Short graft anterior cruciate ligament reconstruction: Current concepts

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ABSTRACT

Short graft anterior cruciate ligament reconstruction is increasing in popularity for performing a primary ACLR. The short graft coupled with the all-inside technique using closed sockets and suspensory fixation at both femoral and tibial ends are its defining features. The outcomes of this technique have been comparable to well-established transportal ACLR techniques. It has the benefits of preserved hamstring strength and less pain attributed to transtibial drilling. However, there is a learning curve involved and will require time before mastery of the technique. Furthermore, in combined osteotomy or multiligament surgery, the use of short graft anterior cruciate ligament reconstruction with sockets preserve bone stock and the single tendon harvest spares the other tendons for use in other ligament reconstruction.

Current concepts

- Short graft anterior cruciate ligament reconstruction (ACLR) is increasingly popular, with more surgeons practising all-inside ACLR techniques.
- The outcomes of short graft ACLR thus far are comparable to the transportal ACLR reconstruction technique, but with additional benefits.
- The technique can be performed with soft tissue grafts only.
- The familiarity with the surgical technique, understanding of optimal graft fixation and biology are all paramount to success.

Future perspectives

- Prospective clinical studies are required to determine which patient is best suited for short graft anterior cruciate ligament reconstruction and the ideal graft source.
- Biomechanical and clinical data are required on the most appropriate short graft to be used with this technique.
- Methods to improve healing of osseous graft interface with the use of biologics or scaffolds should be studied.
- The most time and cost-efficient as well strongest graft short graft anterior cruciate ligament reconstruction preparation technique should be determined to allow reproducibility amongst surgeons.

Introduction

The short graft anterior cruciate ligament reconstruction (SG ACLR), as the name implies, is the use of a shorter graft length to perform an ACLR. Hence, there will be less graft length passed in both the femur and tibia tunnels. The proposed benefit is a larger ACL graft diameter with the same graft tissue and isolated harvest of the semitendinosus tendon. Now, the use of all soft tissue quadriceps tendon (QT) graft has also been increasingly suggested. With the sparing of the gracilis tendon, there is less pain and donor site morbidity and better knee flexion strength compared to when both hamstring tendons are harvested.

The all-inside ACLR (AI ACLR) is the most performed SG ACLR technique. This technique involves the unique preparation method of a short graft, the use of femoral or tibia sockets instead of complete tunnels and the use of cortical suspensory fixation at both ends. Other SG ACLR options include the more recent Tape Locking Screw (TLS) technique. The TLS technique is more challenging due to the need for precise determination of tunnel length and graft length which will affect the tension in the graft after reconstruction. Pacull et al. has also shown the TLS fixation has lower ultimate load to failure than other femoral fixation options.

Most authors describe the use of a quadrupled semitendinosus (ST4) or QT in the SG ACLR. This review looks at the current state of SGACL.
ACL to discuss the biology, biomechanics, surgical techniques and outcomes of this technique.

**Body**

**Classic technique**

The classical AI ACLR technique was described by Lubowitz, Amhad and Anderson [10]. They described a ST4 graft with both ends looped over two adjustable loop cortical suspension devices for the femoral and tibial sockets. High strength ultra-high molecular weight polyethylene sutures are used during special graft preparation. The graft diameter is sized and then marked to the lengths of the tibial and femoral sockets (usually 20–25 mm) for guiding the surgeon during graft passage.

The femoral and tibial sockets are prepared independently. The femoral tunnel is reamed in an either an anterograde or retrograde fashion to create a socket, usually between 20 and 25 mm [10]. The tibial socket is created using a retrograde reamer. The prepared graft is shuttled into the knee joint through the anteromedial portal with the proximal sutures entering the femoral socket initially. After the cortical suspensory device engages on the lateral femoral cortex, the graft is then advanced into the femoral socket. This process is then repeated on the tibial side. Finally, the graft is tensioned with the knee in near full extension. Several tips and technical considerations that should be taken into account when performing the SG ACLR are shown in Table 1.

