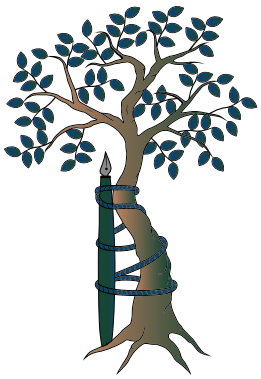
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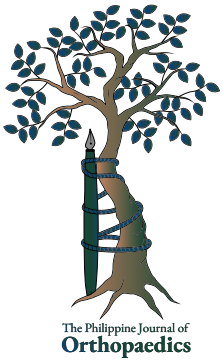
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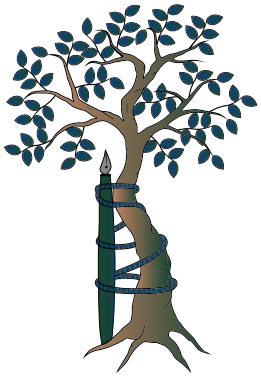


ABOUT THE LOGO: THE TREE OF ANDRY

Nicholas Andry coined the French term “orthopédie” which is derived from the Greek words “orthos” (correct or straight) and “paidion” (child). As implied in its etymology, “orthopédie” was first practiced treating childhood spinal and bone deformities.

The main elements of the logo are the tree of Andry; the Philippine Journal of Orthopaedics wordmark; and the fountain pen. The fountain pen, in replacement of the stake, represents how research has been the backbone of orthopaedic learning and practice.

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It is my pleasure to welcome you to the second issue of the **Philippine Journal of Orthopaedics** (PJO) for 2026!

As we continue to grow and move forward, this Journal remains an important part of our shared mission to advance orthopaedic care in the Philippines. As the official publication of the Philippine Orthopaedic Association (POA), it provides a platform for Filipino orthopaedic surgeons, researchers, residents, and allied specialists to share knowledge, research, clinical experiences, and new ideas that can make a real difference in patient care.

From trauma and degenerative conditions to pediatric and musculoskeletal oncology, the challenges we face in orthopaedics continue to evolve. With ongoing advances in surgical techniques, biomaterials, rehabilitation, and evidence-based practice, it is more important than ever to stay informed, exchange ideas, and learn from one another.

Through its open-access and peer-reviewed publications, the PJO helps bring valuable research and practical insights to the wider orthopaedic community. I encourage our members, colleagues, and fellow healthcare professionals to continue contributing quality research, sharing their experiences, and making the most of the knowledge published in these pages.

To our authors, readers, reviewers, and editorial team, thank you for your continued commitment and support. Your contributions keep this Journal moving forward. Let us continue working together to build a stronger culture of research, collaboration, and innovation—one that ultimately translates into better orthopaedic care and improved outcomes for our patients throughout the country.

Mabuhay ang Philippine Orthopaedic Association! *Mabuhay ang* Philippine Journal of Orthopaedics!

Marcelino T. Cadag, MD, FPOA
President, Philippine Orthopaedic Association, Inc.

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The Philippine Journal of Orthopaedics

Building Local Evidence: The Right Design for the Right Question



In the March issue, I emphasized that evidence is only as relevant as the context in which it is generated. Building that local evidence, however, raises a further question: how should such work be designed and judged?

During training, we learned to rank studies by their place on the evidence pyramid and to regard anything below a randomized controlled trial as somehow second-rate. Levels of evidence are a useful shorthand, but they are not a scorecard. A randomized trial is the best design for comparing two treatments. It is the wrong one for describing a rare injury, testing whether a new technique is feasible, or measuring muscle activity under different conditions. The better question to ask of any study is whether its design fits its question, given the patients, resources, and timeframe available.

This issue illustrates the point well. Its articles range from comparative studies of injection therapies for knee osteoarthritis and post-chikungunya arthralgia to an electromyographic study of shoulder immobilization in Filipinos, an early-outcome cohort of Ponseti treatment for clubfoot, a prospective series on a new Achilles tendon repair technique, and a case report of distal biceps reconstruction. Each design suits its purpose. A case report is the appropriate way to share a salvage reconstruction for a rare chronic injury. A small series is a sensible first step for a new technique. A physiologic study answers a mechanistic question that no outcome trial could, while comparative designs, including quasi-randomized ones, are the right choice when the question is which treatment works better.

The design that fits a question also defines the limits of its answer. A series of five patients can show that a technique is feasible, but not that it is superior. Early clubfoot outcomes are encouraging, but relapse reveals itself only over years of bracing and growth. Allocation by alternation or record number is more open to selection bias than concealed randomization. Stating these limits is not a weakness of a study. It is what makes the study trustworthy and useful.

For authors, this means beginning with what we need to know and choosing the design that answers it best within our constraints. Authors should get used to reporting using established guidelines such as CONSORT for trials,[1] STROBE for observational studies,[2] CARE for case reports,[3] and the IDEAL framework for surgical innovation.[4] Our conclusions should go only as far as the design allows.

Building local evidence is a collective and cumulative effort. Each well-designed and transparently reported study, whatever its level, lays a foundation on which the next can stand. Sustaining the Philippine Journal of Orthopaedics as a home for this work ensures that the questions arising from our own practice are answered in ways that remain relevant to the Filipino patients we serve.

Nathaniel S. Orillaza, Jr., MD
Associate Editor, Philippine Journal of Orthopaedics

The author used Claude (Anthropic) and ChatGPT (OpenAI) to help edit the text for accuracy, clarity and verify the references' format. The author reviewed and revised all content and takes full responsibility for the final manuscript.

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The Philippine Journal of Orthopaedics

ORIGINAL ARTICLE

A Prospective Quasi-Randomized Comparative Study between Intra-Articular Platelet-Rich Plasma and Corticosteroid Injection in Mild to Moderate Knee Osteoarthritis in Patients Aged 40–60 Years: Evaluation of Pain and Functional Outcomes

Chirag V. Thakkar, Bhumil C. Rathod Jr., Mit A. Patel, Harmesh B. Rabari, Sunny K. Patel

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ABSTRACT

Background. Knee osteoarthritis is a prevalent degenerative condition that leads to chronic pain, stiffness, and reduced joint function. While corticosteroid (CS) injections are commonly used for rapid relief of symptoms, platelet-rich plasma (PRP) has gained attention as a regenerative treatment with potential longer-lasting effects.

Objective. To evaluate and compare the clinical outcomes of intra-articular PRP and corticosteroid injections in patients with early-stage knee osteoarthritis.

Methodology. A prospective quasi-randomized comparative study was conducted on 84 patients diagnosed with Kellgren-Lawrence grade 1, 2, and 3 knee osteoarthritis. Participants were allocated into two groups: one receiving a PRP injection and the other receiving a corticosteroid injection. Primary outcomes included pain reduction and functional improvement assessed using the Visual Analogue Scale (VAS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and Knee Injury and Osteoarthritis Outcome Score (KOOS) at baseline, one week, six weeks, three months, and six months. A *p*-value of <0.05 was considered statistically significant.

Results. Both treatment groups demonstrated improvement in pain and functional scores following intervention. The corticosteroid group showed more pronounced improvement during the early follow-up period. However, the PRP group exhibited greater and more sustained improvement at later follow-ups, particularly at three and six months, with better overall clinical outcomes.

Conclusion. Corticosteroid injections were effective for immediate relief of symptoms, whereas PRP provided longer-lasting benefits in terms of pain reduction and functional improvement. PRP may therefore be a preferable option for long-term management in patients with mild to moderate knee osteoarthritis.

Keywords. knee osteoarthritis, platelet-rich plasma, triamcinolone, glucocorticoids, intra-articular injections, pain, functional outcome

INTRODUCTION

Knee osteoarthritis (OA) is a progressive degenerative joint disorder characterized by the gradual breakdown of articular cartilage, subchondral bone remodelling, synovial inflammation, and loss of joint function. It is one of the most common causes of chronic pain and disability worldwide, particularly among middle-aged and elderly populations.[1,2] With increasing life expectancy, sedentary lifestyles, and rising obesity rates, the prevalence and burden of knee osteoarthritis continue to grow globally.[2] Patients commonly present with symptoms such as joint pain, stiffness, swelling, reduced mobility, and difficulty performing activities of daily living, all of which significantly impair quality of life.[1]

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Mild to moderate knee osteoarthritis represents an important stage of the disease, as early intervention may help relieve symptoms, improve function, and potentially delay disease progression and the need for surgical intervention.[3] Therefore, identifying safe, effective, and accessible treatment options during this stage remains a major clinical priority.

The pathophysiology of knee osteoarthritis is complex and involves mechanical, biochemical, and inflammatory mechanisms. Degeneration of cartilage results from an imbalance between anabolic and catabolic processes within chondrocytes, leading to progressive matrix breakdown.[4] Inflammatory mediators released within the joint further contribute to cartilage damage and pain, while structural changes such as osteophyte formation, bone marrow lesions, and joint space narrowing exacerbate disease progression.[5] Conventional treatment options, including analgesics, physical therapy, and lifestyle modifications, primarily focus on symptom control rather than altering disease progression.[6] In recent years, intra-articular injection therapies have gained increasing attention due to their targeted delivery and reduced systemic side effects.[6] Among these, corticosteroids and platelet-rich plasma (PRP) have emerged as commonly used interventions for managing symptomatic knee osteoarthritis.

Corticosteroid injections have long been used to reduce inflammation and provide rapid pain relief in patients with osteoarthritis. Their anti-inflammatory properties help suppress inflammatory mediators and reduce synovial inflammation, leading to short-term symptom improvement.[7] However, the duration of benefit is often limited, and repeated injections may carry potential risks, including cartilage damage and systemic effects.[7] In contrast, platelet-rich plasma is a biological therapy derived from autologous blood that contains concentrated platelets and growth factors. These bioactive molecules may promote tissue healing, modulate inflammation, and enhance cartilage regeneration.[8] Several studies have suggested that PRP may provide longer-lasting symptom relief and functional improvement compared to conventional therapies, although results remain variable due to differences in preparation methods and patient characteristics.[9]

Despite the widespread use of both corticosteroid and PRP injections, uncertainty remains regarding their comparative effectiveness, duration of benefit, and overall clinical outcomes in patients with mild to moderate knee osteoarthritis.[9] There is substantial heterogeneity regarding PRP preparation techniques, leukocyte content, patient selection, and duration of follow-up. Moreover, limited prospective comparative studies from Indian tertiary-care settings focusing specifically on mild-to-moderate osteoarthritis are available. Therefore, further prospective evaluation is necessary to assess reproducibility and clinical applicability in defined patient populations.[10] This study aimed to compare the clinical effectiveness of intra-articular platelet-rich plasma and corticosteroid injections in patients with mild to moderate knee osteoarthritis, focusing on pain reduction, functional improvement, and sustainability of therapeutic outcomes.

METHODOLOGY

Study design

This study was a prospective quasi-randomized comparative study to compare the clinical effectiveness of intra-articular platelet-rich plasma (PRP) injections with intra-articular corticosteroid injections in patients with mild to moderate knee osteoarthritis. Participants were divided into two groups: Group A received an intra-articular PRP injection, and Group B received an intra-articular corticosteroid injection. All procedures were performed by the same orthopaedic surgeon to maintain uniformity and reduce inter-observer variability.

Study setting

The study was conducted in the Department of Orthopaedics at GMERS Medical College and General Hospital, Gotri, Vadodara.

Study duration

The study was carried out over a period of 24 months from December 2023 to November 2025.

Study population

Patients attending the orthopaedic outpatient department with complaints suggestive of knee osteoarthritis were screened for eligibility. A total of 84 patients diagnosed with mild to moderate knee osteoarthritis were included in the study.

