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Functional Outcome of Percutaneous Needling Tenotomy with Autologous Platelet Rich Plasma Injection in Recalcitrant Tendinopathies

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Abstract

Background: Chronic musculoskeletal diseases are the most common cause of severe long-term pain and physical disability. Tendinopathy is a difficult problem requiring lengthy management, and patients often respond poorly to treatment. Tendinopathy causes substantial morbidity during sporting or working activities. The new theory of tendon regeneration has been focused on the role of growth factors in the platelets and the development of different therapeutic strategies and protocols in the treatment of chronic tendinopathy.

Objectives: To evaluate the efficacy and functional outcome of percutaneous needling tenotomy with autologous platelet rich plasma injection in recalcitrant tendinopathies.

Methods: After excluding the patients who failed to satisfy the study protocol, the remaining 184 cases (achilles, patellar and rotator cuff tendinopathy) were treated with percutaneous needling tenotomy with autologous platelet rich plasma injection for recalcitrant tendinopathies. All the cases were followed up pre-procedurally and post-procedurally at the end of 1st, 6th and 12th month for pain relief and range of movements. The improvements in pain and range of movements are charted in terms of VAS and functional scoring system.

Results: The statistical analysis was done for 184 cases of recalcitrant tendinopathies. All cases were followed up for 1 year. They showed a statistical improvement in pain and range of movements with p value <0.05 who received percutaneous needling tenotomy with autologous platelet rich plasma therapy. No serious adverse side effects were noted in the follow up period. Autologous PRP therapy improves the functional quality of life with a long term outcome.

Conclusion: For recalcitrant tendinopathies, percutaneous needling tenotomy with autologous platelet rich plasma injection remains functionally superior as autologous PRP (Platelet Rich Plasma) is a constructive procedure by rejuvenating the degenerative tissues.

Keywords: Platelet rich plasma; Percutaneous needling tenotomy; Patellar tendinopathy; Achilles tendinopathy; Rotator cuff tendinopathy

Introduction

Chronic musculoskeletal diseases are the most common cause of severe long-term pain and physical disability. The term "Tendinopathy" is defined as a chronic tendon injury with molecular disruption without any definitive etiology [1]. Tendinopathy is a difficult musculoskeletal disorder which requires a longer duration of management, and patients often respond fair to poor grades to the treatment.

Tendinopathy is becoming more common in sporting, recreational and occupation related activities. Tendinopathy occurs due to repetitive and/or chronic overloading that exceeds the adaptive capacity of the tendon. Tendinopathy is a chronic connective tissue disorder, regeneration does not occur, resulting in a tissue structure that may incur further injury or rupture due to a failed healing repair response due to impaired vascularity [2]. The term recalcitrant tendinopathy refers to chronic tendon injury with molecular disruption with no implication about etiology without any symptomatic relief from past 3 months duration.

Tendinopathy has significantly increased the morbidity of illness during sporting or occupational activities. The increased morbidity due to tendinopathies warrant an adequate treatment for a longer duration. Histologically, tendinopathies appear as focal areas of intratendinous degenerated collagen bundles without any signs of inflammation [3].

Achilles tendinopathy is a common condition in the adult population. In 59% of patients it is related to sports activities, and 53% of them are runners. It involves hypovascular area situated from 2 to 6 cm above the calcaneal insertion [4]. Patellar tendinopathy is also called as Jumper's knee, where the degeneration is located at the proximal enthesis, is also known as jumper's knee. This disease mostly affects young athletes associated with running, jumping, soccer, and volleyball [5]. Rotator cuff tendinopathy is a group of disorder affecting tendons of rotator cuff group. It involves the tendinal insertions at the head of humerus. It is most commonly seen in age group above 40 years and in 20% of diabetic individuals [6].

Due to the rapid growth of 'Regenerative Science', a new theory of tendon regeneration have been focused on the role of growth factors in the platelets and the development of different therapeutic strategies and protocols in the treatment of chronic tendinopathy. The bioactive micromolecules present in the platelets are histopromotive factors which undergo degranulation and induce cellular migration, proliferation, neoangiogenesis and regeneration of degenerated tendons [7].

Objective

To evaluate the efficacy and functional outcome of percutaneous needling tenotomy with autologous platelet rich plasma injection in recalcitrant tendinopathies.

