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The Differences in Western Ontario Rotator Cuff Scores and Transforming Growth Factor-B Levels Between the use of Platelet Rich Plasma Therapy and Non-Platelet Rich Plasma Therapy in the Conservative Management of Patients with Partial Rotator Cuff Injury

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ABSTRACT

Introduction: Partial rotator cuff injuries are a major cause of shoulder pain and significant functional impairment. Conservative therapy with physiotherapy and steroid injections is commonly used but has limitations in long-term effectiveness. Platelet Rich Plasma (PRP) has emerged as an alternative therapy with the potential to accelerate healing through regenerative and anti-inflammatory mechanisms. However, the effectiveness of PRP in improving shoulder function and Transforming Growth Factor-β (TGF-β) levels in patients with partial rotator cuff injuries still needs further investigation. This study aims to determine the differences in the Western Ontario Rotator Cuff Index (WORC) score and TGF-β levels in patients with partial rotator cuff injuries who receive conservative physiotherapy with and without PRP injections.

Material & Methods: This study is an observational analytic study with a prospective cohort design. Data were obtained from the medical records of patients with partial rotator cuff injuries who underwent conservative therapy with or without PRP injections. WORC scores and TGF-β levels were measured before therapy and three months after treatment. Statistical analysis was performed to evaluate differences between the two groups.

Results: The study results indicate a more significant decrease in WORC scores in the group receiving PRP injections compared to the physiotherapy group without PRP. Additionally, TGF-β levels increased more in the PRP group than in the conservative therapy group, suggesting a better regenerative effect than standard conservative therapy.

Conclusion: The administration of PRP injections in patients with partial rotator cuff injuries yields better outcomes in reducing WORC scores and increasing TGF-β levels compared to conservative physiotherapy. These findings support the potential of PRP

as an adjunct therapy in the conservative management of partial rotator cuff injuries.

Keywords: Conservative Therapy, Partial Rotator Cuff, Platelet Rich Plasma, Transforming Growth Factor-β, Western Ontario Rotator Cuff Index

INTRODUCTION

Rotator cuff injuries, commonly caused by trauma or chronic degeneration, lead to shoulder pain and dysfunction. While surgical treatment generally yields good outcomes, there is no definitive approach for partial tears. Conservative management, including NSAIDs, physiotherapy, and steroid injections, is the first-line treatment[1]. However, physiotherapy alone often shows limited success, with 33% of patients experiencing worsened functional scores (Merolla et al., 2011a). Long-term steroid injections also pose risks, such as tendon atrophy and reduced tissue quality for repairs [1–3]. When conservative methods fail, surgical options include debridement or repair, but both have limitations, particularly for small tears, which can be technically challenging to repair [1]

Partial rotator cuff tears are most common in individuals over 50, with a prevalence of 13%-32%, peaking at 30.85% in those aged 65-69, and predominantly affecting women (54.12%) [4]. In the U.S., nearly 40,000 hospital visits related to partial rotator cuff tears were recorded in 2002, averaging $14,000 per case. As the elderly population grows, degenerative rotator cuff injuries are expected to rise [4]

Platelet-Rich-Protein (PRP) injections, first reported in 1999 in Spain for maxillofacial and plastic surgery, have gained attention as a potential alternative to steroids. PRP promotes collagen production, growth factors, and tissue regeneration, showing benefits in various medical fields, including orthopedics[5,6]. Studies suggest PRP reduces pain and improves shoulder function, but conflicting research indicates no significant difference, with some reports of worsening function post-injection[7,8]. Further studies are needed to assess PRP's effectiveness using WORC scores and TGF-β levels.