Inclusion criteria

- Patients aged between 40 and 60 years
- Radiographic diagnosis of knee osteoarthritis grades 1, 2, and 3 according to the Kellgren-Lawrence classification
- Unilateral knee osteoarthritis or bilateral involvement with one knee more symptomatic
- Availability of baseline scoring using Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Visual Analogue Scale (VAS), and Knee Injury and Osteoarthritis Outcome Score (KOOS) scale

Exclusion criteria

- Immunosuppression or chronic immunocompromised state
- Inflammatory arthritis, including rheumatoid arthritis and gout
- Intra-articular injection within the previous six months
- Known diabetes mellitus
- Bone tumors or metabolic bone diseases
- History of knee arthroscopy within the previous six months

Sample size

The sample size was calculated assuming a prevalence of osteoarthritis of 30%, with a 95% confidence interval and an allowable error of 10%. Based on this calculation, a total sample size of 84 patients was determined. Participants were divided equally into two groups, with 42 patients in the PRP group and 42 patients in the corticosteroid group.

Randomization

Participants were allocated into two groups using an alternate sequence method (Quasi-randomization). Consecutive eligible patients were alternately assigned to either Group A (PRP) or Group B (corticosteroid). This method ensured equal distribution of participants between groups and facilitated feasibility in the outpatient clinical setting.

Intervention protocol

Group A – Platelet-rich plasma injection

Participants in Group A received a single intra-articular injection of 5 ml platelet-rich plasma prepared using a standardized double-spin centrifugation technique as per institutional protocol. Approximately 20 ml of autologous venous blood was collected under aseptic precautions. The first centrifugation was performed at 1500 rpm for 10 minutes, followed by a second centrifugation at 3500 rpm for 10 minutes. The final preparation was leukocyte-poor platelet-rich plasma (LP-PRP) with a platelet concentration approximately 3–5 times the baseline platelet count. The intervention product (IP; in this case, LP-PRP) was administered aseptically into the affected knee joint using fluoroscopic guidance, confirming placement in both antero-posterior and lateral views, targeting the medial compartment.

Group B – Corticosteroid injection

Participants in Group B received a single intra-articular injection of 2 ml (80 mg) triamcinolone acetonide. The IP was administered aseptically using fluoroscopic guidance in both anteroposterior and lateral views, targeting the medial compartment of the knee.

Patients were advised to avoid non-steroidal anti-inflammatory drugs (NSAIDs) and other anti-inflammatory medications for five days before and after injection to prevent interference with platelet activation and treatment response.

Outcome measures

Primary Outcome Measures (reduction in pain and improved functional outcome) were assessed using:

- WOMAC score
- Visual Analogue Scale (VAS)
- KOOS scale

Secondary outcomes included:

- Functional improvement in mobility of the joint
- Duration of relief of symptoms

Assessment tools

WOMAC Index**:** The WOMAC index was used to evaluate pain, stiffness, and physical function. The scores were converted to a percentage scale.

KOOS Scale: The KOOS questionnaire assessed pain, symptoms, activities of daily living, sport and recreation function, and knee-related quality of life. Scores ranged from 0 to 100.

Visual Analogue Scale (VAS)**:** Pain intensity was measured on a scale from 0 (no pain) to 10 (worst imaginable pain).

Kellgren-Lawrence Classification: Radiographic grading was performed using the Kellgren-Lawrence classification to determine the severity of osteoarthritis.

Follow-up schedule

Patients were evaluated at the following intervals:

- Baseline (pre-injection)
- One week
- Six weeks
- Three months
- Six months

At each follow-up, WOMAC, VAS, and KOOS scores were recorded along with range of motion, joint tenderness, crepitus, and joint stability.

Ethical Considerations

Written informed consent was obtained from all participants before enrollment. The study was approved by the Institutional Human Ethics Committee of GMERS Medical College and Hospital, Gotri, Vadodara (IHEC/25/OUT/SRPG0215). Confidentiality of patient data was maintained throughout the study.

Statistical analysis

Data were analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Intergroup comparisons were performed using Student's t-test and Chi-square test as applicable. A *p*-value of <0.05 was considered statistically significant. No artificial intelligence-based tools were used for statistical analysis or data interpretation.

RESULTS

A total of 84 patients with mild to moderate knee osteoarthritis were included in the study, with 42 patients allocated to the corticosteroid (CS) group and 42 patients allocated to the platelet-rich plasma (PRP) group.

The sociodemographic characteristics of participants, including age distribution, sex, body mass index (BMI), affected side, Kellgren-Lawrence grade, and associated comorbidities, are presented in Table 1.

Changes in patient recovery parameters over time, including WOMAC score, VAS score, KOOS score, and range of movement, are summarized in Table 2.

At baseline, mean WOMAC scores were 53.00 ± 8.20 in the CS group and 54.55 ± 9.63 in the PRP group, showing no statistically significant difference (p = 0.43). The differences in WOMAC scores between groups at one week (37.45 ± 7.68 vs 49.17 ± 8.23), six weeks (35.26 ± 7.62 vs 40.88 ± 7.71), three months (41.40 ± 7.44 vs 34.48 ± 7.22), and six months (46.38 ± 8.97 vs 31.55 ± 6.86), were statistically significant (p <0.001, p = 0.001, p <0.001, and p <0.001 respectively) (Table 2, Figure 1).

Baseline VAS scores were 7.23 ± 0.798 in the CS group and 6.88 ± 0.878 in the PRP group, with no statistically significant difference (p = 0.056). At one week (4.98 ± 0.841 vs 6.00 ± 0.960) and six weeks (4.68 ± 0.768 vs 5.08 ± 0.800), the differences were statistically significant (p <0.001 and p = 0.023, respectively). At three months (5.75 ± 0.817 vs 4.16 ± 0.730) and six months (6.41 ± 0.909 vs 3.76 ± 0.789), the differences remained statistically significant (both p <0.001) (Table 2, Figure 2).

At baseline, KOOS scores were 55.10 ± 6.431 in the CS group and 53.64 ± 8.234 in the PRP group, with no statistical significance (p = 0.370). At one week (65.86 ± 7.547 vs 57.67 ± 7.250) six weeks (66.38 ± 6.991 vs 61.57 ± 7.768), three months (62.83 ± 6.900 vs 67.76 ± 7.606), and six months (60.00 ± 8.270 vs 68.74 ± 6.652) the differences were statistically significant (p <0.001, p = 0.004, p = 0.003, and p <0.001, respectively) (Table 2, Figure 3).

In addition to statistical significance testing, effect sizes with 95% confidence intervals were calculated for major outcome measures to assess the magnitude and clinical relevance of treatment effects (Table 2).

At the final follow-up at six months, grade I medial joint tenderness was observed in 66.7% of the PRP group and none in the CS group, while grade II tenderness was observed in 33.3% of the CS group and 31% of the PRP group. Grade III tenderness was seen in 66.7% of the CS group as compared to 2.4% of the PRP group. The difference in medial joint tenderness distribution was statistically significant (p <0.001) (Table 3).

No major complications such as septic arthritis, neurovascular injury, or persistent injection-site complications were observed in either group. Mild transient post-injection pain and mild swelling were noted in a few PRP-treated patients and resolved conservatively within 48 hours.

Table 1. Sociodemographic parameter distribution in study participants (N = 84)

Parameters	Corticosteroid		Platelet-rich-plasma		*p*-value
	N	%	N	%	
Age group (years)					
<50	11	26.2	14	33.3	0.768
51-54	16	38.1	14	33.3	
55-60	15	35.7	14	33.3	
Sex					
Female	26	61.9	27	64.3	0.821
Male	16	38.1	15	35.7	
BMI (kg/ m²)					
18.5–24.9	6	14.3	7	16.7	0.763
25–29.9	36	85.7	35	83.3	
Laterality					
Left	22	52.4	25	59.5	0.510
Right	20	47.6	17	40.5	
KL grade					
1	11	26.2	10	23.8	0.90
2	18	42.9	20	47.6	
3	13	31.0	12	28.6	
Comorbidities					
Asthma	4	9.5	3	7.1	0.924
Dyslipidemia	2	4.8	3	7.1	
Hypertension	6	14.3	8	19.0	
Hypothyroidism	6	14.3	7	16.7	
None	24	57.1	21	50.0	

BMI = body mass index, KL = Kellgren-Lawrence

DISCUSSION

The present study evaluated and compared the clinical effectiveness of intra-articular platelet-rich plasma (PRP) and corticosteroid (CS) injections in patients with mild to moderate knee osteoarthritis. The present study contributes prospective comparative data from an Indian tertiary-care population with predominantly mild-to-moderate osteoarthritis. The findings demonstrate a distinct difference in the pattern of response between the two treatment modalities, with corticosteroids providing rapid short-term relief, while PRP offers superior and sustained long-term improvement in pain and functional outcomes.

Baseline demographic characteristics in the present study were comparable between both groups, allowing for a reliable comparison of outcomes. The majority of patients were in the fifth and sixth decades of life with a female predominance,

Table 2. Patient recovery parameters change over time distribution in patients (N = 84)

Score	CS, Mean ± SD	PRP, Mean ± SD	Mean Difference (95% CI)	*p*-value
WOMAC				
Baseline	53.00 ± 8.20	54.55 ± 9.63	−1.55 (−5.42 to 2.32)	0.430
1 week	37.45 ± 7.68	49.17 ± 8.23	−11.72 (−15.18 to −8.26)	<0.001*
6 weeks	35.26 ± 7.62	40.88 ± 7.71	−5.62 (−8.90 to −2.34)	0.001*
3 months	41.40 ± 7.44	34.48 ± 7.22	6.92 (3.78 to 10.06)	<0.001*
6 months	46.38 ± 8.97	31.55 ± 6.86	14.83 (11.45 to 18.21)	<0.001*
VAS				
Baseline	7.23 ± 0.798	6.88 ± 0.878	0.35 (−0.01 to 0.71)	0.056
1 week	4.98 ± 0.841	6.00 ± 0.960	−1.02 (−1.41 to −0.63)	<0.001*
6 weeks	4.68 ± 0.768	5.08 ± 0.800	−0.40 (−0.74 to −0.06)	0.023*
3 months	5.75 ± 0.817	4.16 ± 0.730	1.59 (1.25 to 1.93)	<0.001*
6 months	6.41 ± 0.909	3.76 ± 0.789	2.65 (2.29 to 3.01)	<0.001*
KOOS				
Baseline	55.10 ± 6.431	53.64 ± 8.234	1.46 (−1.72 to 4.64)	0.370
1 week	65.86 ± 7.547	57.67 ± 7.250	8.19 (4.98 to 11.40)	<0.001*
6 weeks	66.38 ± 6.991	61.57 ± 7.768	4.81 (1.55 to 8.07)	0.004*
3 months	62.83 ± 6.900	67.76 ± 7.606	−4.93 (−8.12 to −1.74)	0.003*
6 months	60.00 ± 8.270	68.74 ± 6.652	−8.74 (−11.96 to −5.52)	<0.001*
ROM (in degrees)				
Baseline	113.83 ± 8.787	114.76 ± 8.998	−0.93 (−4.79 to 2.93)	0.634
1 week	115.38 ± 9.469	115.64 ± 9.318	−0.26 (−4.28 to 3.76)	0.899
6 weeks	115.50 ± 8.721	115.88 ± 8.926	−0.38 (−4.18 to 3.42)	0.844
3 months	115.36 ± 8.582	117.19 ± 9.072	−1.83 (−5.69 to 2.03)	0.344
6 months	114.57 ± 8.311	117.52 ± 8.937	−2.95 (−6.73 to 0.83)	0.121

