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A prospective and retrospective study to evaluate the functional outcome of single hamstring tendon ACL reconstruction with internal bracing versus double hamstring tendon ACL reconstruction without internal bracing

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Abstract
Background: Anterior cruciate ligament tears range from 0.24 to 0.34 injuries per 1000 people. Internal brace is a high-strength suture tape which act as a "safety belt," and secondary stabilizer sharing the load of the graft and helps to reduce the re-tear rate, improve graft integrity and enhance knee function potentially improving overall surgical outcomes. Considering the advantage of using internal brace, this study was taken up.
Methods: 60 patients who underwent surgery at Manipal hospital, Bangalore from November 2022-November 2024 were considered for the study. Patients were divided into 2 groups,30 in internal bracing with single hamstring tendon reconstruction group and remaining 30 in without internal bracing with double hamstring tendon reconstruction group. Both groups were assessed with Lysholm knee score and IKDC score pre-operatively and post-operatively at regular intervals.
Results: Both scores showed statistically significant improvement (P<0.001) during the post-operative period in internal bracing group. In internal bracing group, Lysholm score at 3rd month was 83.4,6th month was 90.4 and 12th month was 95.9 while in without internal bracing group at 3rd month was 80.3,6th month was 86.8 and 12th month was 92.7. In internal bracing group 56.67% scored IKDC grade B at 3rd month, 6th month 70% scored grade A and 12th month 100% scored grade A. In without internal bracing group 50% scored grade B at 3rd month, 6th month 66.67% scored grade A and 12th month 93.33% scored grade A. There was no co-relation between the functional outcome scores with respect to age, gender and side of the knee being operated in both groups.
Conclusion: Single hamstring tendon with internal bracing group showed better functional outcome scores than the other group and also returned to pre-injury status as early as 6th month post-operatively. No re-tear of grafts was noted in either of the groups.

Keywords: Anterior cruciate ligament, single hamstring tendon, internal bracing, Lysholm knee score, IKDC grade

Introduction
The Anterior Cruciate Ligament (ACL) acts as a key stabilizer in the knee joint preventing anterior translation of the tibia and counteracting rotational and valgus stress [2]. ACL is the most commonly injured ligament in the knee, with reported annual incidence rates ranging from 0.24 to 0.34 injuries per 1000 people making it the primary focus of research on knee ligament injuries [1]. Unlike the collateral knee ligaments, which have strong healing capabilities and respond well to non-surgical treatments, the ACL has limited intrinsic healing potential largely due to its exposure to synovial fluid and insufficient vascularization [2]. As a result, surgical reconstruction is often the preferred treatment for ACL tears [1, 3]
Patients who suffer from ACL injuries tend to be younger and more physically active compared to those with other orthopaedic injuries, and if left untreated can hasten the degenerative changes within the knee joint, leading to meniscal tears, cartilage damage and early onset of osteoarthritis thus highlighting the need for durable reconstruction options [2, 4, 5].
ACL reconstruction has evolved significantly since the first repair in 1934, followed by the

first reconstruction using semitendinosus tendon grafts and later using bone-patellar tendon-bone (BPTB) autografts [3, 6]. By the 1970s, extra- articular techniques gave way to intra-articular methods, with arthroscopic single- bundle reconstruction becoming the gold standard [6]. Today, quadrupled hamstring autografts (semitendinosus and gracilis) are widely preferred autografts due to their superior tensile strength, lower risk of anterior knee pain, and fewer complications compared to BPTB grafts [7]. Recent innovations enable single hamstring tendon use, optimizing graft strength while preserving knee stability [7, 8]. Studies demonstrate that over 60% of patients regain pre-injury activity levels with hamstring grafts, which also reduce extension deficits and infection risks, making them a reliable choice in modern ACL surgery [1, 7, 8].

Various fixation techniques for ACL reconstruction have evolved which includes suspensory fixation, interference screw fixation, hybrid fixation and augmentation techniques [1, 3, 5]. According to the surgeon's choice and convenience and the type of graft being used, various fixation devices are being used.

During the remodelling and revascularization phase of graft healing, the graft is continuously elongated due to the movements of the knee joint, which reduces its tension and, consequently, the functionality of the new ligament [6, 7]. To mitigate this issue, IBLA with ACL graft is been used which is a high-strength suture tape which act as a "safety belt," and secondary stabilizer sharing the load of the graft especially in the ligamentization phase, which in theory can help to reduce the re-tear rate, may improve graft integrity and enhance knee function during the early stages, potentially improving overall surgical outcomes for patients [8, 9]. This technique aims to protect the graft during the healing phase, promoting earlier and more secure rehabilitation, which is beneficial for active young patients [6, 10].