METHODS

The design of this study is prospective cohort, investigating on the relationship between PRP injection and conservative physiotherapy towards TGF-ß levels and WORC score, obtained through the patient's medical records. The research was conducted at Prof. IGNG Ngoerah Hospital in Denpasar. The patients were then selected in accordance to the appropriate inclusion and exclusion criteria, whilst confounding factors are recorded to ensure the distribution do not impact the study significantly. Data on the WORC score, are obtained through medical records both initial and 3 months after treatment, while the TGF-ß levels are observed 3 months after treatment. Records of age, sex, obesity, use of corticosteroids, duration of symptoms, and history of injury were obtained and analyzed.

Patient Selection

Patients selection for the study are patients with partial rotator cuff injury treated either conservatively or with PRP injection that were treated in Prof. IGNG Ngoerah Hospital Denpasar. Patients included in this study are of age between 30 to 70 years old, with partial rotator cuff injury diagnosed both clinically and radiologically, and accepted to be part of the study. Cases where the patient is excluded from this study include those with traumatic or congenital deformity of the shoulder, those with incomplete medical record, and those who opposes to be part of the study. A minimum of 10 patients were to be included per group, where 11 patients per group were included to anticipate the 10% of drop-off in the study, resulting in 22 patients in total to be included in the study.

Data Extraction

Data are obtained through consecutive sampling based on the data from medical records and applying both the inclusion and

exclusion criteria. All subject data that meets the research criteria are included up until the minimal sample requirement is fulfilled.

Data Analysis

Data analysis will be conducted using Statistical Package for Social Science (SPSS) version 24.0. Descriptive analysis will be presented as mean and standard deviation for normally distributed data, with WORC scores and TGF-ß levels reported in numerical form. The Shapiro-Wilk test will assess data distribution, considering a sample size of less than 50, with normality determined if $p > 0.05$. For unpaired numerical data between two groups, an Independent T-Test will be used if data is normally distributed, while the Wilcoxon test will be applied for non-normal distributions. For paired numerical data, a paired T-Test will be conducted if the distribution is normal, whereas the Mann-Whitney test will be used for non-normal distributions.

RESULTS

Twenty-two patients with partial rotator cuff tears were included, with an average age of 47.73 ± 15.36 years in the physiotherapy group and 48.45 ± 6.32 years in the PRP injection plus physiotherapy group. Gender distribution was equal, with 11 males and 11 females (50% each). Symptom onset before seeking medical attention averaged 5.45 ± 3.72 months in the physiotherapy group and 8.64 ± 2.54 months in the PRP plus physiotherapy group. Comorbidities included diabetes in 3 patients (13.63%) and hypertension in 4 patients (18.18%). Statistical analysis showed no significant differences in gender distribution or comorbidities between the two groups, indicating no confounding variables in the study.

Analysis of the Difference in WORC Scores in Patients with Partial Rotator Cuff Injuries Before and Three Months After Conservative Physiotherapy Treatment.

This study compares WORC scores in patients with partial rotator cuff tears before and three months after conservative physiotherapy. The Shapiro-Wilk test confirmed a normal distribution ($p < 0.05$), allowing for a parametric Paired T-Test. The mean WORC score at three months was lower than before therapy, and the Paired T-Test showed a statistically significant difference between the two time points ($p < 0.001$).

Table 1 Analysis results of WORC score differences in the physiotherapy-only patient group.

Physiotherapy only group n=11	Mean ± SD	p-value	Mean Difference (95% CI)
Before Therapy	39,73 ± 5,82	< 0,001	(3,64 – 5,55)
After 3 months of therapy	35,13 ± 6,32		

Analysis of the Difference in WORC Scores in Patients with Partial Rotator Cuff Injuries Before and Three Months After Conservative Physiotherapy and PRP Injection Treatment.

The WORC scores in patients with partial rotator cuff tears before and three months after conservative physiotherapy and PRP injection were evaluated. The Shapiro-Wilk test confirmed a normal distribution ($p < 0.05$), allowing for a parametric Paired T-Test. The mean WORC score at three months was lower than before treatment, and the Paired T-Test showed a statistically significant difference between the two time points ($p < 0.001$).