**Discussion**

**SG ACLR graft choice**

The ST4 is the most used autograft for SG ACLR [9,11,12]. Females generally have smaller hamstring tendons than their male counterparts [1]. ACL graft diameter has also been found to be critical. A graft of smaller than 8 mm leads to poorer outcomes and increased risk of graft rupture, especially in young athletes [2]. ST4 grafts have an approximate diameter of 8–9.5 mm [6,13], compared to about of 7.2–8.5 mm in a four-strand hamstring graft [13]. Additionally, ST4 SG ACLR also allows for the sparing of the gracilis tendon, which leads to the improved recovery of knee flexion strength and less donor site morbidity [6,7]. Koulomenas et al. [6] and Monaco et al. [7] both reported better knee flexion strength with the AI ACLR reconstruction than the standard ACL reconstruction.

The choice of ACL graft should be tailored to each individual patient, such as their sporting demand, gender or the presence of ligamentous laxity. There is now an increasing use of the QT as the graft of choice for ACL reconstruction. The ACL registry data from New Zealand show a rise in the use QT grafts since 2019 but they still account for only 6.5% of all primary ACL reconstructions [14]. The advantages of the QT graft include consistently sufficient length compatible with SG ACLR. It often has a wide diameter of 10 mm [15,16] and can be harvested with or without a bone plug [16]. The reported problems with QT harvest include weakness of knee extension, donor site pain and patella fractures [16].

The QT can be prepared via a proprietary Graft Link technique using cortical suspensory buttons [15]. Galan et al. [17] found good to excellent results at 5 years with QT graft AI ACLR in young athletes. The QT graft is considered an option especially in the female athlete, with increased ligamentous laxity and smaller hamstring tendons [1]. It exhibits less post-operative pivot shift laxity and can be harvested with reliable dimensions [16]. Traditionally, bone patella tendon bone (BPTB) grafts have been considered as the gold standard in ACL reconstruction [6]. Recent literature comparing QT to BPTB grafts has shown that QT grafts have similar properties to BPTB, but with better ultimate load to failure rates and less anterior knee pain [17,18].

The peroneus longus (PL) tendon has also been considered as an alternative to the hamstring graft for AIACL [19]. Heetal. [19] in their meta-analysis comparing AIACL using PL grafts versus hamstring grafts reported donor site morbidity with the use of PL grafts, with a decrease in American Orthopaedic Foot and Ankle Scores (AOFAS). More studies are required before PL grafts can be considered a regular graft option in the SG ACLR.

**Graft preparation**

The SG ACLR technique demands a unique method of preparation. These grafts are recommended to be a maximum length of 70–75 mm after tensioning [10], for fear of bottoming out and the grafts becoming slack when sockets are used. The popular methods of graft preparation include the buried-knot method described by Lubowitz [20] and the continuous loop method [21] as seen in Fig. 1. Others have also described alternative methods, for example the Sommerfeldt configuration [22] and the Quad Link technique [15].

The buried-knot method has consistently shown in biomechanical studies to be able to withstand sufficient forces in the post-surgery ACL period [23], with an ultimate failure load range of 908 N [24]. Biomechanical studies have shown that the mode of failure with SG ACLR sutured constructs to mostly be at the cortical suspensory fixation loop [21,25,26]. Richardson et al. [26] reported majority of failures at the button loop with the buried-knot technique. This demonstrates the adequate strength of the graft/button implant construct strength via the buried-knot method.

The considerations for optimal SG ACLR graft preparation are:

1) choice of a strong graft preparation method such as the buried-knot method, which has greater ultimate failure loads and less elongation as compared to the continuous loop method [21];
2) secure fixation at the terminal ends of the graft to improve ultimate failure loads, stiffness and elongation [22,27];
3) use of 4 instead of 2 cerclage sutures to around the graft at the tibial and femoral ends which protects against graft elongation [25];
4) use of a larger suture diameter for graft preparation is recommended to gain better load to failure rates; a Fibrewire No 2 had a mean load to failure of 731 N versus a load to failure of 610 N using Fibrewire No 0 [28];
5) consideration for graft augmentation with suture or suture tapes, to achieve load sharing, better ultimate failure loads and to protect from graft elongation [29].