Considering the advantage of using internal brace this study was taken up.

Materials and methods:

- **Study site:** Department of orthopaedics, Manipal Hospital Old Airport Road
- **Study period:** November 2022-November 2024
- **Selection Criteria:**

1. The selection criteria for the patients for the two surgical groups (double tendon ACL reconstruction and single tendon ACL reconstruction with IBLA) were randomized.
2. Alternative cases were operated with either of the procedure.
3. No specific criteria for selection of patients for either of the surgical procedure.

- **Study design:** Prospective and Retrospective study
- **Study population:** This prospective and retrospective study was conducted on 60 patients above 18 years of age who underwent surgery for ACL tear at Manipal Hospital, Old Airport Road Bangalore during the period November 2022 - November 2024. The patients were allocated into the two study groups randomly. Considering the inclusion and exclusion criteria, all cases were taken as per the case proforma prepared for the study. Informed consent was obtained from the patient.

Methods of collection of data: Sample size was calculated by Lysholm knee score of single tendon ACL reconstruction with internal bracing was 95.88+/-8.69 (chillemiatal 2022) [11] Lysholm knee score of double hamstring tendon ACL reconstruction was 98.87+/- 2.67 (sarangi *et al* 2016) [12]

Using these scores the sample size for the present study, based on formula

$n= (Z\alpha/2+Z\beta)^2 \times 2\times\sum^2 /d^2$

Where $n=(Z\alpha/2+Z\beta)^2 \times 2\times\sum^2 /d^2$

α-error

β-power

$Z\alpha/2$= critical value of the normal distribution at $\alpha/2$

$Z\beta$ = critical value of the normal distribution at β

$\sum^2$ = population variance

d = difference between the means

and the calculated sample size was 29 per group. How ever the scope for extension of sample size was kept open.

- **Statistical Analysis:**
- For Data analysis all the findings were entered in an Excel spread sheet on Microsoft Excel.
- Statistical analysis was done by using descriptive and inferential statistics, using Student's Paired test and Unpaired t test,
- Chi-Square test was used to analyse the significance of difference between frequency distribution of data.
- The Statistical software SPSS version 20.0 and Jamovi software 2.6.16 was used for the analysis of the data.
- P value <0.05 was considered as level of significance.

- **Inclusion Criteria**

1. All skeletally mature patients within age 18-45 years old.
2. Isolated ACL injuries / ACL injuries with grade 1 or 2 meniscal injuries.

- **Exclusion Criteria**

1. Patients age less than 18 years.
2. ACL injuries with avulsion injuries or associated with intra-articular condylar fractures
3. Multi-ligamentous injuries
4. Infected knee joint
5. Pre-existing congenital/developmental/collagen disorders
6. Meniscal injuries requiring partial/total meniscal repair.

- **Investigations required for the study:** MRI scan of the knee.

- **Clinical tests used to diagnose ACL tear:**

1. Anterior drawer test [13, 14]
2. Lachmann test [13, 14]
3. Pivot shift test

Methodology

1. **Surgical technique of ACL reconstruction with single hamstring tendon with internal brace:**

Graft of choice in this group was patients' ipsilateral semitendinosus graft. It was harvested by using a tendon stripper, through a 1.5-2 cm incision medial to the tibial tuberosity (figure 1). The harvested autograft was prepared by removing excess muscle tissue and quadrupled (figure 2). The collagen-coated fibre-tape was looped to the adjustable tightrope suspensory button. Fixation on the tibial side was with another tightrope with a suspensory button. The two tightrope free ends were then looped on to two ends of the quadrupled autograft. The fibre-tape was looped and fixed to the femoral suspensory button, parallel to the autograft which acted as the augmentation. The graft and tightrope system were tensioned for 10 min to eliminate creep (figure 3). Through the anteromedial and anterolateral portal, the injured knee was examined. Intraoperative findings, particularly associated injury diagnosis, autograft length, diameter and surgery duration, were taken into account. Any associated

meniscal tears if any during the arthroscopic procedure, were evaluated, classified based on their characteristics, and treated accordingly. Meanwhile, the medial wall of the lateral femoral condyle was prepared with a radiofrequency probe. The femoral tunnel was first prepared. The ACL impression was depicted on the lateral femoral condyle at 90 degrees of knee flexion. The entry area was bored with a guide wire in 120 degrees of knee flexion using a femoral offset aimer inserted through the anteromedial port. The guide wire was advanced until the guide wire tip appeared on the parallel side of the distal thigh near the femur epicondyle. The femoral tunnel was drilled through the femoral cortices with a 4.5mm endoscopic drill bit and then reamed with a reamer that corresponds to the graft diameter. The tibial tunnel was created by using the tibial guide, at an angle of 55°. First a guide wire was inserted using the guide and positioned at the centre of the footprint of the native ACL The tibial tunnel was drilled using the drill bit and then reamed with a reamer according to the graft diameter. The traction thread was inserted into the joint through the tibial tunnel until the graft had passed through both tunnels. Graft was shuttled through the tunnel and fixed to the femur with the help of endo-button and fixed to the tibia by suspensory endo-button as well with knee in 20 degrees of flexion. Finally the fibre-tape was fixed in extension just below the tibial tunnel using knotless suture anchor (figure 4).