Table 2 Analysis results of WORC score differences in the PRP injection and physiotherapy group.

Physiotherapy with PRP injection group (n=11)	Mean ± SD	p-value	Mean Difference (95% CI)
Before Therapy	38,75 ± 4,91	< 0,001	(13,23 – 15,99)
After 3 months of therapy	24,13 ± 5,34		

Analysis of the Difference in WORC Scores in Patients with Partial Rotator Cuff Injuries Between Post-Conservative Physiotherapy Treatment and Post-Conservative Physiotherapy and PRP Injection Treatment at the Third Month.

The WORC scores in patients with partial rotator cuff tears three months after conservative physiotherapy alone were compared against treatment with physiotherapy combined with PRP injection. The Shapiro-Wilk test confirmed normal data distribution ($p < 0.05$), allowing for a parametric T-test. The mean WORC score at three months was lower in the physiotherapy plus PRP group (24.13 ± 5.34) than in the physiotherapy-only group (35.13 ± 6.32). An Independent T-test showed a statistically significant difference between the two groups ($p < 0.001$).

Table 3 Results of the analysis of the difference in WORC scores.

Physiotherapy with PRP injection group (n=11)	Mean ± SD	p-value	Mean Difference (95% CI)
Before Therapy	35,13 ± 6,32	< 0,001	(-16,20 – -5,78)
After 3 months of therapy	24,13 ± 5,34		

Analysis of the increase in TGF-β levels in patients with partial rotator cuff tears before conservative physiotherapy treatment compared to after conservative physiotherapy treatment at the third month.

The increase in TGF-β levels in patients with partial rotator cuff tears before and after conservative physiotherapy treatment at the third month were evaluated. The Sapiro-Wilk test confirmed normal data distribution ($p > 0.05$), allowing for parametric T-test analysis. Results showed a higher increase in TGF-β levels after three months of physiotherapy compared to before treatment. A non-parametric Paired T-test revealed a statistically significant difference in TGF-β level increase between the two groups ($p < 0.001$).

Table 4 Results of the analysis of the increase in TGF-β levels.

Physiotherapy only group n=11	Mean ± SD	p-value	Mean Difference (95% CI)
Before Therapy	191,36 ± 39,51	< 0,001	(-345,42 – -154,38)
After 3 months of therapy	441,27 ± 148,33		

Analysis of the increase in TGF-β levels in patients with Partial Rotator Cuff Injury between before conservative physiotherapy and PRP injection therapy compared to after conservative physiotherapy and PRP injection therapy at the third month.

The increase in TGF-β levels in patients with partial rotator cuff tears before and after undergoing conservative physiotherapy and PRP injection therapy at the third month were analyzed. The Sapiro-Wilk test confirmed normal distribution of TGF-β levels ($p > 0.05$), allowing for parametric T-test analysis. The mean increase in TGF-β levels at the third month was higher after therapy than before. A Paired T-test revealed a statistically significant difference in TGF-β level increases between the two groups ($p < 0.001$).

Table 5 Results of the analysis of the increase in TGF-β levels.

Physiotherapy with PRP injection group (n=11)	Mean ± SD	p-value	Mean Difference (95% CI)
Before Therapy	183,24 ± 46,68	< 0,001	(-1298,93 – -885,18)
After 3 months of therapy	1275,3 ± 292,01		

Analysis of the increase in TGF-β levels in patients with Partial Rotator Cuff Injury between post-conservative physiotherapy therapy and post-conservative physiotherapy therapy with PRP injection at the third month.

Comparison between the increase in TGF-β levels in patients with partial rotator cuff tears after conservative physiotherapy and after conservative physiotherapy combined with PRP injection at the third month were done. The Sapiro-Wilk test confirmed a normal distribution of WORC scores ($p > 0.05$), allowing further parametric T-test analysis. The mean increase in TGF-β levels at the third month was higher in patients who received physiotherapy and PRP injection compared to those who only underwent physiotherapy. An Independent T-test showed a statistically significant difference in TGF-β level increase between the two groups ($p < 0.001$).