Grafts fashioned from the use of two separate tendons such as the semitendinosus and gracilis do not fare better than the methods of QT4 graft preparation. However, the use of two separate tendons can be considered if there is insufficient final graft length or diameter, such as due to accidental graft transection during harvesting. Wichern et al. [24] and Richardson et al. [26] have demonstrated increased displacement and lower mean ultimate failure loads with different tendon preparation methods for two tendons, in both the four-strand and six-strand constructs.

**Graft length, size and healing**

There are various studies performed to determine a minimum graft length in both the femoral and tibial ACL tunnel. Zanto et al. [30] using goat tendons showed no differences between 15 mm and 25 mm grafts in the femoral tunnel at 12 weeks with regards to stiffness and ultimate

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**Table 1**

Tips when performing a SG ACLR.

<table>
<thead>
<tr>
<th>Tip</th>
<th>Details</th>
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<tr>
<td>If a graft diameter of less than 8.5 mm or a graft length less than 25 mm is obtained after harvesting only the semitendinous tendon, consider harvesting the gracilis tendon as well. Measure the graft length accurately. Add 5 mm when reaming femoral and tibial tunnel socket lengths to avoid bottoming out of the graft, leading to a lax graft. Leave a small amount of muscle on the graft during graft preparation for better healing as it has been shown to contain pluripotent cells. Use outside-in femoral drilling in adolescent anterior cruciate ligament reconstruction to avoid physes damage.</td>
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failure loads. Yang et al. [31] have showed an intraosseous tibial tunnel graft length of 20 mm in a porcine model (compared to 40 mm) had no significant differences in graft slippage or graft movement. They recommended a 20 mm intraosseous graft length to be sufficient for rehabilitation after ACL reconstruction.

The healing and integration of an ACL soft tissue graft depends on the formation of Sharpey fibres, signalling incorporation. These fibres are found closer to the joint [13,30], suggesting that perhaps an increased graft in tunnel length does not aid significantly in graft healing. Short grafts should therefore not be biomechanically inferior to conventional ACL reconstruction methods. A widely accepted guideline is a minimum socket length of 20 mm.

The MOON cohort compared patients with between femoral tunnel grafts lengths more than 25 mm versus patients with between femoral tunnel grafts lengths less than 25 mm [32]; reported that there were no differences in the follow-up KOOS and IKDC scores. Gupta et al. [33] in a recent study revealed no differences between clinical and radiological outcomes for patients with grafts more than 20 mm in the tunnel and patients with grafts less than 20 mm in the tunnel. Moon et al. [34] compared 3 patient cohorts based on the length of graft in the tunnel: less than 15 mm, 15–20 mm and more than 20 mm. They found no significant differences in post-surgery knee laxity, VAS scores, Lysholm and IKDC scores.

Tunnel preparation–femur

In AI ACLR, the femoral tunnel is prepared independently from the tibia; it can be reamed through the anteromedial portal or via outside-in drilling. The additional benefit of drilling the femoral tunnel outside-in is that it can be reamed without the need for knee hyperflexion, therefore requiring less assistance for the surgeon during surgery.

On the tibia side in AI ACLR, the sockets are usually prepared using a retrograde reaming technique [20]. Various companies have retrograde reamers to perform sockets preparation. These retrograde reamers require a learning curve [35] to familiarise and also add additional cost to the ACL surgery. In addition, when a socket is reamed on the tibia side, the graft passage will have to be through the arthroscopic portals, rather than the usual passage from the tibia side externally.

