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EFFECT OF THE USE OF PLATELET RICH BIOLOGICAL AUGMENTS IN PREVENTION OF TUNNEL WIDENING IN ACL RECONSTRUCTION: A SYSTEMATIC REVIEW

Orthopedics

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ABSTRACT

Human knee joint is a complex hinge joint of Saddle variety. Due to the degree of freedom imparted to it, the ligaments that stabilize the knee are subjected to constant stress. This results in increased incidence of ACL injuries particularly during sports. With the advent of Arthroscopy and better understating of ligament injuries with the use of MRI, the ligament reconstruction procedures have increased. The tunnels prepared during the surgery are subjected to constant biological and mechanical stress during post-operative period. The resultant widening leads to failure of graft integration and failure of ACL reconstruction surgery. In recent times biological augments have been used to prevent this tunnel widening. Various studies have been conducted to assess the outcomes of this augments to accelerate the graft healing.

KEYWORDS

ACL reconstruction, PRP, Tunnel widening, Platelet activated factors, biological Augments.

INTRODUCTION AND BACKGROUND:

Anterior Cruciate Ligament is a dynamic stabilizer of the knee. It has Two bundles Anteromedial bundle and Posterolateral bundle. It prevents the anterior Tibial translation (anteromedial) and acts as a secondary stabilizer for Tibial rotation (posterolateral)[1]. It is most commonly injured in sporting activities like soccer, basketball, skiing and football. The male to female ratio of 1:4.5 particularly due to the landing biomechanics and quadriceps dominant neuromuscular activation patterns.

ACL reconstruction is done using an Autograft or an Allograft. Hamstring graft, Central Quadriceps tendon graft and Bone patellar tendon bone graft are amongst the commonly used grafts[2]. The grafts are secured in the tunnels made through the femur and tibia at its anatomical footprint. The graft then during the stages of healing integrates with the bone in the tunnels giving it adequate strength[3]. At times due to mechanical and biological reasons the graft fails to integrate with resultant erosion and widening of the tunnels. This leads to failure of the ACL reconstruction procedure resulting in instability of the knee.

The Role of various Growth factors including Platelet derived growth factors (PDGF), Vascular endothelial growth factor (VEGF), Fibroblast growth factor (FGF), Transforming Growth factor-β (TGF-β) is identified during the various stages of healing process[4]. They have the ability to activate membrane receptors in Integrins while enhancing the formation of components of collagen matrix. Activated platelets release 30 bioactive molecules which leads to tissue maturation and soft tissue regeneration by stimulation of mesenchymal cells and macrophages with osteoblasts. This potential has been exploited to promote graft integration into the tunnels. Various forms of activated platelets like Fibrin clot, Platelet rich plasma, Platelet rich gel have been used in the procedure of ACL reconstruction.

This review was conducted to evaluate several clinical studies using activated platelets in the prevention of tunnel widening after ACL reconstruction evaluated by radiographs, MRI and clinical outcomes. It aims to help surgeons in their decision making regarding the use of biological augments to prevent graft failure after ACL reconstruction surgeries.

REVIEW MATERIAL AND METHOD:

A total of 30 articles were screened for abstract. After reading the full text 11 articles were selected for the literature review. A total of 585 knees underwent ACL reconstruction with the use of platelet activated products which were reviewed here. All the knees were operated with Autografts using hamstring tendons / QTB/ Quadriceps graft. Fibrin clot or Platelet Rich Plasma or both were used each studies. The Radiographs or MRI or CT scans were used to assessed tunnel widening post-operatively 3, 6 and 12 months after surgery.

PRP was prepared using 20 ml autologous blood centrifuged at 3600 RPM for 15 minutes. Fibrin clot was made using 50 ml autologous blood which was stirred in a sterile container for 15 minutes, which was then dried on a gauze piece and applied to the tunnels and graft.

Inclusion criteria:

1. Randomized controlled using Platelet activated growth factors along with ACL reconstruction were included.
2. Studies using Fibrin clot or PRP were included
3. Outcome measures belonging to atleast one of the following Radiographs or MRI were selected.
4. Only English articles were selected

Exclusion criteria:

1. Duplicated or overlapping data
2. Review articles or scientific conference abstracts
3. Cadaver or model studies
4. Unreported data

RESULTS:

In a single center, single surgeon randomized prospective cohort study 41 knees were operated for ACL tear. PRP was made from autologous blood and applied to the tunnels 1 ml and graft 3 ml. MRI was done at follow-up. The groups showed no difference in Tunnel cortical wall bone formation (TBC) at 1 month ($p = 0.928$). However there was a significant increase in the TBC formation at 3 and 6 months (36.2 vs 22.5 and 67.1 vs 53.5, $p = 0.004$ and $p = 0.003$, respectively)[5].

A retrospective multi-center study on 106 knees was done using PRP to study the effect on bone tunnels. Post-operative AP and lateral radiographs were used to evaluate tunnel widening. Widening was present in 23 out of 54 patients in the PRP group (42.6%), compared with 28 out of 52 patients in the no-PRP group (53.8%). Mean widening in the PRP group was 1.4 mm vs. 2.1 mm in the no-PRP group. This was not statistically significant $p = 0.246$[6].