Table 6 Results of the analysis of the increase in TGF-β levels.

Total Patient (n=22)	Mean ± SD	p-value	Mean Difference (95% CI)
3-months post-physiotherapy only	441,27 ± 148,33	< 0,001	(628,03 – 1040,02)
3-months post-physiotherapy with PRP	1275,3 ± 292,01		

DISCUSSION

This study found an average patient age of 47.73 ± 15.36 years in the physiotherapy group and 48.45 ± 6.32 years in the PRP and physiotherapy group. Gender distribution was equal (11 males, 11 females). These findings align with previous research showing partial rotator cuff tears occur in 13%-32% of cases and increase with age, with younger patients (<45 years) experiencing more partial tears and older patients (56-65 years) having more full-thickness tears. Unlike prior studies, this study found no higher incidence in women.[9]

This study found a significant decrease in WORC scores in patients with Partial Rotator Cuff Injury after undergoing conservative physiotherapy, indicating symptom improvement. Previous research supports these findings, showing a significant WORC score reduction after 15 sessions of conventional physiotherapy per week, including TENS, InfraRx, and ultrasound therapy [9]. One possible explanation is mechanical stimulation, which accelerates tendon and bone healing through the IL-4/JAK/STAT pathway, leading to M2 macrophage polarization (Liu et al., 2022). Given the significant WORC score difference before and after physiotherapy, the study confirms its hypothesis, with a statistical significance of $p < 0.05$.

This study found a significant decrease in WORC scores in patients with partial rotator cuff tears who underwent conservative physiotherapy and PRP injection, indicating symptom improvement. These findings align with previous studies by Prodromos and Kwong, which also reported functional score improvements following PRP injections. Kim et al. further demonstrated that PRP led to better clinical outcomes after three months, despite no change in tear size.[10,11] However, Peng et al. reported that steroid injections provided better short-term results than PRP, and Castro et al. found no significant WORC score differences between PRP and placebo groups after six weeks. The variation in PRP effectiveness may be due to differences in platelet concentration, processing methods, and patient characteristics. Based on these findings, the hypothesis that WORC scores improve after physiotherapy and PRP injection at three months is accepted, with statistical significance ($p < 0.05$)[11].

This study found a significant difference in WORC scores between patients with Partial Rotator Cuff Injury who underwent post-conservative physiotherapy treatment alone and those who received physiotherapy combined with PRP injection at the third month. Previous studies support these findings, showing that PRP injections lead to better pain relief and shoulder function

compared to rotator cuff exercises alone over three months [12]. Gharbawy et al. (2020) also reported that both PRP injection and rehabilitation groups showed clinical improvements, but the PRP group demonstrated significantly better outcomes in terms of VAS, WORC, and SPADI scores[13]. Additionally, Zhang et al. (2021) emphasized that PRP is more effective when combined with physiotherapy, as PRP supports tendon healing while physiotherapy reduces shoulder pain and dysfunction. Based on these findings, the study confirms hypothesis 1, as the WORC score analysis showed a statistically significant difference ($p < 0.05$)[14].

There is a significant increase in TGF-β levels in patients with Partial Rotator Cuff Injury after three months of conservative physiotherapy treatment. This finding is supported by previous studies, including research by Han et al., which demonstrated that mechanical exercise increases circulating TGF-β levels. Even mild physical activity can significantly elevate free and total TGF-β1 levels, likely due to the release of TGF-β from mechanically sensitive reservoirs [15]

Another study showed that in patients with ankylosing spondylitis, physical exercise significantly increased circulating TGF-β1 levels, suggesting that physical activity can activate TGF-β. This increase contributes to physiological benefits such as stimulating fibroblast proliferation for tissue repair and improving cartilage health, which supports musculoskeletal recovery. Exercise has also been linked to symptom relief, improved quality of life, and potentially slowing disease progression [16]

Based on these findings, the hypothesis that TGF-β levels differ significantly before and after conservative physiotherapy treatment in Partial Rotator Cuff Injury patients is accepted, with statistical analysis showing $p < 0.05$.