**p*-value – statistically significant

WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index, VAS = Visual Analogue Scale, KOOS = Knee Injury and Osteoarthritis Outcome Score, ROM = Range of motion

Table 3. Patient recovery parameters at six months (N = 84)

Parameters	Corticosteroid		Platelet-rich-plasma		*p*-value
	N	%	N	%	
Medial Joint Line Tenderness [11]					
Grade - 1	0	0	28	66.7	<0.001*
Grade - 2	14	33.3	13	31.0	
Grade - 3	28	66.7	1	2.4	
Crepitus					
Mild	27	64.30	22	52.40	0.54
Moderate	10	23.80	13	31.00	
None	5	11.90	7	16.70	
Varus-valgus laxity [12]					
Grade – 0	33	78.60	35	83.30	0.58
Grade – 1	9	21.40	7	16.70	
Anterior-posterior laxity [13]					
Grade – 0	36	85.70	36	85.70	1.00
Grade – 1	6	14.30	6	14.30	

**p*-value – statistically significant

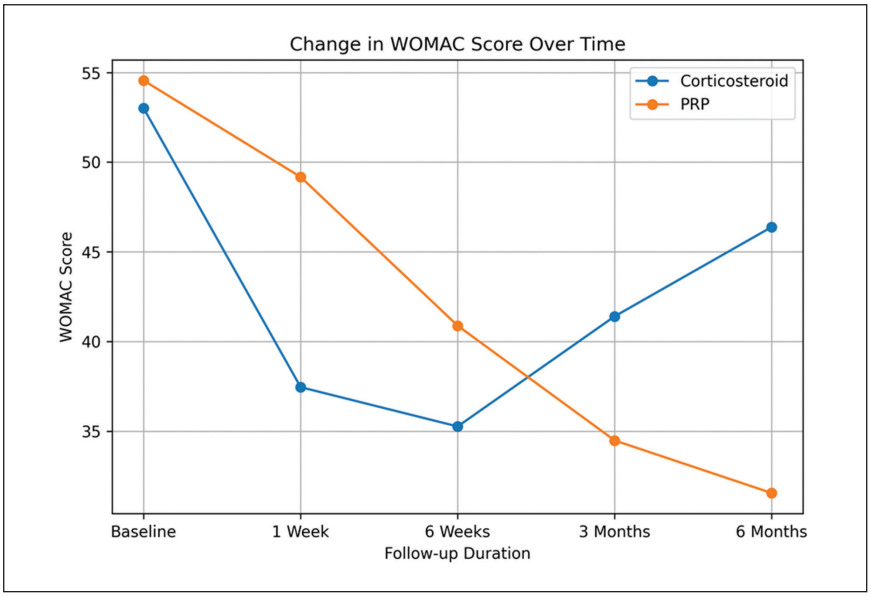


Figure 1. Change in WOMAC score over time (linear distribution) (N = 84).

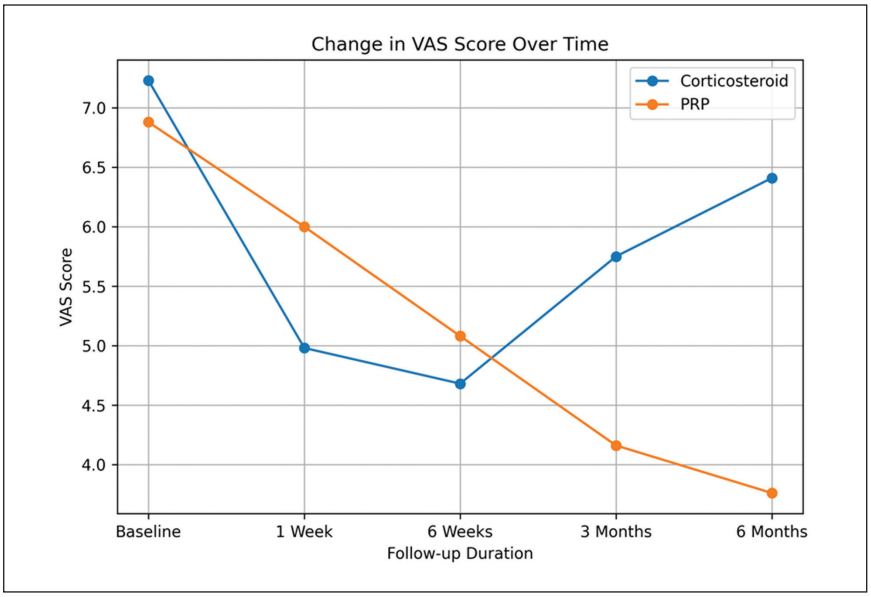


Figure 2. Change in VAS score over time (N = 84).

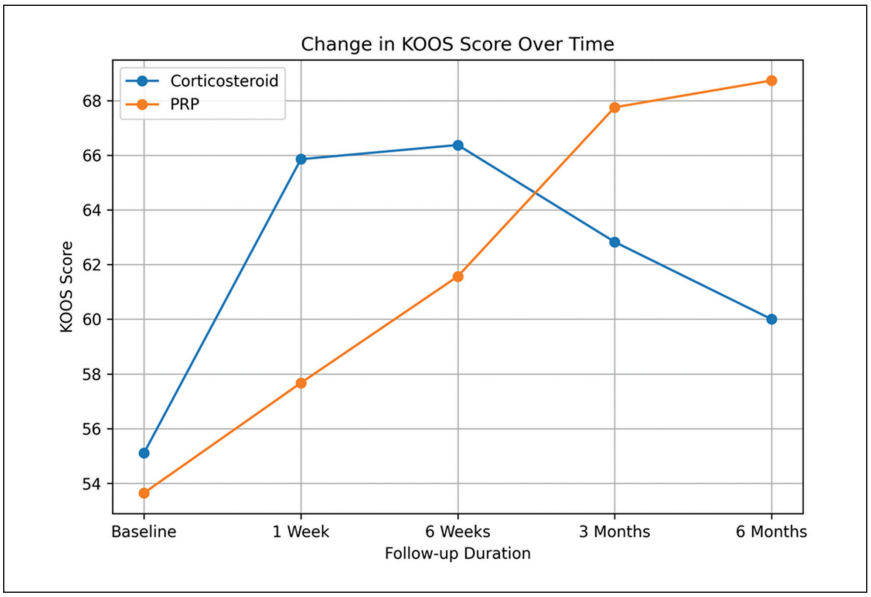


Figure 3. Change in KOOS score over time (N = 84).

which is consistent with the epidemiological profile of knee osteoarthritis reported in previous studies.[14] The high prevalence of overweight individuals in both groups further supports the established association between increased body mass index and osteoarthritis progression.

In the present study, corticosteroid injections showed significant improvement in WOMAC, VAS, and KOOS scores during early follow-up at one week and six weeks. This rapid improvement can be attributed to the potent anti-inflammatory action of corticosteroids, which reduce synovial inflammation and suppress inflammatory mediators within the joint. Similar findings have been reported by Ayhan et al., where corticosteroids provided effective short-term pain relief and functional improvement.[15] However, this benefit declined over time, with reduced efficacy observed at three and six months, respectively, highlighting the transient nature of corticosteroid therapy.

In contrast, PRP injections demonstrated gradual but significantly greater improvement in clinical outcomes at later follow-up periods. At three and six months, PRP showed superior improvement in WOMAC, VAS, and KOOS scores compared to corticosteroids. This sustained effect may be attributed to the biological properties of PRP, which contains growth factors that promote tissue repair, modulate inflammation, and support cartilage homeostasis. Previous studies have similarly reported that PRP provides better long-term pain relief and functional outcomes compared to corticosteroids.[10]

Recent systematic reviews and meta-analyses have further supported these findings. Studies have demonstrated that PRP has a higher probability of improving pain and functional outcomes at mid- and long-term follow-up compared to corticosteroids and other intra-articular therapies.[16] These findings reinforce the results of the present study and highlight the growing role of PRP as a regenerative treatment modality in early osteoarthritis.

Despite improvements in pain and function, no statistically significant difference was observed between the two groups in terms of range of motion. This suggests that intra-articular injections primarily influence symptomatic relief rather than structural joint changes over a short duration. Similar observations have been reported by Ayhan et al.[15]

Although the findings of the present study are consistent with most of the available literature, the lack of standardization remains a major limitation in the widespread application of PRP therapy and requires further investigation.[17]

The present findings are consistent with previously reported pharmacodynamic trends wherein corticosteroid injections provide superior short-term symptomatic relief, while platelet-rich plasma (PRP) demonstrates better sustained improvement at mid-term and long-term follow-up. Recent randomized controlled trials and systematic reviews published after 2020 have similarly reported superior functional and pain-related outcomes with PRP compared to corticosteroid injections in patients with knee osteoarthritis. However, considerable heterogeneity persists across available literature regarding PRP preparation protocols, leukocyte concentration, platelet count, and patient selection criteria, limiting direct comparison between studies. The present study further contributes prospective comparative data from an Indian tertiary-care population with predominantly mild-to-moderate osteoarthritis and lower Kellgren-Lawrence grades. Additionally, the relatively younger age group included in the present study may partially explain the favorable response observed with PRP therapy, as biologic treatment modalities may demonstrate greater regenerative potential in early-stage osteoarthritis.[18]

STUDY LIMITATIONS

This study has certain limitations. It was conducted at a single center with a relatively small sample size, which may limit the generalization to the common population. The quasi-randomized alternate allocation method may introduce selection bias. The sample size may be underpowered for WOMAC-based subgroup analysis. In addition, the study was not blinded, which may have influenced subjective outcome assessment measures. The follow-up duration was limited to six months and may not reflect long-term outcomes for a chronic degenerative condition. Besides, Magnetic Resonance Imaging (MRI) was not performed at baseline or at the endpoint of the study, which may have provided additional information on the potential of PRP in cartilage regeneration. Potential confounding factors, including patient activity level and adherence to lifestyle modifications, were not strictly controlled.

CONCLUSION

The findings of the present study demonstrate that intra-articular corticosteroid injections provided rapid but short-term relief in patients with mild to moderate knee osteoarthritis, whereas platelet-rich plasma injections resulted in gradual yet more sustained improvement in pain and functional outcomes. Although both modalities were effective, PRP showed superior long-term benefits and may be considered a more favorable therapeutic option for ongoing symptom management. These results support the growing role of biologic therapies in early osteoarthritis and highlight the need for further large-scale studies with longer follow-up to establish standardized treatment protocols.

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The authors utilized ChatGPT (an AI tool) for language editing and improvement of manuscript readability. No AI tools were used for data analysis or figure generation. All content has been reviewed and finalized by the authors.

STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE (International Committee of Medical Journal Editors) authorship criteria.

CREDIT AUTHOR STATEMENT

CVT: Conceptualization, Methodology, Writing – review and editing; **BCR:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft preparation, Writing – review and editing; **MAP:** Methodology, Validation, Formal analysis, Writing – original draft preparation, Writing – review and editing; **HBR:** Formal analysis, Investigation, Data curation, Writing – review and editing; **SKP:** Validation, Writing – review and editing.

DATA AVAILABILITY STATEMENT

The datasets generated and/or analyzed during the current study are not publicly available due to patient confidentiality and lack of consent for data sharing, but are available from the corresponding author on reasonable request.

AUTHOR DISCLOSURE

The authors declared no conflict of interest.

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None.

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The Philippine Journal of Orthopaedics

ORIGINAL ARTICLE

Electromyographic Analysis of Rotator Cuff Muscle Activity During Shoulder Immobilization: Standard Sling versus Abduction Sling in Filipinos

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ABSTRACT

Objectives. To compare supraspinatus and infraspinatus muscle activity using needle electromyography (EMG) between a standard arm sling and an abduction sling in healthy Filipino adults.