Alternatively, in a variation of the classical technique, even with the use of short grafts, a full tibial tunnel has been proposed. This allows the graft to be passed as usual from the tibia side externally. Comparing the AI ACLR and this technique with complete tibia tunnels, Lubowitz, Schwartzberg and Smith [3] as well as Desai et al. [35] have shown excellent physical examination findings and outcomes at 2 years follow-up, with no significant differences in the clinical outcomes of both groups.
Table 2
Studies of the all-inside technique.

<table>
<thead>
<tr>
<th>Author</th>
<th>Journal</th>
<th>Year</th>
<th>Number of patients</th>
<th>Mean age (range if any), years</th>
<th>Follow up (range), months</th>
<th>Graft and techniques</th>
<th>Complications</th>
<th>Post-operative clinical results</th>
<th>Comments</th>
</tr>
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<tbody>
<tr>
<td>Lubowitz et al. [3]</td>
<td>Arthroscopy</td>
<td>2013</td>
<td>148</td>
<td>AI: 39.3 Standard: 41.1</td>
<td>24</td>
<td>AI: 2-strand tibialis tendon autograft Standard: 2-strand tibialis tendon autograft</td>
<td>Nil</td>
<td>Standard</td>
<td>No significant difference between both groups in IKDC, KSS, SF-12 scores, femoral and tibial widening, or narcotics consumption.</td>
</tr>
<tr>
<td>Schurz et al. [4]</td>
<td>Arthroscopy</td>
<td>2016</td>
<td>79 Male 53 Female 26</td>
<td>29 (18–54) (24.3–44.8)</td>
<td>30.4</td>
<td>Quadrupled ST AI Deep infection – 2 Numbness – 9</td>
<td>Nil</td>
<td>Standard</td>
<td>Significant improvements in IKDC, Lysholm, Tegner and VAS scores compared to baseline, p &lt; 0.0001 12.7% ACL graft ruptures</td>
</tr>
<tr>
<td>Yansen et al. [11]</td>
<td>The Knee</td>
<td>2016</td>
<td>108 Male 81 Female 27</td>
<td>30.9 (15–61) 49.8 (30–66)</td>
<td>12.7% ACL graft ruptures</td>
<td>Quadrupled ST AI Superficial infection – 1 Superficial haemarthrosis – 1</td>
<td>Nil</td>
<td>Standard</td>
<td>No significant differences between both groups in IKDC, Lysholm, Tegner and VAS scores.</td>
</tr>
<tr>
<td>Baldassarri et al. [42]</td>
<td>Muscles, Ligaments and Tendons Journal</td>
<td>2018</td>
<td>40</td>
<td>AI: 38.4 Standard: 32.6</td>
<td>24</td>
<td>AI: doubled or tripled ST tendon autograft Standard: ST&amp;G</td>
<td>Nil</td>
<td>Standard</td>
<td>No significant differences between both groups in IKDC, Lysholm, Tegner and VAS scores.</td>
</tr>
<tr>
<td>Monaco et al. [43]</td>
<td>KSSTA</td>
<td>2018</td>
<td>44</td>
<td>AI: 32.5 Standard: 31.7</td>
<td>24 (21–27)</td>
<td>AI: quadrupled ST tendon autograft Standard: doubled ST&amp;G</td>
<td>Nil</td>
<td>Standard</td>
<td>No significant differences between both groups in IKDC, Lysholm, Tegner and KT-1000 side-to-side. Significantly larger increase in tibial tunnel widening in the standard technique.</td>
</tr>
<tr>
<td>Colombet et al. [44]</td>
<td>The Orthopaedic Journal of Sports Medicine</td>
<td>2018</td>
<td>97 Male – 64, Female – 33</td>
<td>30.9 (14.8–56.1)</td>
<td>24</td>
<td>Quadrupled ST AI</td>
<td>Nil</td>
<td>Standard</td>
<td>No significant differences between both groups in IKDC, Lysholm, Tegner and KT-1000 side-to-side. Significantly larger increase in tibial tunnel widening in the standard technique.</td>
</tr>
<tr>
<td>Kouloumentas et al. [6]</td>
<td>European Journal of Orthopaedic Surgery &amp; Traumatology</td>
<td>2019</td>
<td>90</td>
<td>AI: 27.6 Standard: 29.7</td>
<td>24</td>