A significant increase was found in TGF-β levels in patients with Partial Rotator Cuff Injury after conservative physiotherapy and PRP injection therapy at the 3rd month. This finding is supported by Pauly et al., who demonstrated that PRP significantly increases TGF-β concentrations in treated tissues, aiding regenerative processes and tissue repair. PRP serves as a major source of TGF-β, released upon platelet activation, promoting cell proliferation, differentiation, and extracellular matrix remodeling, making it a valuable therapeutic strategy for musculoskeletal healing.

Conversely, a study by Kelc et al. found that PRP significantly reduced TGF-β expression in human myogenic cells by more than 30% compared to controls. Despite this reduction in cellular TGF-β production, PRP was still confirmed as an external source of the growth factor. This paradox suggests that while PRP supplies additional TGF-β, prolonged use may suppress endogenous production, impacting tissue regeneration and muscle repair[17].

Based on these findings, the hypothesis that TGF-β levels increase following conservative physiotherapy and PRP injection therapy at the 3rd month is accepted, with statistical analysis showing a significant difference ($p < 0.05$).

The TGF-β levels were found to increased significantly in patients with Partial Rotator Cuff Injury after conservative physiotherapy and PRP injection at the 3rd month compared to physiotherapy alone. This finding is supported by an experimental study by Peng et al., which compared TGF-β concentrations between groups receiving only mechanical stimulation and those receiving a combination of PRP and mechanical stimulation[18].

At four weeks post-operation, the combination group (PRP + mechanical stimulation) had the highest TGF-β concentration (1.35 ± 0.27), significantly higher than the control group (0.69 ± 0.15) and the PRP-only group (1.06 ± 0.20) ($P < 0.01$). This suggests that combining PRP with mechanical stimulation has a synergistic effect in increasing TGF-β levels more effectively than either intervention alone.

However, no significant difference was found between the PRP group and the mechanical stimulation group (0.82 ± 0.16) ($P > 0.05$), indicating that mechanical stimulation alone does not significantly enhance TGF-β levels compared to PRP alone.

By the 8th week, TGF-β levels decreased in all groups, with the combination group still showing the highest value (0.74 ± 0.11), followed by the mechanical stimulation group (0.64 ± 0.13), PRP group (0.63 ± 0.12), and control group (0.58 ± 0.11). The study concluded that PRP combined with mechanical stimulation had a more significant impact on the early increase of TGF-β expression compared to single therapies [18].

Based on these findings, the hypothesis that there is a difference in TGF-β levels between post-conservative physiotherapy alone and post-conservative physiotherapy with PRP injection at the 3rd month is accepted, with statistical significance ($p < 0.05$).

CONCLUSION

There is a significant difference in WORC scores among patients with partial rotator cuff injury before and after conservative physiotherapy, as well as before and after combined physiotherapy and PRP injection at the 3rd month. Additionally, a significant increase in TGF-β levels was observed in patients following conservative physiotherapy alone and in combination with PRP injection. The study's strength lies in its prospective cohort design, enabling broader and more accurate data collection while minimizing bias. Although the WORC score, a subjective patient-reported outcome, was used, the researchers also objectively assessed TGF-β levels. However, limitations include a small sample size, short follow-up duration, and uncontrolled external factors such as patient adherence to physiotherapy, PRP injection composition variations, and comorbidities, which could influence outcomes. Further research with a larger sample size and longer follow-up is needed to strengthen findings, improve generalizability, and explore additional factors affecting clinical outcomes in Partial Rotator Cuff Tear patients.

Declaration by Authors

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