Fig 1: Harvesting single hamstring tendon (semi-tendinosis).

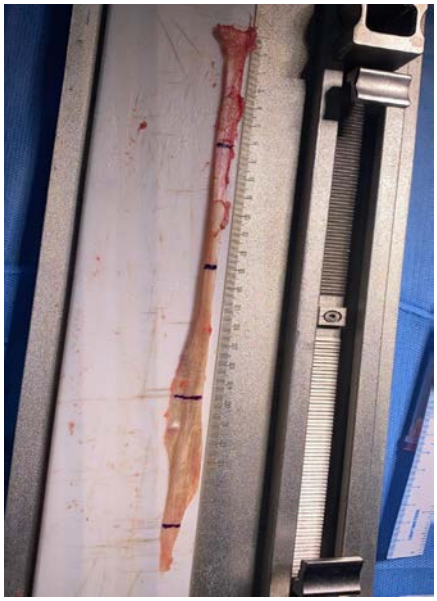

Fig 2: Quadrupled semi-tendinosis autograft.

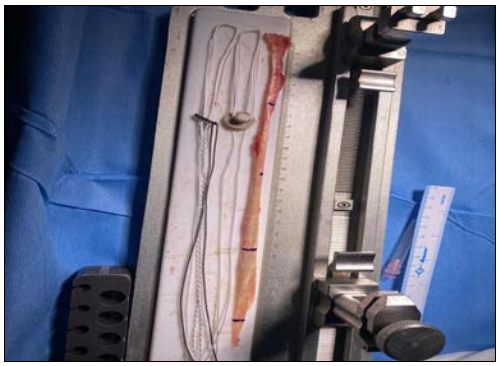

Fig 3: Semi-tendinosis autograft with fibre tape (internal brace) and adjustable loop endo-button.

Fig 4: Knotless suture anchor being introduced to fix the fibre tape at the tibial end.

2. Surgical technique of ACL reconstruction with double hamstring tendon without internal brace:

In this technique graft of choice were patients' ipsilateral semitendinosus and gracilis grafts which were harvested in a similar fashion as in internal bracing group (figure 5). The harvested autografts were prepared and 6 strands were made by tripling the graft (figure 6). The adjustable tight-rope free ends were then looped on to the femoral end of autograft, and tensioned for 10 min to eliminate creep (figure 7). Similar to internal bracing group standard port incisions were made and femoral and tibial tunnels were drilled. The traction thread was inserted into the joint through the tibial tunnel until the graft had passed through both tunnels. Then the graft was shuttled through the tunnel. The graft was fixed to the femur with the help of endo-button and to the tibia by a bioabsorbable interference screw which was 1 mm larger in diameter than the tibial tunnel in 20 degrees of knee flexion (figure 8).

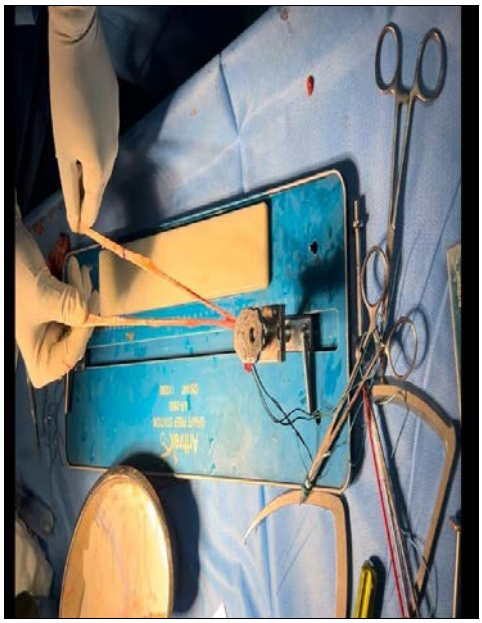

Fig 5: Double hamstring tendon both semi-tendinosis and gracilis being prepared.