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Materials and Methods

The prospective study was conducted in Bapuji Hospital and Chigateri Government General Hospital, JJM Medical College, Davangere, Karnataka from 2016 to 2018 (3 years). The sampling procedure employed in the study was convenient sampling with 231 patients. Among 231 cases of tendinopathy, after excluding 47 cases, the remaining 184 cases were treated with percutaneous needling tenotomy with autologous platelet rich plasma injection as per our study protocol. All the patients who got treated as per the study were followed up at the end of 1st, 3rd, 6th and 12th month. The functional quality of life was assessed with VAS, AOFAS, Lysholm and DASH scores (Figure 1).

Inclusion criteria

1) Patients with recalcitrant chronic ankle, knee and shoulder pain who have taken conservative treatment without any improvement from past 6 months.
2) Patients who gave consent for treatment with percutaneous needling tenotomy with autologous PRP injection as per our protocol.
3) Regular follow-up in the out-patient department.

Exclusion criteria

1) Patients with haemoglobin <10 g/dL and platelet count $<10^5$/mL.
2) Patients with usage of analgesics prior to 72 hours of PRP therapy.
3) Patients who received steroid injection at treatment site within 1 month.
4) Patients who underwent surgical treatment for chronic ankle, knee and shoulder pain.
5) Patients with local infection at the site of the procedure, seropositivity to HIV, HbsAg or HCV, coagulation and bleeding disorders and other systemic metabolic disorders.
6) Patients refusal for treatment as per our protocol.

After getting the informed written consent from the patients enrolled in our study, they were subjected for thorough clinical examination to rule out the other causes of pain over ankle, knee and shoulder. The baseline laboratory investigations and radiographic analysis of affected joints were done. All the cases were investigated for the usage of NSAIDs 72 hour's prior and local steroid infiltration 4 weeks prior to percutaneous needling tenotomy with autologous platelet rich plasma injection.

Preparation of platelet rich plasma

By differential centrifugation method, a total of 20 cc of venous blood were withdrawn into vacutainers containing sodium citrate and were subjected for soft spin centrifugation at a rate of 3000 rpm for 15 minutes. Then the resultant plasma admixed with platelets were transferred into plain vacutainer which were subjected for further hard spin centrifugation at a rate of 5000 rpm for 15 minutes. The resultant solution in the vacutainer contains upper 2/3rd portion of platelet poor plasma and lower 1/3rd portion of platelet rich plasma. 20 mL of autologous venous blood yield 3–4 mL of autologous platelet rich plasma solution. Before injecting autologous PRP injection, 10% of calcium chloride solution was added to autologous PRP in the ratio of 1:10 [4,5] (Figure 2).

Interventional procedure

All the study cases (n=184) were treated with percutaneous needling tenotomy with 3-4 mL of autologous platelet rich plasma injection after securing all sterile precautions. After 10-15 minutes of the procedure, gentle joint mobilizations were done. The patients were trained for home based ankle, knee and shoulder, joint strengthening programmes. All the patients were advised not to bear weight for minimum of 2 weeks and the pain is combated with ice pack application. Then the patients were followed on (pre-procedure) day 0 and (post-procedure) at the end of 1st, 3rd and 6th month for pain relief and range of movements. The improvements in pain and range of movements were charted in terms of VAS, AOFAS, Lysholm and DASH functional scoring system (Figures 3-5).

The patients, who come with recurrence, were offered a second dose of treatment with an interval of 3 weeks for the organization of collagen in the affected tendons. All the recorded data were subjected for statistical analysis with repeated measures ANOVA test.

Results

After excluding 47 cases, a total of 184 cases entered our study and were treated with percutaneous needling tenotomy and autologous platelet rich plasma injection and they were followed up as per our protocol. The statistical analysis with repeated measures ANOVA test and p value were derived from IBM SSPS statistics for Windows, Version 20.0, IBM Corp, Chicago, IL (Tables 1 and 2).

Achilles tendinopathy (n=56): Among 56 cases, 38 (67.85%) cases got cured with first dose of intervention and 14 (25.00%) cases got

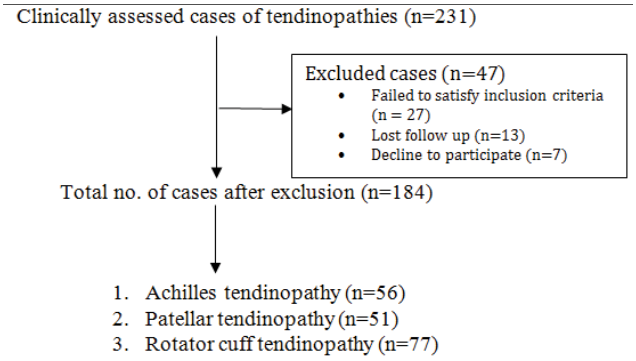

Figure 1: Patient's allocation.