Methodology. This experimental pilot study included 34 healthy Filipino adults aged 18–40 years without prior shoulder pathology. Needle electromyography was performed by a single licensed and experienced electromyographer. Baseline electromyographic recordings obtained during active shoulder forward flexion, abduction, and external rotation confirmed appropriate muscle activation and correct needle placement before immobilization testing. Motor unit action potential (MUAP) recruitment and amplitude were evaluated under two immobilization conditions: a standard arm sling with the shoulder positioned in internal rotation and adduction, followed by an abduction sling positioned at approximately 30° of shoulder abduction with slight external rotation.

Results. Thirty-four participants completed the study. The study population consisted of 21 males (61.8%) and 13 females (38.2%), with a mean age of 28.9 ± 5.5 years. Twenty-eight participants (82.4%) were right-hand dominant, while six (17.6%) were left-hand dominant. Baseline electromyographic recordings demonstrated normal motor unit recruitment in both target muscles. During resting immobilization, complete absence of detectable motor unit recruitment and MUAP amplitude was observed in both the supraspinatus and infraspinatus muscles under both the standard arm sling and abduction sling conditions. Identical electromyographic findings were demonstrated in all participants regardless of the immobilization method.

Conclusion. Both the standard arm sling and the abduction sling demonstrated complete electromyographic quiescence of the supraspinatus and infraspinatus muscles during resting immobilization. Neither immobilization method demonstrated a measurable advantage over the other with respect to resting electromyographic muscle activity. However, because this study evaluated muscle electrical activity rather than passive tendon tension, these findings should not be interpreted as evidence of biomechanical equivalence between sling positions. Further prospective studies involving postoperative rotator cuff repair patients are warranted.

Keywords. rotator cuff, electromyography, shoulder immobilization, arm sling, abduction arm sling

INTRODUCTION

Rotator cuff tears are a frequent cause of shoulder pain and weakness, with prevalence increasing with age and affecting approximately 30–50% of individuals over 50 years.[1] Several factors influence outcomes following rotator cuff repair, including tear size, location, muscle atrophy, tendon quality, repair tension, smoking status, and postoperative rehabilitation.[2-4] Despite advances in surgical management, there remains no clear consensus regarding optimal postoperative immobilization strategies.[5,6] Postoperative shoulder immobilization plays a critical role in protecting the repaired tendon during the early phases of healing by minimizing excessive mechanical stress across the repair construct. Among the available methods, the abduction sling has traditionally

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been favored because biomechanical studies have demonstrated reduced passive tension and gap formation across the repaired supraspinatus tendon when the shoulder is maintained in slight abduction and external rotation.[7-11] However, despite these biomechanical advantages, randomized clinical trials and systematic reviews have demonstrated comparable pain scores, functional outcomes, tendon healing rates, and retear rates compared with standard arm slings.[2,7,12-14]

Electromyography (EMG) is an objective method for evaluating muscle activation by recording electrical activity generated by motor units.[6] The motor unit action potential (MUAP) reflects the combined electrical activity of muscle fibers within a motor unit.[15] EMG has been widely used to assess muscle function and guide rehabilitation, particularly in postoperative settings.[4] Needle electromyography permits selective evaluation of deep muscles such as the supraspinatus and infraspinatus, which cannot be reliably isolated using surface electrodes because of signal contamination from adjacent musculature.[16,17] However, there is limited evidence comparing rotator cuff muscle activity across different immobilization positions. Furthermore, passive tendon loading and active muscle contraction represent distinct biomechanical mechanisms. Although shoulder position may influence passive tension across the repaired tendon, electromyography measures only the electrical activity generated by muscle contraction and therefore provides complementary information regarding postoperative muscle quiescence.[9-11,17]

This study aimed to compare rotator cuff muscle activity between a standard arm sling and an abduction sling using EMG in a Filipino population. To our knowledge, no published study has compared electromyographic activity of the supraspinatus and infraspinatus muscles between a standard arm sling and an abduction sling in a Filipino population. Establishing baseline electrophysiologic data among healthy Filipino adults may provide locally relevant evidence to guide future investigations involving postoperative rotator cuff repair patients and contribute to evidence-based shoulder rehabilitation protocols. This study sought to establish baseline data and identify the immobilization position that minimizes voluntary muscle activation of the supraspinatus and infraspinatus muscles during resting shoulder immobilization.

METHODOLOGY

The study protocol was approved by the Institutional Review Board of a tertiary hospital (IRB No. 2022-33-01-A) and was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrollment. The experimental pilot study was conducted at the Electromyography-Nerve Conduction Study (EMG-NCS).

A total of 34 participants were recruited based on a priori sample size calculation using G*Power version 3.1 with an alpha level of 0.05 and a statistical power of 80%. Healthy Filipino adults aged 18–40 years without prior shoulder injury or surgery involving the dominant limb were included. To minimize the possibility of including participants with asymptomatic rotator cuff pathology, only young adults were recruited. For consistency and standardization of the examination, only the dominant shoulder of each participant was evaluated. Participants were screened clinically to exclude shoulder pathology using standard shoulder examination protocols.[18] The clinical evaluation included inspection for deformity and muscle atrophy, palpation for tenderness, assessment of active and passive range of motion, rotator cuff muscle strength testing using a handheld dynamometer, and examination for shoulder instability and impingement. Participants demonstrating pain, weakness, restricted range of motion, instability, or any clinical findings suggestive of rotator cuff pathology were excluded from the study.

Needle electromyography was performed by a single licensed and experienced electromyographer using a Cadwell Sierra Summit® 2-Channel electromyography system (Cadwell Laboratories, Kennewick, WA, USA) and sterile disposable monopolar EMG needle electrodes (PRO-37SAF, 37 mm × 27 gauge; The Electrode Store, Buckley, WA, USA). Standard EMG settings include sensitivity of 100μV per division and sweep speed of 10 milliseconds per division. Needle electromyography was selected instead of surface electromyography because the supraspinatus and infraspinatus are deep muscles that cannot be reliably isolated using surface electrodes due to signal contamination from adjacent musculature. Needle EMG permits selective assessment of individual rotator cuff muscles and remains the reference standard for evaluating motor unit activity in deep muscles.[4,16,17]

Prior to immobilization, baseline needle electromyographic recordings were obtained during active shoulder forward flexion, abduction, and external rotation to confirm appropriate muscle localization and correct needle placement. Demonstration of normal motor unit recruitment during these maneuvers confirmed accurate localization of the target muscles before recordings under resting conditions were performed.

Participants were comfortably seated in a straight-backed examination chair with back support, both feet resting flat on the floor, and the trunk maintained in an upright neutral position. The standard arm sling was applied first with the shoulder positioned in internal rotation and adduction, followed by the abduction sling positioned at approximately 30° of shoulder abduction with slight external rotation. Following application of each immobilization device, a standardized 5-minute accommodation period was observed to allow proper sling fit, maintenance of the intended shoulder position, and participant comfort before electromyographic recordings were obtained. Recordings were performed only after participants confirmed that they were comfortable and no further sling adjustments were required (Figure 1).

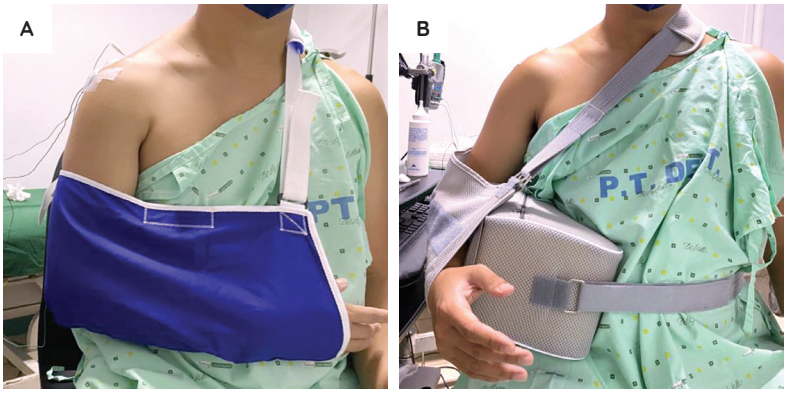


Figure 1. Immobilization techniques of the upper limb used in the study. Standard arm sling: the shoulder is adducted, the arm is on the side and the forearm rests on the anterior torso **(A)**. Abduction arm sling: arm is approximately 30° abducted and the shoulder is in slightly external rotation **(B)**.

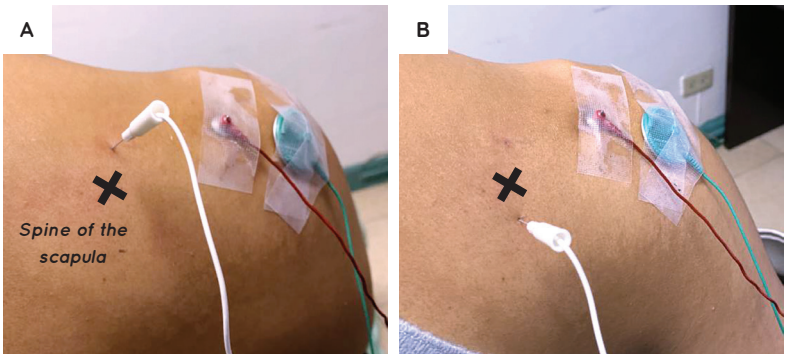


Figure 2. Anatomic placement of needle electrodes. A single disposable needle electrode was inserted at separate times into the supraspinatus and infraspinatus muscles. Needle electrodes were inserted into the supraspinatus 1.5 cm superior to the midpoint of spine of the scapula **(A)** and into the infraspinatus 2.5 cm inferior to the midpoint of spine of the scapula **(B)**.

Needle electrodes were inserted into the supraspinatus and infraspinatus muscles individually using standard anatomical landmarks (Figure 2). Needle electrodes were then inserted into the supraspinatus 1.5 cm superior to the midpoint of spine of the scapula and into the infraspinatus 2.5 cm inferior to the midpoint of spine of the scapula, for isolated EMG testing.

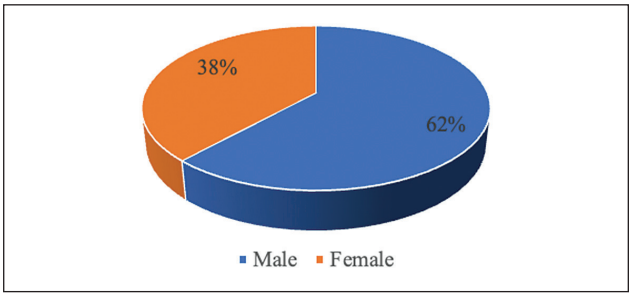


Figure 3. Distribution of participants according to sex.

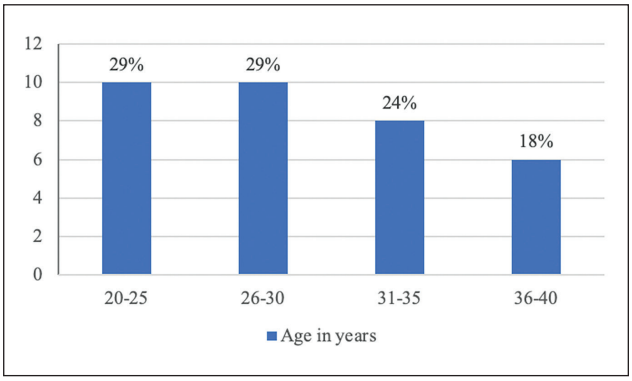


Figure 4. Distribution of participants according to age group.

All examinations were performed by the same electromyographer under identical testing conditions and standardized recording parameters to maximize reproducibility and minimize measurement variability.