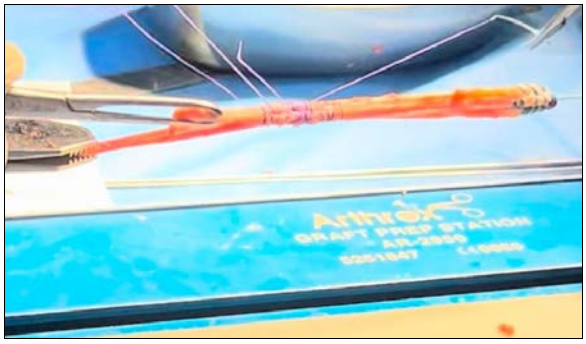

Fig 6: Double hamstring tendon made into 6 stranded.

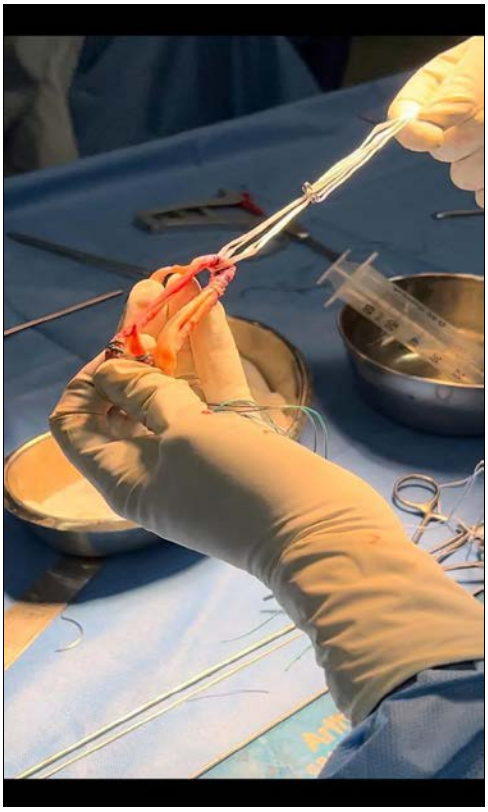

Fig 7: 6 stranded double hamstring tendon with adjustable loop endo-button.

Fig 8: Bio-absorbable screw being inserted to fix the graft at the tibial end.

3. Follow up

Pre-operatively patients were assessed for clinical and functional outcome. Post operatively patients were followed up for a period of 1 year at 1 month,3months, 6months, 12months post-operatively. Clinical, functional and subjective evaluation using Lysholm knee score and IKDC grading were done in each follow up. The data collected were transferred into a master chart and was subjected to statistical analysis by the biostatistician of our institution.

Results

In our study we calculated the Lysholm knee score and IKDC grade in both study groups and also compared both the scores between the two groups. Age, gender, occupation, mode of injury, and operation time were the other parameters which were also analysed in our study. The mean age was 31.9 years, with a standard deviation of 6.37 in internal bracing group while the mean age was 30.9 years, with a standard deviation of 9.82 in without internal bracing group, thus indicating younger age population were commonly involved in ACL tears. In the internal bracing group 90% of the patients were males and in the without internal bracing group 76.7% were males thus reflecting higher incidence of males being involved in ACL tears. In both the groups injury due to sports activities was the common mode of injury comprising 83% in internal bracing group and 67% in without internal bracing group. In terms of occupation, we found that students and engineers made up the majority in both groups encompassing students (40%) and engineers (30%) in internal bracing group and students (36.7%) and engineers (33.3%) in without internal bracing group. The mean operation time was similar for both groups being 61.5 minutes for the internal bracing group and 60.8 minutes for the without internal bracing group. The median times were also close, with 61.0 minutes for internal bracing and 60.5 minutes for without internal bracing. Both groups have a low standard deviation, indicating that the operation times are relatively consistent across patients in both groups.

When we analysed the Lysholm knee scores in internal bracing group, pre-operatively 70% had poor scores (less than 64), post-operatively at 1 month 86.67% improved to fair scores (65-83), at 3rd month post-operative period 66.67% reached good scores (84- 90)**,** 6th month post-operative period 63.33% achieved excellent scores (91-100) and at final follow up 12th month 100% of patients had excellent scores (91-100)(table 1). The Lysholm knee score in without internal bracing group pre-operatively 66.67% had poor scores (less

than 64), post-operatively at 1 month 83.33% improved to fair scores (65-83), at 3rd month post-operative period 53.33% reached good scores (84- 90)**,** 6th month post-operative period 66.67% achieved good scores (84-90) and at final follow up 12th month 83.33% of patients had excellent scores (91-100) (table 2). We compared the Lysholm knee scores between both the groups and found that all the values were statistically significant (p<0.001) and internal bracing group scored better than the other group (table 3).