<td>AI: quadrupled ST tendon autograft Standard: 4-strand ST&amp;G</td>
<td>Nil</td>
<td>Standard</td>
<td>No significant differences between both groups in IKDC, Lysholm, Tegner and VAS scores.</td>
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<th>Complications</th>
<th>Post-operative clinical results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayr et al. [45]</td>
<td>KSSTA 2020</td>
<td>30</td>
<td>25</td>
<td>24</td>
<td>AI: quadrupled ST tendon autograft Standard: 4-strand ST &amp; G</td>
<td>AI: intraoperative button mislocation and button loop rupture, septic arthritis, 3 early ruptures Standard: intraoperative screw breakage</td>
<td>Standard: Lysholm 94 IKDC subjective 88 Tegner 6 KT-1000 2.9 mm Single leg hop 97</td>
<td>No significant differences in IKDC, Tegner, Lysholm scores and KT-1000 measurements between both groups. Significantly larger tunnel widening in standard group with screw fixation</td>
</tr>
<tr>
<td>Roger et al. [46]</td>
<td>KSSTA 2020</td>
<td>60</td>
<td>30.5</td>
<td>24</td>
<td>AI: quadrupled ST tendon autograft Standard: 4-strand ST &amp; G</td>
<td>Cyclops lesion requiring revision AI group (3%), STG group (3.7%)</td>
<td>Standard: IKDC subjective 80.2 Standard: IKDC subjective 83.6</td>
<td>No statistically significant differences between AI and full tunnel groups for subjective IKDC score, laxity, morbidity, hamstring strength recovery or knee flexion. Less tourniquet time in AI group (p &lt; 0.001). Low complication rate of 5.15% no significant anterior knee pain</td>
</tr>
<tr>
<td>Galan et al. [17]</td>
<td>Journal of Experimental Orthopaedics 2020</td>
<td>291 Male – 64, Female – 33</td>
<td>23.2 (17–42)</td>
<td>60</td>
<td>QT with bone block Harvest site pain – 3 Patellofemoral syndrome-type pain – 12 Intraoperative patella fractures – 2 Postoperative infection – 1 Haematoma – 5</td>
<td>Lysholm 91 IKDC A 174 (59.79%), B 102 (35.4%), C 14 (4.61%), Tegner 6 – 8 KT-1000 1 mm</td>
<td>No statistically significant differences in IKDC and Lysholm scores between both groups in terms of side-to-side difference in laxity, IKDC, KOOS, Marx, SF-12 mental and physical and return to preoperative sporting level. Standard group had higher post operative pain on post operative day 2, 3 and 7.</td>
<td></td>
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<tr>
<td>Smith et al. [18]</td>
<td>Arthroscopy 2020</td>
<td>64</td>
<td>17.7 (13–24)</td>
<td>24</td>
<td>AI: quadrupled ST tendon autograft Standard: BPTB graft</td>
<td>AI: Graft failure – 2 Standard: Removal of tibia iscrew</td>
<td>AI IKDC subjective 94.8 KOOS function 92.5 KOOS Qol 83.3 KOOS symptoms 89.7 KT-1000 0.3 mm Marx 13.3 SF-12 physical 55.5 SF-12 mental 58.0</td>
<td>No statistically significant between both groups in terms of side-to-side difference in laxity, IKDC, KOOS, Marx, SF-12 mental and physical and return to preoperative sporting level. Standard group had higher post operative pain on post operative day 2, 3 and 7.</td>
</tr>
<tr>
<td>Desai et al. [35]</td>
<td>The Orthopaedic Journal of Sports Medicine 2021</td>
<td>136 Male – 82, Female – 54</td>
<td>25.8 (21.1)</td>
<td>24</td>
<td>AI: ST&amp;G tendons or ST only Standard: ST&amp;G tendons or ST only</td>
<td>AI: 1 infection, 1 arthrofibrosis, 3 revision meniscal surgery, 2 chondral defects Standard: 1 arthrofibrosis, 2 revision meniscal surgery</td>
<td>AI Lysholm 93.8 IKDC 93.5 Tegner 6.4 AI Lysholm 94.4 IKDC 93.3 Tegner 6.8</td>