The primary outcome measures were MUAP recruitment and amplitude under both immobilization conditions. Electromyographic recordings were evaluated for the presence or absence of spontaneous motor unit recruitment and measurable MUAP amplitude during resting shoulder immobilization.

Data were summarized using descriptive statistics. Continuous variables are presented as mean ± standard deviation, whereas categorical variables are presented as frequencies and percentages. Because all EMG recordings demonstrated absence of activity (zero values) in both conditions, inferential statistical comparisons were not applicable. Since no variability existed within the electromyographic dataset, hypothesis testing was not performed.

RESULTS

Thirty-four participants successfully completed the study protocol. The study population consisted of 21 males (61.8%) and 13 females (38.2%), with a mean age of 28.9 ± 5.5 years (range, 20–39 years) (Figures 3 and 4). Twenty-eight participants (82.4%) were right-hand dominant, while six (17.6%) were left-hand dominant (Figure 5).

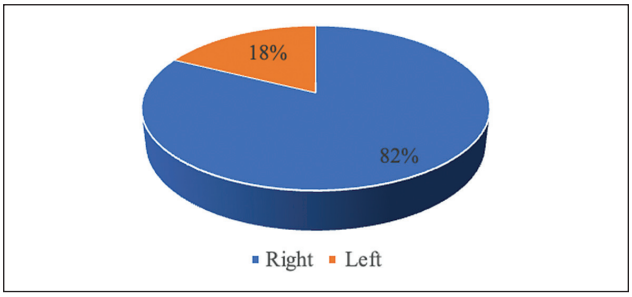


Figure 5. Distribution of participants according to handedness.

Baseline needle electromyographic recordings obtained during active shoulder forward flexion, abduction, and external rotation demonstrated normal motor unit recruitment in both the supraspinatus and infraspinatus muscles in all participants, confirming appropriate muscle localization and correct needle placement before immobilization testing (Figures 6 and 7).

During resting immobilization, electromyographic analysis demonstrated complete absence of detectable motor unit recruitment and motor unit action potential (MUAP) amplitude in both the supraspinatus and infraspinatus muscles under both the standard arm sling and abduction sling conditions. Identical findings were observed in all participants, demonstrating complete electromyographic quiescence regardless of immobilization method. Because all recordings demonstrated uniformly absent electromyographic activity, no variability existed within the dataset; therefore, inferential statistical analysis was not performed.

DISCUSSION

Various shoulder immobilization methods are used in clinical practice, yet no universally accepted postoperative protocol exists following rotator cuff repair.[5,19] While immobilization is traditionally recommended during the early postoperative period to protect the repair and facilitate tendon healing,[20] early mobilization has also been proposed to improve functional recovery without compromising repair integrity in selected patients.[5,21]

The mechanical environment plays a critical role in tendon healing, with increased repair-site tension associated with a greater risk of structural failure.[12] Biomechanical studies

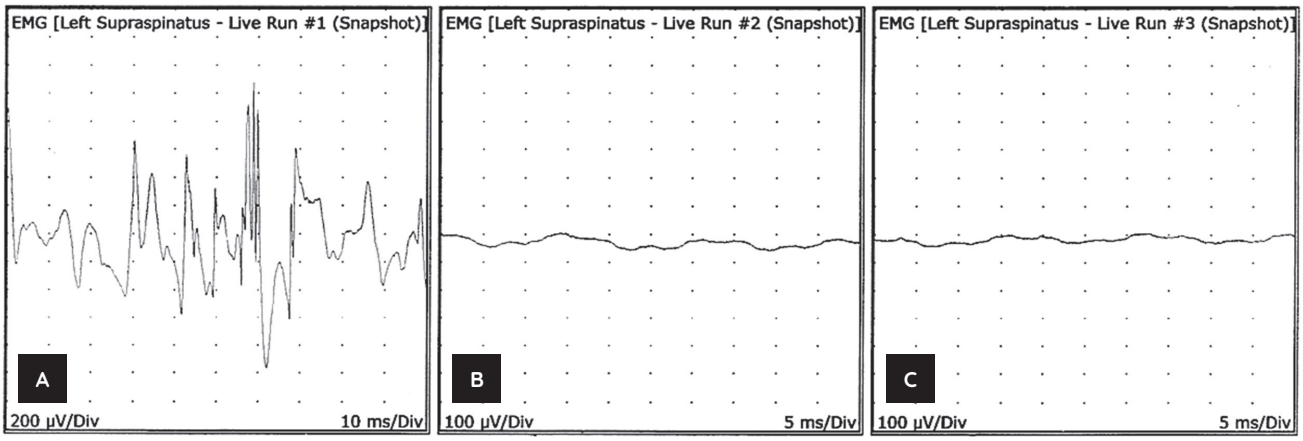


Figure 6. Sample electromyography waveforms of the supraspinatus muscle. During active shoulder movement **(A)**, with standard arm sling **(B)**, and with abduction sling **(C)**.

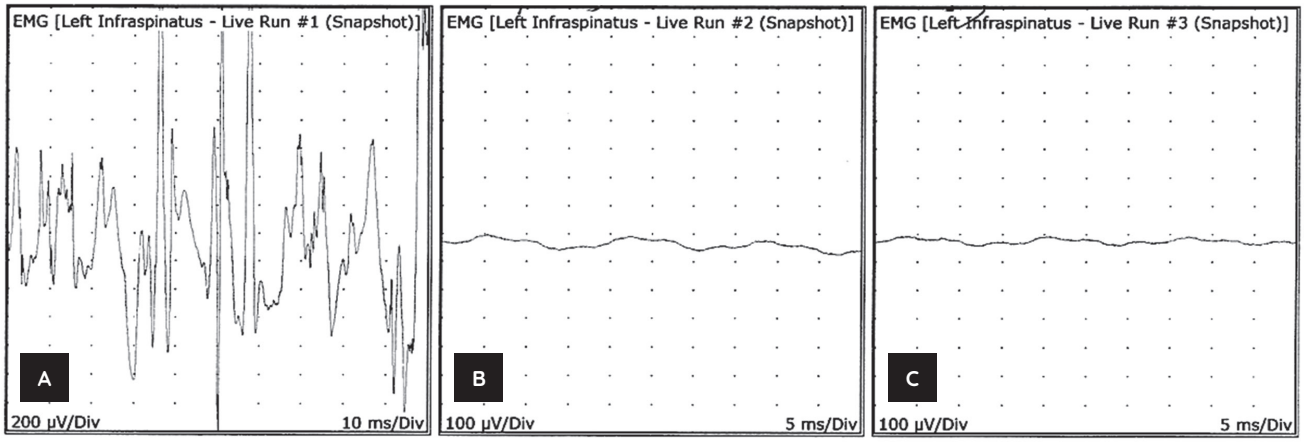


Figure 7. Sample electromyography waveforms of the infraspinatus muscle. During active shoulder movement **(A)**, with standard arm sling **(B)**, and with abduction sling **(C)**.

have demonstrated that positioning the shoulder in slight abduction decreases passive strain across the repaired supraspinatus tendon and reduces gap formation at the repair site.[8-11] Consequently, abduction slings have traditionally been recommended, particularly following repair of large or massive rotator cuff tears. However, randomized clinical trials and systematic reviews have reported no significant differences in postoperative pain, functional outcomes, tendon healing, or retear rates between patients treated with standard arm slings and those managed with abduction slings.[2,7,12-14]

The present study evaluated electromyographic muscle activity rather than passive tendon tension, and this distinction is fundamental when interpreting the findings. Passive tendon loading and active muscle contraction represent separate biomechanical mechanisms. Although shoulder position may influence passive tension across the repaired tendon, electromyography measures only the electrical activity generated by muscle contraction. Consequently, the complete absence of electromyographic activity observed under both immobilization conditions indicates successful suppression of voluntary supraspinatus and infraspinatus muscle activation during resting immobilization but should not be interpreted as evidence that both immobilization methods produce identical passive biomechanical loading of the repaired tendon.

The present study provides objective electrophysiologic evidence that both the standard arm sling and the abduction sling eliminate detectable rotator cuff muscle activity during resting immobilization. Because electromyographic activity was uniformly absent across all participants under both conditions, meaningful statistical comparison was not possible owing to the absence of variability in the recorded outcomes.

Our findings complement previous biomechanical investigations rather than contradict them. Whereas earlier studies demonstrated reduced passive tendon strain with shoulder abduction, the present study demonstrates that both immobilization methods effectively eliminate detectable supraspinatus and infraspinatus muscle activation during resting conditions. Together, these findings suggest that passive tendon tension and muscle electrical activity should be regarded as complementary rather than interchangeable considerations when selecting postoperative immobilization strategies.

These findings are particularly relevant during the early postoperative period, when minimizing mechanical stress on the repair construct is critical for tendon healing. Although the present study did not directly evaluate postoperative patients or tendon biomechanics, the demonstration of complete electromyographic quiescence under both immobilization conditions suggests that either sling effectively suppresses voluntary rotator cuff muscle activation while the shoulder remains at rest.

From a clinical perspective, these findings support a more individualized approach to postoperative immobilization. Selection of the immobilization device should continue to consider tear characteristics, repair configuration, surgeon preference, patient comfort, compliance, availability, and cost rather than relying solely on theoretical differences in muscle activation. This is particularly relevant in resource-limited environments such as the Philippines, where the lower cost and wider availability of a standard arm sling may improve patient adherence without compromising electromyographic muscle quiescence during resting immobilization.

Several strengths of the present study should be acknowledged. Needle electromyography remains the reference standard for evaluating motor unit activity in deep muscles such as the supraspinatus and infraspinatus. All examinations were performed by a single experienced electromyographer using a standardized protocol, thereby minimizing interobserver variability. Baseline muscle activation confirmed appropriate muscle localization and correct needle placement before immobilization testing, while identical participant positioning, recording conditions, and examination sequence enhanced the reproducibility of the findings.

Limitations of the study include the use of healthy participants rather than postoperative patients and the relatively small sample size. Electromyographic activity was evaluated only during resting immobilization and did not include dynamic shoulder movement or rehabilitation exercises. Passive tendon tension was not directly measured; therefore, biomechanical differences between immobilization methods cannot be inferred solely from electromyographic findings. Although participants underwent standardized clinical screening to exclude shoulder pathology, advanced imaging such as magnetic resonance imaging or ultrasonography was not routinely performed to exclude asymptomatic rotator cuff abnormalities. Finally, participants were evaluated sequentially using the standard arm sling followed by the abduction sling without randomization of the testing order. Although identical findings were obtained under both conditions, the possibility of an order effect cannot be completely excluded.

Future prospective studies involving postoperative rotator cuff repair patients should integrate electromyographic assessment with biomechanical measurements, imaging evaluation of tendon healing, and validated clinical outcome measures to further define the relationship between muscle quiescence, passive tendon tension, and optimal postoperative shoulder immobilization.

CONCLUSION

Both standard arm sling and abduction sling immobilization positions resulted in complete electromyographic quiescence of the supraspinatus and infraspinatus muscles during resting shoulder immobilization in healthy Filipino adults. Neither immobilization method demonstrated a measurable

advantage over the other with respect to resting electromyographic muscle activity.

However, because this study evaluated muscle electrical activity rather than passive tendon tension, these findings should not be interpreted as evidence of biomechanical equivalence between sling positions.

Postoperative immobilization should therefore continue to be individualized according to tear characteristics, surgical technique, biomechanical requirements, surgeon preference, patient comfort, compliance, availability, and cost.

Further prospective studies involving postoperative rotator cuff repair patients incorporating electromyographic, biomechanical, imaging, and clinical outcome assessments are warranted.