Similarly, we interpreted the IKDC grades in both groups. In internal bracing group pre-operatively 56.67% scored grade D, and 43.33% scored grade C. At 1st month post-operative follow up 86.67% scored grade C, and 3.33% scored grade D. 3rd month post-operative period 23.33% achieved grade A, and 56.67% scored grade B. 6th month post-operative period 70% scored grade A and 30% scored grade B. At final follow up at 12th month 100% of patients achieved grade A (table 4). In without internal bracing group pre-operatively 63.34% scored grade D, and 33.33% scored grade C. At 1 month follow up 90% improved to grade C, and 10% remained at grade D. At 3rd month 50% scored grade B, and 50% scored grade C. At 6th month 66.67% scored grade A and 33.33% scored grade B. At final follow up 12th month post-operative period 93.33% achieved grade A (table 5). We compared the IKDC grades between both the groups and found that all the values are statistically significant (p<0.001) and internal bracing group scored better than the other group (table 6).

Discussion

ACL reconstruction has evolved over the years in terms of its technique, graft selection, number of grafts being used and type of fixation of ACL graft on the femoral and tibial side. Incidence of ACL injuries is gradually increasing and of late involving more female athletes and even involving pediatric age group. The basic aim is to provide stable knee joint with stable ACL fixation and hence returning to pre-injury status as early as possible without any re-tear of the graft. Studies have shown that the functional outcome of using internal brace augmentation with ACL graft is superior than without using internal brace.

In our study we have compared the functional outcome of single hamstring tendon ACL reconstruction with internal bracing versus double hamstring tendon ACL reconstruction without internal bracing. Total study population include 60 subjects, with 30 patients in each subgroup.

The age distribution of patients in the internal bracing group were between 31-40 years (46.67%), followed by 20-30 years (43.33%), and only 10% were in the 41-50 years range. The mean age was 31.9 years, with a standard deviation of 6.37. The age distribution of patients in the without internal bracing group were between 20-30 years (36.67%), followed by 31-40 years (30%). The 41-50 years group represented 20% of patients, while the 10-20 years group had 13.33%. The mean age was 30.9 years, with a standard deviation of 9.82. When analyzing both the groups, majority of the patients were young patients having ACL injuries and there is no statistical significance observed in the age distribution between the two groups. A study by Szakiel P *et al***.,** [7] also mentioned that the mean age group involved in ACL injuries was 31.53 ± 8.37 years. Even in other studies [15, 16] the age distribution was found to be not significant between the two groups.

In both the groups male dominance is observed. In the internal bracing group 27 patients were male (90%) and 3 patients were female (10%). In without internal bracing group 23 patients were male (76.7%) and 7 patients were female (23.3%). Studies done by Yadav *et al*., [4] and Bilal *et al*., [3] also shows that ACL injuries are predominantly affecting male patients. There is no statistical significance observed in the gender distribution between the two groups and similarly in other studies the gender distribution was found to be not significant between the two groups.

In the internal bracing group majority of the patients had the left knee affected (56.7%, 17 patients), while 43.3% (13 patients) had the right knee involved. Even in the without internal bracing group majority of patients had the left knee affected (66.7%, 20 patients), while 33.3% (10 patients) had the right knee involved. No other studies have compared the side of involvement between the two groups and in our study we found that there is no statistical significance observed in the side of the knee involved between the two groups.

In the internal bracing group, most patients (83%) injured themselves while playing sports which is a non-contact injury. A smaller portion (10%) had injuries from road traffic accidents, and 7% were due to slips and falls which are contact injuries. In the without internal bracing group, most patients (67%) injured themselves while playing sports which is a non-contact injury. Road traffic accidents (17%) and slips and falls (16%) each contributed to a smaller portion of the injuries which are contact injuries. In both the groups non-contact injuries are significantly higher than the contact injuries. Boden *et al*., [17] in his study mentioned that 70% of the patients acquired ACL injuries due to non-contact injuries and remaining 30% patients acquired through contact injuries. Nathan *et al*., [18] in his study also mentioned the most common mechanism of injury to ACL is non-contact injury. Saeko *et al*., [19] in his study emphasized that the number of non-contact ACL injuries was significantly higher than the number of contact ACL injuries.

In both groups regarding occupation wise distribution, students and engineers make up the largest groups prone for ACL injury. In the internal bracing group, students (40%), engineers (30%), homemakers (10%), teachers (6.7%) and businessmen, drivers, and physicians together constitute (13.3%) are less represented, suggesting fewer severe injuries in these occupations. In without internal bracing group, students (36.7%), engineers (33.3%), Homemakers (16.7%) and smaller groups like teachers, businessmen, drivers, and retired individuals (3.3% each) are less represented, possibly due to lower physical strain in their daily activities. No other studies have compared the occupation wise distribution between the two groups and in our study we found that there is no statistical significance observed between the two groups. As students and engineers are the most represented groups, it may suggest that individuals who are physically demanding or active occupations are more prone to ACL injuries, potentially influencing the need for reconstruction and requiring internal brace so that they can return to their pre-injury status as early as possible. These occupation patterns may offer insight into how occupation-related factors affect ACL injuries and their outcomes in different reconstruction methods.