30 patients were enrolled in a study and randomly assigned to PRP or control group. They were followed up 3,6,9 months. MRI was done to assess the graft incorporation in the tunnels. The mean time for PRP group was 3.4 months for PRP and 8.1 months for the other group. There was no significant difference observed in the case of tunnel widening[7].

A prospective single center ACL reconstruction was done on 70 knees. PRP was used in the study group. Subjects followed up at 0,6 weeks and 3 months. AP and lateral radiographs were used for evaluation. The difference was not significant for tunnel diameters. At the immediate postop, the mean Tibial tunnel width for non-PRP group was

8.51±0.507, 8.79±0.503 at 6 weeks and 9.05±0.516 at 12 weeks, 3 of 6 while for PRP group it was 8.54±0.610 at immediate postoperative period, 8.83±0.622 at 6 weeks and 9.12±0.603 at 12 weeks[8].

A study was conducted on 40 knee which underwent ACL reconstruction with use of PRP in study group. Post operatively CT scan was used to assess for tunnel widening. Femoral tunnel in study and control group at final follow-up were 9.8 ± 0.3 mm and 9.4 ± 0.5 mm in group B respectively. Tibial tunnels were 10.9 ± 0.2 mm and 10.1 ± 0.4 mm. This difference was not significant[9].

A prospective randomized study on 50 isolated ACL tear was done using PRP. CT scans were used to evaluate tunnel widening. At final 3 months follow-up slightly less Tibial tunnel widening was observed in the study group but this difference was not significant. Tibial tunnel opening in mm PRP group 23 1.65 (0.98) and Control group 23 1.99 (1.31), p-value 0.225. Mid-Tibial tunnel PRP group 23 2.09 (1.52), Control group 23 2.70 (1.48), p-value 0.206[10].

A Prospective study evaluated 40 knee at 3 and 12 months post ACL reconstruction for tunnel widening. MRI was used to evaluate the results. There was less tunnel widening in PRP group and better graft integration but the difference was not significant. 9 patients in control group had increased tunnel diameter as opposed to 7 in study group ($p = 0.751$)[11].

In a single center, single surgeon prospective study on 85 knee PRP was used in ACL reconstruction. MRI was done at 3,6,12 months. There was significant difference in signal intensity of Tibial tunnel at 6 months ($P < 0.05$). The difference at the Femoral end was not significant[12].

44 knees underwent MRI evaluation at 12 months with use of fibrin clot in ACL reconstruction. The difference was statistically significant for proximal thirds of the tunnels and not in mid-body and distal thirds p value= 0.044[13].

A clinical study done on 51 patients assessed the effect of PRP on Femoral tunnel widening after ACL reconstruction using MRI at 1 year follow-up. There was a significant difference of the tunnel diameter for the PRPG (82.40 ± 4.59 to 85.79 ± 6.80) and the CG (80.19 ± 5.91 to 86.50 ± 8.88), respectively (< 0.005), between the baseline and the 12-month assessment. However the change in percentile and mean tunnel diameter was not significantly different (> 0.05) and (=0.062) respectively[14].

A Prospective evaluation of 28 knee was done. MRI was done at 1 and 2 years to evaluate effect of fibrin clot to prevent tunnel widening. The signal intensity and synovial fluid at graft tunnel interface was similar in both groups indicating no clinically significant improvement in graft upatake[15].

DISCUSSION:

This Review was conducted to evaluate whether the theoretical probability of enhanced graft integration into bony tunnels could translate into superior radiological outcomes. A systematic review on this topic in 2022 has shown similar tunnel diameters in the study and control group[16].Hence we have numerous data to review the effect of activated platelets factors in prevention of tunnel widening post ACL reconstruction.

The understanding of a biological phenomenon is essential prior to any attempt for intervention. Over the last two decades several studies have been published trying to figure out the graft healing procedure mainly in the ACL reconstruction surgery. Early animal studies have demonstrated that the bone-graft interface is initially characterized by increased numbers of fibroblasts and inflammatory cells, which are then replaced with progressively matured collagen fibers [17,18]. There is a literature consensus that the graft heals in three phases inside the tunnel through three major histological changes, namely, the maturation of fibrous tissue, the new bone formation, and the bone remodeling.

In our review of 11 articles the Graft integration was found to be superior in the group that had PRP or fibrin clot used alongwith the graft. The Tibial tunnel showed better graft integration as opposed to Femoral tunnel between the study and control group. The mid and distal portion of the tunnel showed the greatest signal intensities on MRI. However this difference between the study and control group in whom normal saline was used was found to be not significant. The mean values for graft integration and cumulative percentile values were also not significant. None the less the use of such augments in a sterile setting will not cause any harm if at all will promote necessary growth factors for graft ligamentization.

However this review had two limitations, First, in combining randomized control trials and cohort studies simultaneously, the bias caused by different types of trials could not be eliminated. Second, the method of preparation of PRP was not same for all studies.

CONCLUSION:

Our Review showed that use of Platelet activated factors in the form of PRP or Fibrin clot did not show any significant decrease in the incidence of Femoral and Tibial tunnel widening post ACL reconstruction. However the graft uptake was better in the mid and distal portions of the tunnels indicating a likely enhanced graft healing with the use of platelet activated factors augments.

Additional Information:

Disclosures:

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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