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STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

CREDIT AUTHOR STATEMENT

RAAE: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Visualization, Project administration; **JMOA:** Conceptualization, Methodology, Validation, Investigation, Resources, Data curation, Writing – review and editing; **JCR:** Conceptualization, Methodology, Validation, Supervision, Writing – Review and editing; **RNE:** Conceptualization, Methodology, Formal analysis, Validation, Supervision, Writing – review and editing.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed in this study are included in the published article.

AUTHOR DISCLOSURE

The authors declared no conflict of interest.

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ORIGINAL ARTICLE

Early Outcomes of Ponseti Treatment for Idiopathic and Non-Idiopathic Clubfoot at a Philippine Tertiary Government Hospital

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ABSTRACT

Background. The Ponseti method achieves less predictable outcomes and higher workloads in rigid non-idiopathic clubfoot compared to idiopathic cohorts. Structural and socioeconomic barriers further complicate management in low- and middle-income countries.

Objective. The purpose of the study was to evaluate the early outcomes of Ponseti treatment for both idiopathic and non-idiopathic clubfoot in a Philippine tertiary government hospital setting.

Methodology. This retrospective chart review (August 2019 to December 2023) evaluated early Ponseti outcomes at BGHMC. Through total enumeration, 42 eligible patients aged ≤2 years (36 idiopathic, 6 non-idiopathic) were analyzed. Initial clinical success was defined as achieving an initial plantigrade foot (Pirani score ≤0.5), allowing transition into a minimum of six months of maintenance bracing.

Results. Baseline severity was high across both cohorts (median Pirani 5.5 idiopathic vs. 6.0 non-idiopathic). The early clinical success rate was 100%, enabling all feet to complete initial casting and transition into bracing with 100% full short-term brace compliance documented at six months. Univariate linear regression demonstrated that a non-idiopathic etiology was a strong predictor of an increased casting workload (B = 2.085, 95% CI [0.56, 3.61], p = 0.008), requiring approximately two additional casts. Etiology did not significantly predict baseline severity, pre-tenotomy casting duration, or percutaneous Achilles tenotomy rates, which were uncommonly low (~36% for both groups). Early deformity recurrence within the limited follow-up period (maximum 13 months) occurred exclusively in idiopathic feet (12.07%).

Conclusion. The Ponseti method achieves favorable initial clinical correction and short-term brace compliance during early maintenance across both cohorts. However, conclusions are strictly limited by a small non-idiopathic sample size and a short follow-up duration. Given an uncommonly low institutional tenotomy rate (~36%) that deviates from global benchmarks, this cohort faces a high risk for late, weight-bearing relapses and requires strict longitudinal surveillance up to at least age 5 years.

Keywords. congenital talipes equinovarus, Ponseti method, Pirani score, idiopathic clubfoot, non-idiopathic clubfoot

INTRODUCTION

Congenital talipes equinovarus, or clubfoot, affects approximately 1 in 1,000 live births globally, with nearly 80% of the 200,000 annual cases occurring in low- and middle-income countries (LMICs).[1] Clinically, true clubfoot is a stiff deformity that does not correct with gentle manipulation. In contrast, positional clubfoot can be corrected gently. True clubfoot is defined by the CAVE acronym: Cavus (high midfoot arch), Adductus (forefoot turned in), Varus (heel turned in), and Equinus (hindfoot pointed down). Clubfoot has two main types: idiopathic, which is most common and presents with normal physical findings elsewhere,[2] and non-

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idiopathic (syndromic), which is associated with conditions such as arthrogryposis or cerebral palsy.[3] In 1950, Dr. Ignacio Ponseti developed the Ponseti method, which involves serial manipulation, casting, and a minimally invasive Achilles tendon tenotomy (ATT). This is followed by long-term bracing. This conservative technique became the gold standard for idiopathic clubfoot in the early 2000s due to its excellent outcomes.[4] The minimally invasive Ponseti method is the global gold standard for clubfoot care, successfully replacing extensive soft tissue surgeries that historically caused long-term joint stiffness.[5,6]

Treatment outcomes diverge sharply by etiology. Idiopathic clubfoot yields predictable, near-normal functional results,[6] while non-idiopathic clubfoot represents a far more challenging clinical subgroup.[7] Due to inherent tissue rigidity, non-idiopathic cases routinely require more serial casts, are less predictable, and relapse more often.[5,7] Recent literature shows that the Ponseti method can also be effective in non-idiopathic cases by reducing deformity severity and the need for major surgery.[8] A local study by Eusebio et al. at the Philippine General Hospital also reported good clinical outcomes for both types.[9] Regardless of type, if clubfoot is left untreated, it progresses into a painful, lifelong physical disability that causes severe mobility limitations and social exclusion.[10]

Implementing this treatment protocol in LMICs presents distinct structural and clinical challenges. In the Philippines, managing clubfoot remains a critical public health challenge, as geographic isolation, fragmented healthcare infrastructure, and economic constraints frequently delay intervention. Although percutaneous Achilles tenotomy is required in up to 90% of cases to correct residual equinus,[6] technique variability persists; some regional providers favor general over local anesthesia due to a lack of clinical confidence, which escalates procedural costs and risks.[11] Furthermore, overall compliance in resource-limited environments is threatened by socioeconomic barriers, including severe transportation hurdles, financial constraints, lack of basic supplies, and a scarcity of standardized materials for tenotomy and orthotic maintenance.[10,11] Evaluating structured clinical frameworks helps to optimize regional care pathways.

The partnership between Baguio General Hospital and Medical Center (BGHMC) and MiracleFeet provides a coordinated, template-driven model to standardize clubfoot care in an under-resourced region.

OBJECTIVES

The purpose of the study was to evaluate the early outcomes of Ponseti treatment for both idiopathic and non-idiopathic clubfoot in a Philippine tertiary government hospital setting. The study further aimed to describe the population's demographic profile, including age, sex, and laterality. Crucially, this investigation focused on the deformity correction (using the Pirani scoring system) following serial casting with or without Achilles tendon tenotomy.

METHODOLOGY

A retrospective chart review was done of early Ponseti treatment outcomes among eligible clubfoot patients treated at BGHMC from August 2019 to December 2023. All patients were managed by orthopedic residents and MiracleFeet staff under the direct supervision of the institution's pediatric orthopedic surgeon. To address potential inter-rater variability in the original charts, all clinical entries and progress notes were cross-referenced by a single researcher against standardized clinical photographs and physical exam descriptions. Representative clinical photographs demonstrating baseline deformity and post-correction outcomes (Figures 1 and 2) were obtained with appropriate parent/guardian waiver/consent, with all identifying features redacted to protect patient privacy. The six components of the Pirani scoring system were assessed.[12] These were recorded at the initial meeting and at every encounter thereafter, before and after tenotomy, and before and after bracing. The investigators also recorded the number of casts required, the rates of tenotomy, and recurrence of the deformity if present.

Inclusion criteria

1. Patients diagnosed with idiopathic or non-idiopathic clubfoot who presented for consultation and management at the BGHMC Orthopedics Outpatient Department (OPD).
2. Patients aged two years or younger at the time of treatment initiation.
3. Patients who underwent the Ponseti method of treatment at this institution and completed at least six months of the post-correction maintenance (bracing) phase.

Exclusion criteria

1. Foot deformities not attributed to congenital talipes equinovarus (e.g., positional clubfoot, metatarsus adductus).
2. History of prior surgical or non-surgical clubfoot interventions performed at an outside facility before presenting to BGHMC.
3. Clubfoot managed initially by techniques other than the standard Ponseti protocol.
4. Patients with incomplete medical records, including those who defaulted, were lost to follow-up, or discontinued the protocol before reaching the six-month maintenance milestone.

A formal sample size calculation was performed using OpenEpi version 3.01 for independent cohort studies comparing two proportions. Assuming a two-sided significance level of 5% ($\alpha = 0.05$), a statistical power of 80% ($1 - \beta = 0.80$), and an allocation ratio of 5:1 based on clinical distribution, the minimum required sample size to detect a significant difference in early outcomes was determined to be 18 patients (15 idiopathic and 3 non-idiopathic).

However, to maximize statistical power and minimize selection bias, total enumeration (census sampling) was employed.

To eliminate variability in follow-up duration across the retrospective cohort, the timing of clinical outcome assessment was standardized. All primary and secondary clinical outcomes were cross-sectionally audited and assessed uniformly at six months after the start of the maintenance (bracing) phase, regardless of any extended charting available up to the maximum 13-month tracking window. The primary outcome of initial clinical success was operationally defined as achieving a fully corrected, plantigrade foot, indicated by a Pirani score of ≤0.5 through serial casting and/or percutaneous Achilles tenotomy, thereby allowing the patient to successfully transition into and sustain the bracing protocol for the first six months. Conversely, treatment failure was defined as the inability to achieve deformity correction into a plantigrade foot during the initial casting phase, necessitating premature discontinuation of the Ponseti protocol and an early escalation to extensive soft tissue release or major surgical intervention. Finally, secondary outcomes tracked within this standardized timeframe included the total number of serial casts required to achieve initial correction, the utilization rate of percutaneous Achilles tenotomy, early recurrence rates (within the first six months of bracing), complications, and any documented clinical or socioeconomic compliance barriers.

To ensure clinical consistency across the retrospective cohort, the institutional decision to perform or skip a percutaneous Achilles tenotomy was governed by a strict, two-stage objective protocol. First, full correction of the midfoot deformity was verified, operationally defined as a completely straightened lateral column (Pirani lateral column curvature score = 0) and a neutral or abducted forefoot relative to the hindfoot. Second, the hindfoot was evaluated for residual equinus contracture. A percutaneous Achilles tenotomy was indicated and executed only if objective clinical parameters (Pirani hindfoot sub-score >0, i.e., a persistent posterior heel crease, an empty heel pad, and a rigid inability to bring the ankle above the neutral horizontal axis) remained uncorrected. Conversely, if the ankle demonstrated a clear, flexible passive correction above the neutral position with a completely corrected midfoot, the tenotomy was skipped, and the patient transitioned directly into maintenance bracing.

Brace compliance during the initial six-month maintenance phase was categorized dichotomously based on documented clinic charts and caregiver interviews at follow-up: "Compliant" was defined as the documented adherence to the standard protocol of wearing the foot abduction brace for 23 hours a day for the first three months, followed by 12–14 hours a day (during naps and nighttime) for the subsequent three months; "Non-compliant" was defined as any documented premature discontinuation, prolonged bracing holidays, or regular failure to meet the prescribed hourly wear time. Deformity recurrence was operationally defined as the clinical return of any clubfoot deformity component (cavus, adductus, varus, or equinus) after complete initial correction had been achieved, resulting in an increase of the total Pirani score to >0.5 or requiring a return to serial casting or secondary surgical intervention.

Statistical analysis was performed using SPSS Version 26.0. For descriptive statistics, continuous data were evaluated for normality using the Shapiro-Wilk test. Normally distributed data were expressed as mean ± standard deviation (SD) alongside clinical ranges, while skewed continuous data and ordinal clinical scores were presented as median and interquartile range (IQR). Categorical variables were expressed as frequencies and percentages (*n*, %). For the baseline patient cohort (N = 42), cross-group comparisons between the idiopathic and non-idiopathic populations were performed using the non-parametric Mann-Whitney U test for continuous variables and Fisher's exact test for categorical distributions to accommodate the small, unbalanced nature of the subgroups.