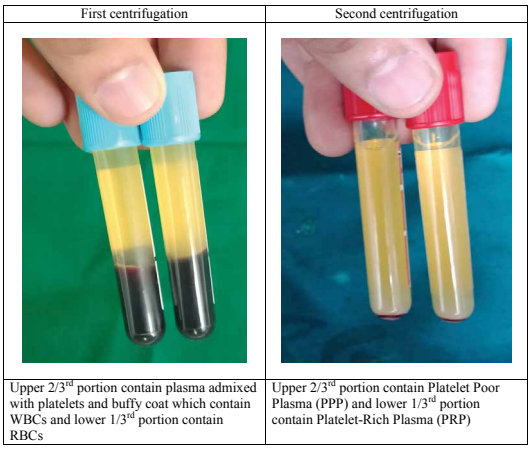

Figure 2: Preparation of autologous platelet rich plasma injection.

Figure 3: Percutaneous needling tenotomy with autologous PRP injection for achilles tendinopathy.

Figure 4: Percutaneous needling tenotomy with autologous PRP injection for patellar tendinopathy.

Figure 5: Percutaneous needling tenotomy with autologous PRP injection for rotator cuff tendinopathy.

cured with second dose of intervention. By the end 12th month, a total of 4 (7.14%) cases reported recurrence who were counselled for surgical intervention.

Patellar tendinopathy (n=51): Among 51 cases, 33 (64.70%) cases got cured with first dose of intervention and 11 (21.56%) cases got cured with second dose of intervention. By the end 12th month, a total of 7 (13.72%) cases reported recurrence who were counselled for surgical intervention.

Rotator cuff tendinopathy (n=77): Among 77 cases, 51 (66.23%) cases got cured with first dose of intervention and 23 (29.87%) cases got cured with second dose of intervention. By the end 12th month, a total of 3 (3.89%) cases reported recurrence who were counselled for surgical intervention.

Quality of life

A total of 122 cases returned to their daily routine pain free activities within an average of 23.41 ± 2.76 days after 1st dose of treatment. The cases (n=48), who undertook 2nd dose of treatment, returned to normal routine activities within an average of 19.34 ± 1.56 days (Table 3).

Functional outcome

Achilles tendinopathy (n=56): The functional outcome of patients with recalcitrant achilles tendinopathy who received treatment as per our study have improved significantly at the end of 12th month with mean VAS score of 2.09 ± 0.06 ($p<0.001$) and mean AOFAS score of 89.46 ± 2.91 ($p=0.01$) (Figure 6).

Patellar tendinopathy (n=51): The functional outcome of patients with recalcitrant patellar tendinopathy who received treatment as per our study have improved significantly at the end of 12th month mean VAS score of 3.01 ± 0.79 ($p<0.001$) and mean Lysholm score of 88.44 ± 3.89 ($p=0.028$) (Figure 7).

Rotator cuff tendinopathy (n=77): The functional outcome of patients with recalcitrant patellar tendinopathy who received treatment as per our study have improved significantly at the end of 12th month mean VAS score of 2.11 ± 1.28 ($p<0.001$) and mean DASH score of 30.20 ± 4.55 ($p=0.02$) (Figure 8 and Table 4).

Disease pattern		No of male cases	No of female cases
Achilles tendinopathy (n=56)		33 (58.92%)	23 (41.07%)
Patellar tendinopathy (n=51)		29 (56.86%)	22 (43.13%)
Rotator cuff tendinopathy (n=77)		43 (55.84%)	34 (44.15%)
Age	(Mean±SD)	57.49 ± 10.00	51.85 ± 10.14
	Range	39-77	36-72

Table 1: Patient's demography according to disease patterns.

Group	Total	No of patients cured with 1st dose (at end of 1st month follow up)	No of patients cured with 2nd dose (after 4 weeks of initial dose)	No of patients with recalcitrant disease (at the end of 12th month follow up)
Achilles tendinopathy	n=56	38 (67.85%)	14 (25.00%)	4 (7.14%)
Patellar tendinopathy	n=51	33 (64.70%)	11 (21.56%)	7 (13.72%)
Rotator cuff tendinopathy	n=77	51 (66.23%)	23 (29.87%)	3 (3.89%)
Total	184	122	48	14

Table 2: Number of injections.