No other studies have compared the operation time between both the groups and in our study we found that the mean operation time is similar for both groups 61.5 minutes for the internal bracing group and 60.8 minutes for the without internal bracing group. The median times are also close, with 61.0 minutes for internal bracing and 60.5 minutes for without internal bracing. Both groups have a low standard deviation, indicating that the operation times are relatively consistent across patients. The minimum operation time is 59 minutes

for internal bracing and 57 minutes for without internal bracing, showing only slight differences in the time taken for surgery in both groups. Overall, the operation times are almost identical for both groups and thus using internal bracing thus not prolong the surgical time and thus reducing the incidence of infection.

In our study the functional outcome for both the groups were assessed using Lysholm knee score and IKDC grade scores at regular follow up post-operatively. Both the scores were assessed during 1month,3months,6months and 12months post-operatively.

The Lysholm knee score in internal bracing group are as follows; Pre-op the mean was 58.7, 1month post-operatively the mean was 69.6, 3months post-operatively the mean was 83.4, 6months post-operatively the mean was 90.4 and 12months post- operatively the mean was 95.9.

The Lysholm knee score in without internal bracing group are as follows; Pre-op the mean was 61.3, 1month post-operatively the mean was 70.4, 3months post-operatively the mean was 80.3, 6months post-operatively the mean was 86.8 and 12months post-operatively the mean was 92.7. When comparing the Lysholm knee scores between both the groups, the internal bracing group showed constant significant improvement scores during the early phase of rehabilitation especially at the 3rd, 6th and 12th month post-operative period and they scored better than the other group and all values are statistically significant (all p-values < 0.001).

The IKDC grade in the internal bracing group are as follows; Pre-op 56.67% scored grade D and 43.33% scored grade C. 1month post-operatively 86.67% scored grade C and 3.33% scored grade D. 3months post-operatively 20% scored grade C, 56.67% scored grade B and 23.33% scored grade A which was remarkable improvement in the functional outcome. 6months post-operatively 70% scored grade A, and 30% scored grade B. 12months post-operatively 100% scored grade A.

The IKDC grade in without internal bracing group are as follows; Pre-op 63.34% scored grade D, 33.33% scored grade C and 3.33% scored grade B. 1month post-operatively 90% scored grade C and 10% scored grade D. 3months post-operatively 50% scored grade C and 50% scored grade B. 6months post-operatively 66.67% scored grade A, and 33.33% scored grade B. 12months post-operatively 93.33% scored grade A and 6.67% scored grade B. When comparing the IKDC grade between both the groups, the internal bracing group showed constant significant improvement scores during the early phase of rehabilitation especially at the 3rd, 6th and 12th month post-operative period and they scored better than the other group and all values are statistically significant (all p-values < 0.001).

In our study we found that Lysholm knee score and IKDC grade are scored better in internal bracing group and there is a significant improvement in the scores especially during 3rd month and 6th month follow up which suggests that internal bracing with single hamstring tendon ACL reconstruction has better functional outcome and patient have returned to their pre-injury status much quicker than compared to the without internal bracing group. Kitchen *et al*., [6] in his comparative study of ACL reconstruction with suture tape augmentation versus without suture tape augmentation mentioned that patients whom were treated with suture tape augmentation scored better Lysholm knee scores than the other group. Kyriakopoulos *et al*., [20] in his 3year follow up study between all inside single hamstring tendon ACL reconstruction with suture tape augmentation versus double hamstring tendon ACL reconstruction concluded that using suture tape augmentation has provided better graft versatility and better functional outcome. Krych *et al*., [15] did a cohort comparison of hamstring autograft ACL reconstruction with and without internal brace and found that internal bracing group has better statistically significant functional outcome scores. Dr Sunil Dhanger *et al*., [21] in 2022 did a comparative review on ACL reconstruction versus internal brace augmentation and concluded that internal bracing group has scored better Lysholm knee score, IKDC grade and KOOS knee score than the other group. Massey *et al*., [9] in 2020 published a article on biomechanical comparison of anterior cruciate ligament repair with internal brace augmentation versus anterior cruciate ligament repair without augmentation and concluded that internal brace augmentation demonstrates significantly higher load to failure.

