European Journal of Orthopaedic Surgery & Traumatology (2019) 29:1481–1484
https://doi.org/10.1007/s00590-019-02467-7

ORIGINAL ARTICLE • KNEE - LIGAMENTS

Chronic anterior cruciate ligament insufficiency results in inferior quality hamstring autografts

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Received: 20 February 2019 / Accepted: 6 June 2019 / Published online: 8 June 2019

Abstract

Background Availability of a good quality autograft of adequate length is the first step towards a successful knee ligament reconstruction. Being able to predict the quality and length of hamstring autograft can go a long way in making the surgeon's pre-operative planning a lot easier. The purpose of this study was to find out if any correlation existed between the duration of ACL injury with history of repeated instability episodes and the quality and length of Hamstring graft that was harvested.

Methods Forty consecutive patients who underwent ACL reconstruction using quadrupled Hamstring tendon graft were evaluated with regard to the duration of injury, number of instability episodes and graft characteristics like difficulty in harvesting the graft, quality and length of the graft.

Results We found a statistically significant difference between the usable length of harvested Hamstring tendon in patients with acute and chronic injury ($p = 0.004$). There was a significantly high risk of the graft being shorter and of poor quality in patients with chronic injury (odds ratio = 5.7).

Conclusion Chronicity of ACL injury with repeated strains can cause fibrosis at the musculotendinous junction and result in harvest of a poor quality and short hamstring autograft. A detailed history with regard to duration of injury and repeated instability episodes will help a surgeon plan better when anticipating a sub-optimal graft.

Keywords Hamstring · ACL · Instability

Introduction

Hamstring tendon autografts have become an essential part of the armamentarium of surgeons involved in routine as well as complex knee ligament reconstruction surgeries [1]. The importance of harvesting good quality Hamstring autograft of adequate length for better results in ACL reconstructions cannot be over-emphasized. However, the quality of Hamstring autograft is affected by multiple factors and it is vital to be aware of these factors so that arrangements can be made for alternative grafts or fixation devices if the surgeon anticipates poor quality Hamstring autograft. This study was conducted to find out if the duration of ACL injury and a history of repeated instability episodes have any significant influence on the quality and length of the Hamstring graft that is harvested.

Materials and methods

This observational study was conducted during the period October 2017 to August 2018 at the Department of Orthopaedics, Father Muller Medical College Hospital, India. Forty consecutive patients who underwent ACL reconstruction were included in the study with their informed consent. A detailed history with regard to the duration of injury and recurrent instability episodes was recorded for all the patients. Only the instability episodes causing pain in the hamstring region were considered significant and included in the history. All the patients underwent arthroscopic ACL reconstruction using quadrupled hamstring tendon graft. All the surgeries were performed by the same surgeon who was blinded to the history of the patients with regard to the number of instability episodes.

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Fig. 1 Depicts a graft harvested from a case of acute ACL injury having adequate thickness and length with smooth end

Fig. 2 Depicts a graft harvested from a chronic ACL injured knee. The proximal end is ragged resulting in a shorter and thinner usable graft

Fig. 3 Depicts a graft harvested from a patient with chronic ACL deficiency and multiple instability episodes resulting in an unusable inferior quality graft

The semitendinosus tendon was harvested in all the patients using the same standard surgical technique with a closed tendon stripper. The tendon was exposed by splitting the Sartorius fascia. The distal end of the tendon was incised and passed through a double suture loop. After carefully dividing the extra-tendinous tethers, a closed tendon stripper was passed over the tendon and advanced proximally. The surgeon made an assessment of difficulty in advancing the tendon stripper beyond the myotendinous junction. Once the tendon was harvested it was assessed with regard to the quality of the proximal end and the total length. The proximal end was classified as smooth or ragged (Figs. 1, 2 and 3). Based on surgeon's experience, the length of usable tendon was measured and its percentage in relation to the total length was calculated.

Analysis

Statistical analysis was performed using SPSS 23 for Windows 10 using χ^2 test and t tests. A p value of <0.005 was taken as being statistically significant. Results are presented as means and confidence intervals.

Table 1 Mean percentage of usable tendon harvested in the acute and chronic instability groups ($p<0.005$)

Duration	*N*	Mean	SD	*t* Test value
Usable percentage				
> 3 months	23	89.1304	5.49632	0.004
< 3 months	17	93.8824	3.83866	HS

This is highly significant

Table 2 Signifies the risk of harvesting a shorter graft in chronic ACL deficient knee

	Value	95% Confidence interval	
		Lower	Upper
Odds ratio for amputation site (smooth/ragged)	5.7	1.06	31.20

Results

The study involved forty patients with mean age of 30.83 ± 7.30 years (range 18–44 years). The group consisted of thirty-one males and nine females. The mean duration of injury prior to surgery was 142.2 ± 115.8 days (range 21–365 days). Twenty-three patients were classified as having chronic injury (duration > 3 months) and 17 as having acute injury (duration < 3 months). All the patients with chronic injury reported having multiple significant instability episodes. Only five patients from the acute injury group had these instability episodes.