Follow up	Achilles tendinopathy (n=56)		Patellar tendinopathy (n=51)		Rotator cuff tendinopathy (n=77)	
	Mean VAS score	Mean AOFAS score	Mean VAS score	Mean Lysholm score	Mean VAS score	Mean DASH score
Day 0	8.89 ± 0.76	46.71 ± 7.92	8.79 ± 0.76	39.08 ±6.32	8.98 ± 0.57	77.91 ± 5.03
1st month	7.12 ± 0.47	54.77 ± 4.25	7.06 ± 0.87	53.95 ± 4.38	7.09 ± 1.09	63.70 ± 4.18
3rd month	5.14 ± 0.61	73.31 ± 6.74	6.01 ± 0.81	61.40 ± 5.21	6.89 ± 0.09	57.56 ± 6.09
6th month	3.54 ± 0.19	86.28 ± 2.67	5.73 ± 0.99	73.22 ± 3.17	3.96 ± 1.94	45.22 ± 6.63
12th month	2.09 ± 0.06	89.46 ± 2.91	3.01 ± 0.79	88.44 ± 3.89	2.11 ± 1.28	30.20 ± 4.55
p value	<0.001	0.01	<0.001	0.028	<0.001	0.02

Table 3: Functional improvement in recalcitrant tendinopathies.

Group	Pain	Swelling	Recurrence (at the end of 12th month)
Achilles tendinopathy (n=56)	17 (30.35%)	21 (37.50%)	4 (7.14%)
Patellar tendinopathy (n=51)	20 (39.21%)	29 (56.86%)	7 (13.72%)
Rotator cuff tendinopathy (n=77)	24 (31.16%)	13 (16.88%)	3 (3.89%)

Table 4: Complications.

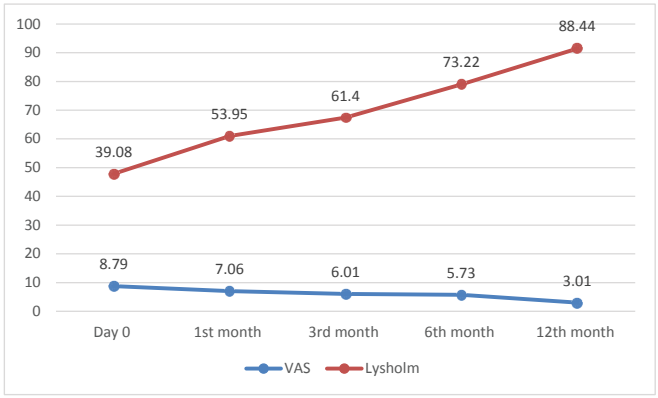

Figure 6: Functional improvement in achilles tendinopathy.

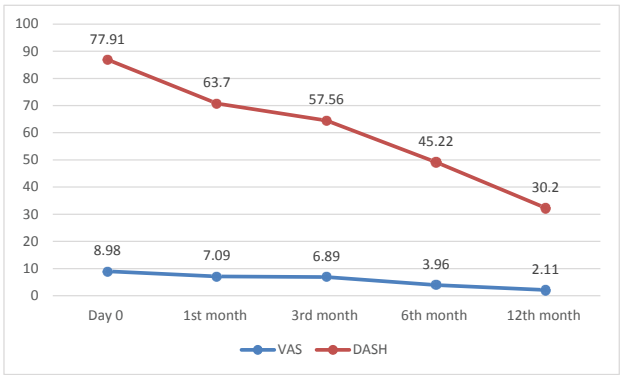

Figure 7: Functional improvement in patellar tendinopathy.

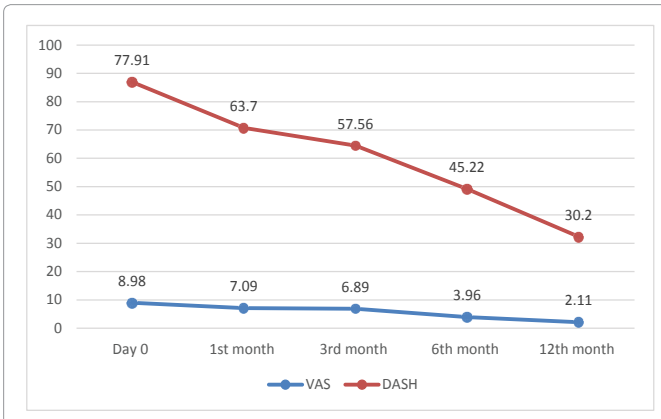

Figure 8: Functional improvement in rotator cuff tendinopathy.