For the clinical intervention and treatment outcome data, the individual foot was designated as the primary unit of analysis. Univariate regression models were utilized to evaluate the relative impact of clubfoot etiology on treatment dynamics, employing linear regression for continuous outcomes and logistic regression for dichotomous outcomes. Longitudinal, within-group therapeutic efficacy from baseline to final post-casting was evaluated using the Wilcoxon signed-rank test. Two-sided p-values <0.05 were considered statistically significant, and the precision of primary categorical estimates was reflected via 95% confidence intervals (CIs). It must be noted that because the individual foot was treated as the primary unit of analysis across a cohort containing bilateral deformities, these models did not statistically adjust for inter-limb dependency or patient-level clustering. This lack of statistical adjustment for bilateral clustering represents a known limitation in the precision of our standard errors and regression coefficients.

This retrospective chart review was conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki and complied with the Philippine Data Privacy Act of 2012. The study protocol received formal ethical review and approval from the Institutional Review Board / Research Ethics Committee (REC) of Baguio General Hospital and Medical Center (BGHMC). Because this study relied purely on historical medical records from a retrospective cohort covering August 2019 to December 2023, a formal waiver of active parental informed consent was requested and granted by the REC. To protect patient privacy and mitigate the heightened risk of re-identification inherent to the small, rare secondary conditions within the non-idiopathic subgroup, strict data anonymization protocols were enforced. All patient identifiers, including names, birth dates, hospital registry numbers, and specific geographic details, were completely stripped and replaced with unique alphanumeric codes during data extraction. No patient-identifying data was retained in the final analytic dataset.

Programmatic support for clinical data infrastructure was provided through the localized institutional partnership with the MiracleFeet Foundation's clubfoot clinic model. While

MiracleFeet facilitated standardized registry documentation frameworks and clinical software access, this research received no direct financial grants, funding, or corporate subsidies for its execution. The authors declare no conflicts of interest, and the programmatic support did not influence the study design, analysis, or manuscript preparation.

RESULTS

A total of 42 patients were evaluated, comprising 36 idiopathic cases (85.71%) and 6 non-idiopathic cases (14.29%). Among the non-idiopathic cohort, the specific underlying etiologies identified were arthrogryposis (n = 2, 33.33%), constriction band syndrome (n = 2, 33.33%), CHARGE syndrome (n = 1, 16.67%), and neurogenic clubfoot (n = 1, 16.67%). The overall mean age at the start of treatment was 0.36 months (IQR 1.52; 0.23 - 1.75; range 0.03 - 18). No statistically significant difference in treatment initiation age was observed between the idiopathic (median 0.32 months, IQR 0.79) and non-idiopathic (median 1.00 month, IQR 1.79) (Table 1).

The majority of the study population was male (69.05%). Sex distribution was highly homogeneous between the idiopathic (69.44% male) and non-idiopathic (66.67% male) groups, showing no statistically significant difference (p = 1.00). Bilateral clubfoot was the most prevalent presentation overall (64.29%) and across both sub-cohorts (61.11% in idiopathic vs. 83.33% in non-idiopathic). Statistical analysis demonstrated no significant association between etiology and deformity laterality (p = 0.81) (Table 1).

The baseline clinical severity and initial Ponseti casting dynamics were analyzed across 69 feet (58 idiopathic, 11 non-idiopathic). Both groups presented with high baseline severity scores, yielding a median initial Pirani score of 5.5 (IQR 1.00; range 3.0–6.0) for idiopathic feet and 6.0 (IQR 0.38; range 5.0–6.0) for non-idiopathic feet (see Figure 1 for a representative example of a foot at initial presentation with a high Pirani score). The non-idiopathic cohort required a higher mean number of total corrective casts (6.33 ± 2.80 casts; range 3–10) compared to the idiopathic cohort (4.47 ± 2.24 casts; range 2–11). For the subset requiring a percutaneous Achilles tenotomy, the mean number of casts applied prior to the procedure was 5.50 ± 2.54 casts (range 3–10) in the idiopathic group and 5.50 ± 3.54 casts (range 3–8) in the non-idiopathic group. Percutaneous Achilles tenotomy was needed in 36.21% of idiopathic feet (n = 58) and 36.36% of non-idiopathic feet (n = 11). Fisher's exact test demonstrated no statistically significant difference in tenotomy rates between groups (p = 1.00), though this metric is highly constrained by the small non-idiopathic sample size. Because zero recurrences occurred in the non-idiopathic group (0%, 0/11



Figure 1. Representative clinical photograph of an idiopathic clubfoot at initial presentation demonstrating high severity with a baseline Pirani score of 6.

Table 1. Demographic and Baseline Characteristics of Clubfoot Patients (N = 42 Patients)

Characteristics	Total (N = 42)	Idiopathic (n = 36)	Non-idiopathic (n = 6)	*p*-value
Age at initiation, in months, Median (IQR) [Range]	0.36 (1.52) [0.03–18]	0.32 (0.79) [0.03–18]	1.00 (1.79) [0.23–13]	0.11 [a]
Sex, n (%)				1.00 [b]
Male	29 (69.05%)	25 (69.44%)	4 (66.67%)	
Female	13 (30.95%)	11 (30.56%)	2 (33.33%)	
Laterality, n (%)				0.81 [b]
Unilateral, Right	7 (16.67%)	7 (19.44%)	0	
Unilateral, Left	8 (19.05%)	7 (19.44%)	1 (16.67%)	
Bilateral	27 (64.29%)	22 (61.11%)	5 (83.33%)	
Non-Idiopathic Etiologies, n (%)				
Arthrogryposis	2 (4.76%)		2 (33.33%)	
Constriction Band Syndrome	2 (4.76%)		2 (33.33%)	
CHARGE Syndrome	1 (2.38%)		1 (16.67%)	
Neurogenic	1 (2.38%)		1 (16.67%)	

[a] Calculated using Mann-Whitney U test

[b] Calculated using Fisher's exact test



Figure 2. Side profile clinical photograph of the same clubfoot at the 6-month maintenance phase, demonstrating full clinical correction and maximum passive dorsiflexion out of the brace.

feet) compared to 7 in the idiopathic group (12.07%, 7/58 feet), standard logistic regression suffered from quasi-complete separation. Evaluated by Fisher's exact test, etiology was not significantly associated with early deformity recurrence (p = 0.587). Given the small non-idiopathic sample size and short follow-up duration, this lack of statistical significance cannot be used to infer true parity in recurrence risk. Safety profiles during casting demonstrated a 100% absence of complications uniformly across both groups (Table 2).

Both cohorts experienced a highly significant longitudinal reduction in deformity severity, with the median final Pirani score dropping to 0 for both groups. When evaluated by individual feet, the early clinical success rate, defined as achieving an initial plantigrade foot (Pirani score ≤0.5) enabling brace transition, was 100%. To clinically validate this full correction despite the low institutional tenotomy rate, Figure 2 demonstrates a side profile of a patient's foot at the 6-month maintenance phase in maximum passive dorsiflexion. At the patient level (N = 42), the mean duration of follow-up from the initiation of primary casting to the final recorded clinic visit was 10.4 ± 2.1 months (range 7.5–15.5 months), incorporating both the active serial casting phase and a mean duration of 6.8 ± 0.9 months (range 6–13 months) strictly within the maintenance bracing phase. Documented caregiver diaries and clinical interviews revealed a 100% full short-term brace compliance rate (N = 42) at the standardized 6-month indexing checkpoint. Returning to individual feet as the unit of analysis, early deformity recurrence within this limited tracking window occurred exclusively within the idiopathic group, affecting 12.07% of limbs (n = 58 feet); no recurrences were captured in the small non-idiopathic group (n = 11 feet; Fisher's exact p = 1.00) (Table 3).

Table 2. Clinical Baseline and Ponseti Treatment (N = 69 Feet)

Variables	Idiopathic Feet (n = 58)	Non-idiopathic Feet (n = 11)
Initial Pirani Score, Median (IQR)	5.5 (1.00)	6.00 (0.38)
Casting Requirements		
Total casts, Mean ± SD [Range]	4.47 ± 2.24 [2–11]	6.33 ± 2.80 [3–10]
Casts before tenotomy, Mean ± SD [Range]	5.5 ± 2.54 [3–10]	5.5 ± 3.54 [3–8]
Percutaneous Achilles Tenotomy [c]		
Performed, n (%) [95% CI]	21 (36.21%) [23.96, 49.93]	4 (36.36%) [10.93, 69.21]
Not Performed, n (%)	37 (63.79%)	7 (63.64%)
Complications During Casting, n (%)		
Skin Abrasions/Pressure Sores	0 (0%)	0 (0%)
Cast Slippage	0 (0%)	0 (0%)
None	58 (100%)	11 (100%)

[c] Tenotomy was performed uniformly across cohorts if residual equinus persisted (Pirani hindfoot sub-score >0 with inability to dorsiflex the ankle above neutral) following full correction of midfoot deformities.

Table 3. Early Outcomes, Compliance, and Recurrence (N = 69 Feet)

Outcome Measures	Idiopathic Feet (n = 58)	Non-idiopathic Feet (n = 11)
Post-Casting Deformity Score		
Final Pirani Score, Median (IQR)	0	0
Within-group change (Pre vs Post), p-value [d]	<0.001*	0.03*
Early Clinical Outcome, n (% [95% CI])		
Success	58 (100%) [93.84, 100.00]	11 (100%) [71.51, 100.00]
Failure	0 (0%)	0 (0%)
Brace Adherence Rates, n (%)		
Full Compliance	58 (100%)	11 (100%)
Partial Compliance	0 (0%)	0 (0%)
Non-Compliance	0 (0%)	0 (0%)
Deformity Recurrence, n (% [95% CI])	7 (12.07%) [4.99, 23.29]	0 (0%) [0.00, 28.49]

* p <0.05

[d] Within-group longitudinal analysis tracks the direct, unstratified therapeutic drop in severity scores from baseline to the removal of the final post-tenotomy cast.

For all univariate regression models evaluated across 69 feet, etiology was treated as a binary variable with idiopathic clubfoot serving as the reference baseline category (coded as 0) to assess the relative impact of non-idiopathic cases. Consequently, effect sizes are expressed as unstandardized linear coefficients (B) for continuous outcomes, and as odds ratios (OR) relative to a baseline of 1.00 for dichotomous outcomes (Table 4).

Non-idiopathic etiology was identified as a strong and statistically significant predictor of an increased casting workload (B = 2.085, 95% CI [0.56, 3.61], p = 0.008), indicating that non-idiopathic feet required an average of approximately two additional corrective casts compared to idiopathic feet. Conversely, etiology did not serve as a statistically significant predictor for any other clinical outcome

Table 4. Univariate Regression Analysis of Factors Associated with Clubfoot Treatment Outcomes (N = 69 Feet)

Outcomes	Regression Model Type	Effect Size	95% Confidence Interval (CI)	*p*-value
Initial Pirani Score	Linear Regression	B 0.201	[-0.484, 0.885]	0.560
Total Casts Required	Linear Regression	B 2.085	[0.56, 3.61]	0.008*
Casts Before Tenotomy	Linear Regression	B 0.024	[-2.9, 2.95]	0.987
Tenotomy Performed	Logistic Regression	OR 1.007	[0.26, 3.85]	0.992
Deformity Recurrence	Fisher Exact Test	N/A (0 vs 12.07%)	N/A	0.587

* $p < 0.05$

[e] The confidence interval upper bound for deformity recurrence approaches infinity because zero recurrences were observed within the non-idiopathic subgroup (n = 11 feet), resulting in a quasi-complete separation in the logistic model.

evaluated, including initial Pirani severity (B = 0.201, 95% CI [-0.484, 0.885], p = 0.560), the number of casts required before tenotomy (B = 0.024, 95% CI [-2.9, 2.95], p = 0.987), the likelihood of undergoing a percutaneous Achilles tenotomy (OR = 1.007, 95% CI [0.26, 3.85], p = 0.992), or the odds of deformity recurrence (OR = 7.286, 95% CI [0.00, >999.99], p = 0.438). However, these non-significant predictive findings must be interpreted with extreme caution due to the low statistical power inherent to the highly unbalanced and small non-idiopathic subgroup (n = 11 feet). The broad confidence intervals, particularly for deformity recurrence, indicate that clinically meaningful differences in treatment dynamics cannot be excluded; a larger, more balanced multicenter cohort is needed to clarify these associations (Table 4).