In our study we also have compared the Lysholm knee score and IKDC grade scoring between both the groups in terms of age, gender, and side of knee being involved and compared the same in each follow up visit. No other studies have done that and we have done it to see if there is any co-relation between the functional outcome with the age, gender and side of knee being involved. This comparison was done in two steps. Initially the comparison was done considering all 60 patients as one unit and then the second step comparison was done based on each individual group.

Lysholm knee score comparison

Now considering all 60 patients as one whole unit, we compared the Lysholm knee score in terms of age, gender and side of knee being involved in different months of follow up. When comparing the Lysholm knee scores in terms of age wise distribution in all 60 patients considered as one unit in different months of follow up, we found that in 20-30 years old age group there was improvement of mean score from 61.6 pre- operatively to 94.4 at 12 months follow up. In 31-40 years old age group there was improvement of mean score from 58.7 pre-operatively to 94.6 at 12 months follow up. In 41-50 years old age group there was improvement of mean score from 58.2 pre- operatively to 93.6 at 12 months follow up. A statistically significant difference (p value 0.045) was observed at 1 month and at other months follow up did not show any significant difference (p value > 0.05). All the age groups improved the functional outcome scores over the period of time, a significant difference was noted at 1 month with old age groups showing slightly lower score improvement than the younger population.

When comparing the Lysholm knee scores in terms of gender wise distribution in all 60 patients considered as one unit in different months of follow up, we found that in males there was improvement of mean score from 60.1 pre-operatively to 94.6 at 12 months follow up. In females there was improvement of mean score from 59.5 pre- operatively to 92.9 at 12 months follow up. Significant difference was found only at 6th month (p value 0.012) and 12th month follow up (p value 0.046) with males showing slightly better scores than females suggesting males do have a better recovery at the end of 1 year post surgery.

When comparing the Lysholm knee scores in terms of side of the knee being involved in all 60 patients considered as one unit in different months of follow up, we found that there is no significant statistical difference between both the knees at any point of follow up.

We compared the Lysholm knee score with different age groups at different months of follow up in the internal bracing

group alone and found that there were variations in score distributions across different age groups at different time of follow up but no significant statistical differences were found. When comparing the Lysholm knee score with different age groups at different months of follow up in the without internal bracing group there was also no significant statistical differences found.

We compared the Lysholm knee score with gender wise distribution in the internal bracing group alone and found that in the 6th month follow up there was statistically significant difference in favor of males having better scores than females (p value 0.010) and in other follow up months it was not statistically significant. In without internal bracing group there were no significant statistical differences found between males and females at any of the follow up.

We compared the Lysholm knee score of based on the side of the knee being involved in the internal bracing group alone and found that only in the 6th month follow up there was statistically significant p value 0.010 suggesting the left knee showed higher proportion of excellent score than the right knee. In without internal bracing group there were no significant statistical differences found between both the knees at any point of follow up.

IKDC grade scoring comparison:

Now considering all 60 patients as one whole unit, we compared the IKDC grading score in terms of age, gender and side of knee being involved in different months of follow up. We found that there was no statistical significance difference in the IKDC score in terms of age, gender and side of knee being involved throughout the follow up.

We compared the IKDC score with different age groups at different months of follow up in the internal bracing group and in without internal bracing group separately. There were no significant statistical differences in IKDC score grading across age groups at any point of follow up in both groups.

We compared the IKDC score with gender wise distribution at different months of follow up in the internal bracing group and in without internal bracing group separately. There were no significant statistical differences in IKDC score grading between males and females at any point of follow up in both groups.

We compared the IKDC score based on the side of the knee being involved at different months of follow up in the internal bracing group and in without internal bracing group separately. There were no significant statistical differences in IKDC score grading between the right and left knee at any point of follow up in both groups.

Table 1: Lysholm knee score in internal bracing group

Lysholm Score	Pre-op	Pre- op%	Post-op (1 Month)	Post- op (1 month) %	Post-op (3months)	Post-op (3months) %	Post-op (6 months)	Post- op (6 months) %	Post-op (12 months)	Post-op (12 months) %
Less than 64 (POOR)	21	70%	4	13.33%	0	0%	0	0%	0	0%
65-83 (FAIR)	9	30%	26	86.67%	10	33.33%	3	10%	0	0%
84-90 (GOOD)	0	0%	0	0%	20	66.67%	8	26.67	0	0%
91-100 (Excellent)	0	0%	0	0%	0	0%	19	63.33	30	100%
Total	30	100%	30	100%	30	100%	30	100%	30	100%