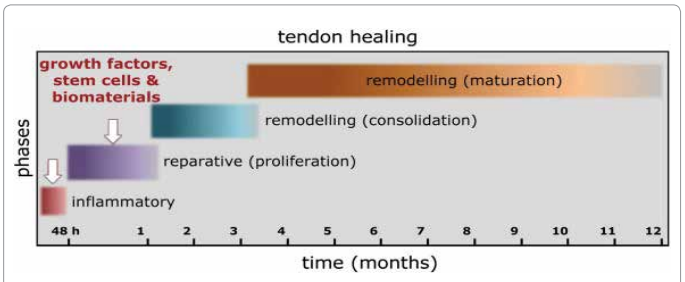

Figure 9: Stages of tendon healing.

Discussion

Tendon disorders are responsible for substantial and significant increased morbidity in sporting, recreational and occupational activities. Tendinopathies are clinical conditions in and around tendons arising from overuse. Tendinopathy is a difficult problem requiring lengthy management, and patients often respond poorly to treatment. The major risk factor for acute tendon rupture is the pre-existing degeneration which is a result of traumatic insult over a long period of time. Despite appropriate management, due to hypovascular nature of tendons, the tendon injuries produce considerable morbidity to the individuals [8].

Metabolism of tendon

Tenocytes are active in energy generation through the Kreb's cycle, anaerobic glycolysis through lactate and HMP shunt. Through these energy, they synthesize collagen and extracellular matrix network. The metabolic pathways shift to more anaerobic glycolysis due to increasing age and degeneration. The tendons and ligaments have 7.5 times lesser oxygen consumption than skeletal muscles. Due to low metabolic rate and anaerobic energy generation capacity, tendons withstand tension for longer duration and reduce the risk of ischemic necrosis. The

resultant slow and insidious healing of tendons after injury are sue to low oxygen demand and low metabolic rates [9,10].

Stages of tendon healing

I Stage of inflammation: The predomination of monocyte-macrophage system with phagocytosis of necrotic materials occur in first 24 hours. Due to release of pro-inflammatory molecules, increased vascular permeability, neoangiogenesis, stimulation of tenocyte proliferation are seen. The synthesis of type III collagen are initiated.

II Stage of proliferation: Starts after few days. The peaking of synthesis of type III collagen with raised water content and glycosaminoglycan concentrations remain in this stage.

III Stage of remodeling:

1) ***Consolidation stage*:** Begins at about 6-10 weeks. In this stage, fibrous nature of the repair tissue occurs with high tenocyte metabolism. The proliferated tenocytes and collagen fibers are aligned in the direction of stress. The synthesis of type I collagen is initiated.

2) ***Maturation stage*:** Occurs after 10 weeks of injury, with gradual formation of scar-like tendon tissue over the course of one year. The tenocyte metabolism and tendon vascularity decline in this stage [11-13] (Figure 9).

Pathways of tendon injury healing

The injured tendon follow intrinsic pathway of healing by proliferation of epitenon and endotenon over the tenocytes and extrinsic pathway by cellular invasion from the surrounding tendon sheath and synovium [14].

Different types of tendon diseases

a) Tenosynovitis-Inflammation of synovial sheath surrounding the tendon without any tendon injury.

b) Tendinitis/Tendonitis-Acute inflammatory tendon injury.

c) Tendinosis-Chronic non-inflammatory tendon injury with degeneration at the cellular and molecualr level.

d) Tendinopathy-Chronic tendon injury with molecular disruption without any definitive etiology [1,15,16].

Pathogenesis of tendon injury

Tendinopathies are responsible for 30% of consultations to sports physician and musculoskeletal health providers. Tendinopathy most commonly result after significant sporting and occupational hazards in the sedentary populations. Tendinopathies follows a web of causative as no definitive etiology is being proposed. Tendinopathy result from tensile overload of tendons, collagen synthesis disruption, neoangiogenesis & thermal injury, adaptive compressive forces, intratendinous sliding motion & shearing forces of fascicles and administration of quinolone antibiotics [9,10].

Molecular mechanism in tendinopathy: The reduced expression of type I collagen mRNA in human tenocyte leads to extracellular matrix degradation in tendon.