Thirteen patients in the chronic injury group the surgeon reported difficulty in advancing the tendon stripper beyond the musculotendinous junction, whereas this problem was not encountered in any of the patient belonging to the acute group. The mean total length of the harvested Hamstring tendon was 28.18 ± 2.8 cm (range 22–33 cm). In ten out of twenty-three patients with chronic injury, the proximal end of the harvested tendon was classified as ragged as against only two out of seventeen patients with acute injury ($p = 0.003$, χ^2 test). The mean percentage of usable tendon in the chronic injury group was 89.1304 ± 5.496 as against 93.8824 ± 3.838 in the acute injury group ($p = 0.004$, t test) [Table 1]. Risk of harvesting a shorter graft was higher in a chronic knee injury (odds ratio = 5.7) [Table 2].

Discussion

Hamstring tendon autografts are being increasingly used for arthroscopic ligament reconstructions of the knee. Reduced morbidity compared to the 'Gold standard' bone–patellar tendon–bone (BPTB) autograft makes them an attractive option for routine anterior cruciate ligament reconstructions. However, unlike with BPTB grafts the surgeon does not have absolute control over the hamstring tendon graft dimensions as these are predetermined by the patient's anatomy. Scott and Insall [2] have reported that a minimum tendon length of 28 mm has to be obtained while harvesting to ensure the optimal 7 cm graft length after quadrupling. This may put to test surgeons skills and decision-making with regard to the type of graft and fixation device that can be used [3]. The need to predict the Hamstring autograft dimensions, specifically the length becomes all the more critical in countries where allografts are not readily available or in situations like complex multi-ligament reconstructions of knee which requires grafts of specific dimensions [4]. To add to the problem, Charalambous reported that the length of Hamstring tendon graft that is obtained may be influenced by the kind of tendon harvester that is used [5].

Inadequate length of hamstring graft may mandate use of a suspensory type of fixation device like suture disc or screw post on the tibial side. Suspensory fixation may increase the chances of tunnel widening and is more likely to cause soft tissue graft elongation and residual laxity resulting in inferior surgical outcome [6].

This problem of unpredictability of Hamstring tendon length is being approached in a two pronged way; one being, to find ways to predict the Hamstring graft dimensions preoperatively and the second being to make alternative graft options available. Yasumoto et al. [7] have reported a positive correlation between the total length of harvested semitendinosus tendon with the pre-operative length measured by 3D-CT scanning. Multiple studies have analysed the predictability of Hamstring tendon dimensions by anthropometric parameters, with a correlation being found between the individuals height and hamstring graft length in males [8–10]. Liu et al [11] have reported use of additional half peroneus longus tendon for reinforcement when the dimension of harvested hamstring tendons is inadequate.

We are reporting what we believe is another important variable to be considered while using Hamstring tendon autografts for knee ligament reconstructions. Our point of interest in this study was to find an association between repeat injuries and harvesting of sub-optimal length of Hamstring tendon in those patients.

George et al. [12] in their study on MR imaging identifiable parameters to predict recurrent Hamstring injuries reported that the only statistically significant risk factor for recurrent hamstring strain is a history of ACL injury. Garret [13] conducted animal studies and reported that muscles are more susceptible to reinjury after an incomplete disruption at the myotendinous junction. Similar conclusion was derived by Orchard [14] in their paper on hamstring injuries in Australian footballers. Thus, the ACL injury makes an individual prone to hamstring injuries which further increase the propensity to repeat hamstring strains which happen during the recurring episodes of instability in ACL deficient knees.

Garret and Lohnes [15] reported that mechanical injuries at the myotendinous junctions initially exhibit inflammatory response followed by a fibrotic response leading to scar formation. This fibrous tissue has less tensile strength and alters the normal biomechanics resulting in more susceptibility to strain injuries. This vicious cycle of strain and healing response ultimately leads to scarred and fibrotic myotendinous junction of hamstrings.

Our results show a statistically significant difference between the usable length of harvested Hamstring tendon in patients with acute and chronic injuries; the length being shorter in patients with chronic ACL injuries and associated repeat instability episodes. This is probably the result of scarring at the myotendinous junction due to repeated Hamstring strain seen in these patients.

The limitations of our study were the small number of patients included and the subjective nature of assessment done by the surgeon with regard to the difficulty in advancing the tendon stripper and the unusable length of the harvested graft. A histopathological examination of the discarded tendon would have been able to confirm the presence of scarring and fibrosis. Also, in our study confounding variables like anthropometry and other factors predicting poor graft quality have not been considered or correlated. This is because we have primarily focussed on finding a correlation between chronic ACL instability and poor quality hamstring graft harvest.

Conclusion

Our results have led us to conclude that patients with chronic history of ACL tear, especially with repeated instability episodes, are likely to have fibrosis at the musculotendinous junction resulting in poor quality Hamstring graft being harvested. A detailed history in relation to the duration of injury and repeated knee instability episodes will add to the anthropometric measurements and 3D CT scanning in predicting the graft length and quality while harvesting Hamstring autografts.

Compliance with ethical standards

Conflict of interest The conflict of interest disclosure form is signed by both the authors and attached with the other documents. Dr. Arjun Ajith Naik and Dr. Prashant Acharya declare that they have no conflict of interest.

Ethical Approval All human and animal studies have been approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Specific national laws have been observed.

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