Table 2: Lysholm knee score in without internal bracing group

Lysholm Score	Pre- op	Pre-op %	Post- op 1 Month	Post- op 1 month%	Post-op 3months	Post-op 3month%	Post-op 6 months	Post- op 6 Months%	Post-op 12 months	Post-op 12 Months%
Less than 64 (POOR)	20	66.67 %	5	16.67 %	0	0%	0	0%	0	0%
65-83 (FAIR)	10	33.33 %	25	83.33 %	14	46.67%	4	13.33%	0	0%
84-90 (GOOD)	0	0%	0	0%	16	53.33%	20	66.67%	5	16.67%
91-100 (Excellent)	0	0%	0	0%	0	0%	6	00%	25	83.33%
Total	30	100%	30	100%	30	100%	30	100%	30	100%

Table 3: Comparison of Lysholm knee scores between both groups

Group	Duration	Mean	Std. Deviation	t-value	p-value
Internal bracing group - Lysholm score	Pre-op	58.7	7.43	-	-
	1 month	69.6	5.36	17.29	<.001
	3 months	83.4	4.95	13.71	<.001
	6 months	90.4	4.24	7.73	<.001
	12 months	95.9	2.58	10.38	<.001
Without Internal bracing group - Lysholm score	Pre-op	61.3	7.51	-	-
	1 month	70.4	5.89	10.01	<.001
	3 months	80.3	5.93	9.16	<.001
	6 months	86.8	3.71	7.12	<.001
	12 months	92.7	2.61	10.94	<.001

Table 4: IKDC grade scores in internal bracing group

IKDC Grade	Pre-op	Pre-op%	Post- op 1month	Post-op1month%	Post- op 3months	Post-op 3months%	Post- op 6 months	Post- op 6 months %	Post-op 12 months	Post-op 12 months %
A(Great)	0	0%	0	0%	7	23.33%	21	70%	30	100%
B(Good)	0	0%	3	10%	17	56.67%	9	30%	0	0%
C(Average)	13	43.33%	26	86.67%	6	20%	0	0%	0	0%
D(Bad)	17	56.67%	1	3.33%	0	0%	0	0%	0	0%
Total	30	100%	30	100%	30	100%	30	100%	30	100%

Table 5: IKDC grade scores in without internal bracing group

IKDC Grade	Pre- op	Pre- op%	Post- op 1month	Post-op1month%	Post- op 3months	Post-op 3months%	Post- op 6 months	Post- op 6	Post-op 12 months	Post-op 12 months%
A (Great)	0	0%	0	0%	0	0%	20	66.67%	28	93.33%
B(Good)	1	3.33%	0	0%	15	50%	10	33.33%	2	6.67%
C (AveraGe)	10	33.33%	27	90%	15	50%	0	0%	0	0%
D (BAD)	19	63.34%	3	10%	0	0%	0	0%	0	0%
Total	30	100%	30	100%	30	100%	30	100%	30	100%

Table 6: Comparison of IKDC grade scores between both groups in%

IKD C Grade	Pre-op		Post-op (1month)		Post-op (3months)		Post-op (6 months)		Post-op (12 months)	
	IBLA	Without IBLA	IBLA	Without IBLA	IBLA	Without IBLA	IBLA	Without IBLA	IBLA	Without IBLA
A	0	0	0	0	23.33	0	70	66.67	100	93.33
B	0	3.33	0	0	56.67	50	30	33.33	0	6.67
C	43.33	33.33	86.67	90	20	50	0	0	0	0
D	56.67	63.34	3.33	10	0	0	0	0	0	0
Total	100	100	100	100	100	100	100	100	100	100

Conclusion

Age, gender and side of the knee being involved has no co-relation with the functional outcome of the patients in both groups. Older age group people tend to recover slowly than the younger age group patients during the 1st month post-operative period. Males have slightly better Lysholm knee score than females in the 12th month follow up indicating the fact that males are better than females in following up with rehabilitation protocol to get back to pre-injury status as early as possible. No re-tear of the grafts was noted in either of the groups.

With so much articles supporting internal bracing having better functional outcomes scores, similarly in our study both Lysholm knee score and IKDC grade is significantly scored better in internal bracing group. As only semi-tendinosis tendon is being used in internal bracing group it has various advantages which are listed below,

- It reduces the hamstring weakness and thus reducing the risk of re-injury.
- It reduces the healing time for single hamstring graft incorporation.
- It reduces the risk of saphenous nerve injury during harvest of single hamstring tendon.
- The internal grace augmentation serves as safety belt to protect the graft during the ligamentization phase and thus additionally preventing re-injury of ACL graft.
- Internal bracing with single hamstring tendon ACL reconstruction patients return to pre-injury status as early as possible by 6th month post-surgery without any complications.

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