three quarters of respondents stated they would allow a patient who underwent combined ACLR and cartilage restoration procedure return to sport. Cartilage restoration procedures in general have demonstrated high rates of return to sport in the literature.[45–48] Conversely, while the literature suggests a high rate of return to play after meniscus allograft transplantation,[49–51] 63% of respondents in our study would not recommend a patient return to sport after ACLR and meniscus transplant. Despite the high rate of return to play in patients after meniscus allograft transplantation in general, several authors recommend exercising caution regarding return to sports after meniscus allograft transplant, especially higher-impact activities.[52 53]

This study reflects the thoughts and preferences of the ACL SG and thus is not necessarily a reflection of the orthopaedic surgery community at large, which is a clear limitation of this study. However, the ACL SG is an international group of accomplished surgeons that are focused on furthering the field of knee surgery in order to improve on and optimise ACL reconstructive surgery.

CONCLUSION

This study presented the thoughts and preferences of the ACL SG on the management of ACL injuries. The results of this survey provide an important insight into the management of ACL injuries with evidence-based support from the current orthopaedic surgery literature. The results of this study should facilitate an ongoing discussion with regard to ACLR by providing global insights into the current surgical trends in ACLR.

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Contributors The manuscript has been read and approved by all authors. Each author believes that this manuscript represents honest work and conveys an important message. Regarding individual contributions, the majority of the manuscript was written by SLS, JC, TR and MPA. All authors were involved in study design. RAM, TR, VM, CCK, MC and JAB were involved in initial and final manuscript editing.

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