<td>No significant differences in IKDC and Lysholm scores between both groups. Longer return to sport in AI group as compared to standard group. AI: 9.8% ACL reconstruction failure Standard: 18.5% ACL reconstruction failure</td>
</tr>
<tr>
<td>Kyriakopoulos et al. [5]</td>
<td>Cureus 2021</td>
<td>44</td>
<td>27.5 (26.6)</td>
<td>36</td>
<td>AI: ST Standard: ST &amp; G</td>
<td>AI: postoperative haematoma requiring surgery</td>
<td>AI Lysholm 87 KT-1000 1.92 mm Standard: Lysholm 86.1 KT-1000 2.41 mm</td>
<td>Statistically significant improvements in Lysholm scores in both groups AI group had statistically significant lower VAS scores in early postoperative period at 2 weeks. No graft failures in either group, Statistically significant improvement in Tegner activity score in the AI group</td>
</tr>
<tr>
<td>Kulhrestha et al. [47]</td>
<td>European Journal of Orthopaedic Surgery &amp; Medicine</td>
<td>80 Male – 40, Female – 40</td>
<td>30</td>
<td>24</td>
<td>AI: quadrupled ST &amp; G</td>
<td>AI: Superficial infection – 1 Laxity ≤ 5 mm – 3</td>
<td>AI Tegner 5.9 KSS objective AI Tegner 5.3 KSS objective 65.3</td>
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<th>Complications</th>
<th>Post-operative clinical results</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Pautasso et al.   | European Journal of Orthopaedic Surgery & Traumatology 2021 | 157 | 23.4 (16–30) | AI: 36.5 | AI: quadrupled ST | Nil | KSS symptoms 13.6, KSS satisfaction 31.5, KSS expectation 1.3, KSS function 83.9 | Statistically significant improvement in preoperative and postoperative Lysholm, KOOS, Tegner scores in all 3 surgical techniques. No statistical difference in KT-1000 values, postoperative Tegner, Lysholm and KOOS scores between both knees for all 3 surgical techniques. Significantly longer surgery duration (p < 0.001) in AI technique as compared to the other 2.
| Lowenstein et al. [12] | Arthroscopy 2021 | 100 Male – 38 Female – 62 | 31.3 (14–58) | 24 | Quad autograft (54%) or allograft (46%) | Nil | VAS pain 1.07, Marx scale 8.75, KOOS pain 89.03, KOOS symptoms 80.79, KOOS ADL 95.4, KOOS sports 81.25, KOOS quality of life 71.56, WOMAC pain 92.65, WOMAC stiffness 84.13, WOMAC function 95.4 | Patients who had autograft had better Marx activity scores, KOOS Sport and KOOS ADL scores. No significant differences in outcomes scores of males and females. Better Marx scores in males at 1 year, and greater KOOS ADL scores in females at 1 year.
| Greif et al. [49] | Arthroscopy 2022 | 124 | 28.3 | 28.3 | All soft tissue QT autograft | Suspensory fixation: 27.74 Interference screw fixation: 31.29 | Suspensory fixation: 4 arthrofibrosis, 1 button removal due to infection, 7 anterior knee/kneeling pain | 3 graft failures in interference screw fixation. 1 graft failure in suspensory fixation. No significant difference in anterior knee/kneeling pain (p > 0.22). Significantly better Lysholm scores in suspensory fixation group (p = 0.04).
| Goyal et al. [2] | European Journal of Orthopaedic Surgery & Traumatology 2022 | 80 | 28.3 | 28.3 | All quadrupled ST | Nil | VAS 0.1, Quad power 40.9bs, HS power 25.8bs | Lower VAS score in the AI group at the 2 and 6 weeks follow up mark. No significant differences in Tegner, IKDC and Lysholm scores between both groups. No significant differences in quadriceps power (significant difference in HS power (p < 0.002) between both groups. |