Management of chronic tendon injuries

A) Non pharmacological management - PRICE and POLICE regimen.

B) Pharmacological management

- Analgesics in the form of NSAIDs and opioids
- Topical application with capsaicin
- Local steroid infiltration into the affected tendon sheath which reduces inflammation followed by rest for 72 hours

C) Physical therapy

- Active and passive range of affected joint movements
- Hot pack application in the form of ultrasonic therapy, interferential therapy and short wave diathermy to the affected joints
- Home based exercise programme in the form of muscular stretching
- Orthotics like braces and splints which reduce the micromotion at the injured area

D) Surgical therapy

- Open or arthroscopic release of fibrosis of tendon sheath covering tendons
- Ultrasound guided percutaneous needle tenotomy of the affected tendon sheath

E) Biological therapy

- Whole body cryotherapy with -110°C to -140°C provides anti-inflammatory and analgesic effect to the degenerated tissues
- Autologous or allogenic platelet rich plasma (PRP) injections
- Autologous tenocyte injection
- Injection of recombinant microRNA to increase the expression of type 1 collagen in the tenocyte
- Mesenchymal stem cell tissue engineering with silk scaffolds [1,7,17,18]

Achilles tendinopathy

Ferrero et al. studied ultrasound guided PRP injections in 30 achilles and 28 patellar tendons. At the end of 6th month follow up, VISA score increased from a mean value of 57-75.5 ($p<0.01$). They concluded PRP injection for patellar and achilles tendinopathy lead to recovery of the tendon matrix, prevent degenerative lesions and improved functional demand of the individuals [19].

Filardo et al. observed a statistical significance in VISA-A scores at 2 months ($p=0.002$), with a further improvement at 6 months ($p<0.0005$), and stable results at 4.5 years in 27 patients treated PRP injection for refractory achilles tendinopathy [20].

In our study, the patients who received percutaneous needling tenotomy with autologous PRP injection for recalcitrant achilles tendinopathy improved clinically and functionally at the end of 12 months with p value <0.05 which is statistically significant. A total of 4 (7.14%) cases reported with recurrence at the end of 12 months follow up.

Patellar tendinopathy

Gosens et al. proved a statistically significant improvement in terms of VAS and VISA-P scores in terms of pain and activity levels before and after PRP injection treatment of patellar tendinopathy with 36 patients [21]. Filardo et al. concluded the significant pain relief and improved functional outcome in 16 patients with refractory jumper's knee with platelet rich plasma treatment [22].

In our study, the patients who received percutaneous needling

tenotomy with autologous PRP injection for recalcitrant patellar tendinopathy improved clinically and functionally at the end of 12 months with p value <0.05 which is statistically significant. A total of 7 (13.72%) cases reported with recurrence at the end of 12 months follow up.

Rotator cuff tendinopathy

Tahririan et al. used US guided PRP injection in 17 patients with rotator cuff arthropathy showed a statistical significance in terms of pain relief after the procedure [23]. Scarpone et al. concluded a single shot intralesional platelet rich plasma injection under ultrasound guidance is safe which result in the significant improvement in the functional quality of life in the participants with refractory RCT [24]. In our study, the patients who received percutaneous needling tenotomy with autologous PRP injection for recalcitrant rotator cuff tendinopathy improved clinically and functionally at the end of 12 months with p value <0.05 which is statistically significant. A total of 3 (3.89%) cases reported with recurrence at the end of 12 months follow up.

Chronic tendinopathy

Finnoff et al. determined the efficacy of ultrasound (US)-guided percutaneous needle tenotomy followed by a Platelet-Rich Plasma (PRP) injection in 51 patients and concluded ultrasound guided percutaneous needle tenotomy followed by PRP injection to be an effective treatment for chronic, recalcitrant tendinopathy [25].

In this article, we considered the usage of percutaneous needling tenotomy with autologous platelet rich plasma injection for treating recalcitrant achilles, patellar and rotator cuff tendinopathies which showed a statistically significant outcome ($p<0.05$) at the end of 12 months follow up.

Conclusion

For recalcitrant tendinopathies, percutaneous needling tenotomy with autologous platelet rich plasma injection remains functionally superior as autologous PRP is a constructive procedure by rejuvenating the degenerative tissues. Platelet rich plasma has significantly reduced the morbidity among sporting, recreational and occupation related activities. Platelet rich plasma injection has improved the functional quality of life of the patients with recalcitrant tendinopathies by providing an environment for regeneration of degenerated tissues.

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