* Median values.
Fixation devices

Graft fixation is important for the success of ACL reconstruction. With the use of sockets in SG ACLR, cortical suspensory devices have become the choice of fixation for short grafts. The benefits of using cortical suspension fixation in ACL reconstruction are the high load to failure strength of cortical fixation and less risk of graft fixation compared to interference screw fixation [36]. A randomised controlled trial by Lubowitz et al. [37] compared suspensory cortical fixation to aperture screw fixation and found no significant differences in knee anteroposterior stability or other outcomes. A recent meta-analysis by Fu et al. [38] comparing cortical suspension fixation in short grafts to aperture fixation also showed no significant differences between knee outcome scores in both groups.

Adjustable loop cortical suspension devices are the mainstay of SG ACLR technique. They enable further tightening after insertion to achieve maximum amount of graft in tunnel and do not require precise calculations prior to tunnel reaming. However, there are concerns with regards to lengthening of the adjustable loop devices, with differences observed with cyclic displacement between fixed and adjustable loop ACL fixation devices [23,39]. Barrow et al. [23] reported that adjustable length fixation devices experienced a clinically significant increase in loop lengthening during cyclic testing, caused by suture slippage into the adjustable length loop. Noonan et al. [39] proposed that re-tensioning and knot tying after initial reduction of the tendon graft with an adjustable loop fixation device may help to reduce loop slippage and displacement. These concerns in biomechanical studies are, however, not translated in clinical studies. Boyle et al. [40] showed no significant differences in short-term knee stability and graft failure rates between adjustable and fixed loop femoral cortical suspension in their study of 188 ACL reconstruction patients.

Outcomes

The results of SG ACLR have consistently shown similar outcomes compared to standard techniques with no significant differences across various papers, summarised in Table 2. There is a total of 19 studies included, with multiple high-quality studies comparing different techniques of ACL reconstruction [2] [6,11,12,17,18,35,41] – [49]. A total of 1812 patients were included in the studies. All the studies have shown a significant improvement in outcome scores with SG ACLR compared to the baseline. Graft ruptures ranged across different studies from 2.1% to 12.7% in the SG ACLR technique (Table 2). SG ACLR can be considered as a good, viable alternative to the standard technique.

Lowenstein et al. [12] reported that anatomic ST4 AI ACLR had improved functional outcomes at 1 and 2 years post-operatively and is comparable in both male and female patients alike. Smith et al. [18] showed that ST4 AI ACLR had equivalent KT-1000 stability testing when compared to gold standard BPTB ACL reconstruction in young athletes. Both groups had similar retear rates. Comparing different graft choices in SG ACLR, Galan et al. [17] achieved similar IKDC outcomes with the QT graft as the ST4 AI ACLR group shown by Volpi [41] et al. Galan et al. achieved 59.79% IKDC A, 35.4% IKDC B and 4.81% IKDC C, whereas Volpi et al. obtained scores of 55%, 40%, and 5%, respectively, in their cohort. Greif et al. [49] also had good outcomes in their experience with QT grafts in terms of IKDC scores and low rates of graft failure.

Benefits

Studies have shown that the AI technique is associated with less pain when compared to standard techniques [2,3,5,6,9]. This has been postulated to be due to less bone loss with tibial sockets and less tibial periosteal irritation [9]. This allows for earlier rehabilitation and faster recovery as well. The benefit of SG ACLR with ST4 with the preservation of the gracilis or QT, leads to improved recovery of knee flexion strength [6,7]. This is ideal in female athletes, as it may be difficult to reliably obtain a graft of the required diameter for ACLR.