The early clinical outcome was uniformly successful across the entire cohort, with 100% of both idiopathic (n = 58) and non-idiopathic (n = 11) feet achieving full correction during the initial casting and bracing transition phase. Because there was no variance in early clinical success, a logistic regression analysis could not be performed for this specific outcome (Table 3).

DISCUSSION

Baseline demographics and initial severity

This study evaluated a cohort of 42 patients comprising 69 feet, with a distribution of 85.71% idiopathic and 14.29% non-idiopathic cases. The non-idiopathic cohort displayed diverse etiologies, namely arthrogryposis, constriction band syndrome, CHARGE syndrome, and neurogenic clubfoot. Demographics, including age at treatment initiation, sex distribution, and deformity laterality, were statistically homogeneous between the sub-cohorts (p >0.05). Both groups demonstrated high initial severity, presenting with a baseline median Pirani score of 5.5 for idiopathic feet and 6.0 for non-idiopathic feet.

While this high baseline clinical severity aligns with findings from other comparative studies where syndromic or secondary clubfoot deformities presented with severe initial indices,[13,14] the structural homogeneity at baseline within this cohort must be interpreted with caution. Because the non-idiopathic subgroup was highly limited (n = 11 feet) and clinically heterogeneous, our statistical power to detect subtle baseline demographic or clinical differences was restricted. Direct inference regarding population-wide baseline parity is therefore limited by the sample size.

Casting workload and pathophysiological dynamics

The data demonstrate a descriptive difference in the total casting workload required to achieve initial correction. Non-idiopathic feet required a higher mean number of total casts compared to idiopathic feet. In a univariate linear regression model, non-idiopathic etiology acted as a statistically significant predictor of an increased casting workload, adding approximately two corrective casts per foot. Descriptively, non-idiopathic cases required a longer casting phase before bracing in this cohort. However, given the heterogeneous diagnoses spanning rigid arthrogryposis, constriction band syndrome, CHARGE syndrome, and neurological pathologies, the subgroup is too small and diverse to draw meaningful, diagnosis-specific conclusions. These trends should be interpreted descriptively rather than as definitive proof of generalized syndromic casting behaviors.

Interestingly, for the subset of patients requiring a percutaneous Achilles tenotomy, the mean number of casts applied prior to the procedure was identical at 5.5 for both groups, and etiology was not a significant predictor of pre-tenotomy casting duration (p = 0.987). While this cohort did not yield a statistically significant association between etiology and pre-tenotomy casting duration or tenotomy rates, these final statistical models are highly constrained by low statistical power. Given the small non-idiopathic sample (n = 11 feet), the lack of statistical significance should not be interpreted as evidence of true parity in clinical behavior. This heavily restricts robust predictive inference and underscores the need for a larger, well-powered sample to determine whether clinically meaningful differences exist. Furthermore, because week-by-week serial Pirani data after each cast were not captured in this retrospective review, we cannot draw conclusions regarding the dynamic rate of early deformity reduction.

Tenotomy and safety profile

The rate of percutaneous Achilles tenotomy was nearly identical between the cohorts, being performed in 36.21% of idiopathic feet and 36.36% of non-idiopathic feet. Univariate

logistic regression confirmed that etiology did not significantly influence the likelihood of undergoing a tenotomy ($p = 0.992$, Table 4). While some literature found higher tenotomy rates to overcome resistant equinus in rigid syndromic cohorts,[7] we found that meticulous, sequential manipulation can achieve midfoot correction without inherently increasing surgical tendon release rates.

Crucially, the safety profile of the protocol was excellent. Both groups achieved a 100% absence of casting-related complications, with zero instances of skin abrasions, pressure sores, or cast slippage. This matches established data demonstrating that the Ponseti method remains a safe, minimally invasive alternative to primary extensive soft-tissue surgeries, effectively minimizing soft-tissue complications when proper molding techniques are utilized, even in rigid, atypical feet.[5,15]

The low tenotomy rate: local practice patterns and clinical risks

A critical finding of this study is the low rate of percutaneous Achilles tenotomy, which was performed in only 36.21% (95% CI [23.96, 49.93]) of idiopathic feet and 36.36% (95% CI [10.93, 69.21]) of non-idiopathic feet. This means that nearly two-thirds of the evaluated feet (63.79% and 63.64%, respectively) transitioned into bracing through casting alone. This tenotomy rate is substantially lower than international benchmarks, where tenotomy is required in 70% to 90% of Ponseti-treated cases to adequately address fixed equinus.[16,17]

This remarkably low tenotomy rate likely reflects local practice patterns, subjective surgeon preferences, distinct clinical decision thresholds, or potential gaps in documentation regarding precise ankle dorsiflexion angles before bracing. Crucially, a low tenotomy rate may indicate an underuse of the procedure or a clinical misinterpretation of spurious midfoot correction (rocker-bottom deformity) as true ankle dorsiflexion.

Skipping a tenotomy when residual equinus persists constitutes a severe deviation from the standard Ponseti guidelines. Literature indicates that inadequate release of a tight Achilles tendon may leave residual equinus and has been implicated as a factor in recurrent deformity once the child begins weight-bearing.[16,18] While 63.77% of this cohort transitioned directly to bracing without an initial tenotomy, longer longitudinal follow-up is mandatory to determine whether this conservative approach maintains true hindfoot correction or merely masks a high risk for late relapse.

Short-term efficacy, recurrence, and management

Longitudinal analysis demonstrated a drop in the median final Pirani score to 0 for both idiopathic ($p < 0.001$) and non-idiopathic ($p = 0.03$) groups at the time of final cast removal. All 69 feet achieved complete initial deformity correction during the immediate transition from casting to bracing, which coincided with a recorded 100% full compliance rate with prescribed bracing protocols. It must be emphasized, however, that these findings reflect early clinical correction rather than permanent, durable success.

Deformity recurrence during the available follow-up period occurred exclusively within the idiopathic group, affecting 7 feet (12.07%, 95% CI [4.99, 23.29]), while no recurrences were documented in the small non-idiopathic group (0%, 95% CI [0.00, 28.49]). Univariate logistic regression showed that etiology was not a statistically significant predictor of recurrence ($p = 0.438$). In the broader literature, non-idiopathic clubfeet show substantially higher relapse rates than idiopathic clubfeet (approximately 43% vs 10% to 12%), attributed to persistent neuromuscular imbalance.[5,7,19] Our findings are constrained by the short follow-up duration (maximum 13 months) and the small non-idiopathic sample ($n = 11$ feet).

Because this study only tracks patients through early bracing, these results represent short-term endpoints. A follow-up window of this duration is entirely inadequate to declare long-term success against recurrence, which most frequently occurs within the first 3 to 5 years of life.[18] Consequently, this entire cohort remains at a high risk for late relapses and requires continuous tracking up to at least age 5.

Furthermore, this retrospective data lacks granular details regarding the specific timing of recurrence after bracing initiation, the exact anatomical components involved (e.g., dynamic forefoot adduction vs. hindfoot varus), and the objective quantification of daily brace adherence beyond basic clinical charts. While the recorded recurrences in the idiopathic group were managed effectively using repeat serial casting without additional major surgical intervention during the available follow-up period, their long-term stability remains unverified. Nevertheless, these short-term outcomes strongly imply that when strict, absolute, and rigorous brace compliance is maintained, highly favorable initial corrections can be achieved using the Ponseti technique regardless of whether the clubfoot is idiopathic or non-idiopathic.[13,20]

Methodological limitations and clinical implications

Direct comparison between these findings and international historical data is limited by variations in study design, cohort sizes, treatment thresholds, and definitions of clinical success. The primary value of this study lies in its reflection of local programmatic data from a government hospital setting rather than a generalized validation of the Ponseti method. The interpretation of these outcomes is restricted by several key methodological limitations, including a retrospective design that relies heavily on historical medical records and exposes the data to documentation gaps. Furthermore, the small sample size ($n = 6$ patients, 11 feet) and high diagnostic heterogeneity of the non-idiopathic subgroup prevent any meaningful diagnosis-specific pooling. The short overall follow-up

duration, which reached a maximum of only 13 months, inherently misses late-stage relapses that typically manifest later. Additionally, a potential selection bias may have resulted from the exclusion of incomplete records or patients lost to follow-up, while the lack of objective, sensor-based brace-compliance metrics forced a reliance on subjective caregiver reports. Furthermore, reporting a median final Pirani score of 0 across both groups may inadvertently overstate the true clinical correction. While a Pirani score of 0 confirms excellent passive midfoot and hindfoot alignment at the immediate completion of the casting phase, it remains a purely static, morphology-based assessment. Because this clinical snapshot is not paired with standardized functional mobility scales, dynamic muscle balance assessments, or long-term weight-bearing outcomes, it may mask underlying muscle imbalances or early joint stiffness that predispose the foot to late relapses during ambulation.

Furthermore, a major statistical limitation arises from the non-independence of our data; because bilateral clubfoot was highly prevalent (64.29%), analyzing outcomes by individual feet (n = 69) without adjusting for patient-level clustering or intra-patient correlation artificially narrows the confidence intervals. Future well-powered studies should utilize Generalized Estimating Equations (GEE) or mixed-effects models to control this inter-limb dependency. Finally, the statistical power is also constrained by this unadjusted model, alongside a broader lack of standardized, validated functional or patient-reported outcome measures.

Despite these limitations, several vital clinical implications can be drawn for regional clubfoot programs. Regarding workload counseling, caregivers of children presenting with non-idiopathic clubfoot must be thoroughly counseled at baseline that the treatment course will likely require a longer casting phase and a higher overall casting workload. To ensure the standardization of protocols, clinical criteria for performing a percutaneous Achilles tenotomy must be strictly standardized locally, utilizing objective measures like a minimum of 15° passive dorsiflexion and a completely corrected hindfoot score, to actively eliminate the risk of clinical under-treatment. Finally, to maintain vigilance in follow-up, clinicians must not allow successful early midfoot correction or immediate bracing compliance to reduce their diagnostic vigilance, as late recurrences remain a high risk, particularly in patients in whom the Achilles tendon was not released. Longitudinal tracking must therefore be strictly maintained through age 5 to catch late-stage relapses.

CONCLUSION AND RECOMMENDATION

This study establishes a localized baseline programmatic report on the short-term outcomes and protocol adherence of the Ponseti method within a structured tertiary government hospital framework. These early findings suggest that the Ponseti method can achieve favorable short-term clinical correction in both idiopathic and selected non-idiopathic cases, with a 100% initial success rate in transitioning plantigrade feet into the maintenance bracing phase. However, definitive long-term effectiveness cannot be inferred from this study, as conclusions are strictly limited by the small non-idiopathic subgroup and a short follow-up window.

While non-idiopathic etiology was a statistically significant predictor of an increased casting workload, requiring an average of two additional corrective casts, this cohort did not demonstrate a clear association between etiology and the need for a tenotomy or pre-tenotomy casting duration. Nevertheless, the small sample size severely limits broader predictive inference, and these findings may be underpowered to rule out real clinical associations.

Crucially, given the uncommonly low institutional percutaneous Achilles tenotomy rate observed across both groups (~36%) compared to global benchmarks, this entire cohort must be considered at a high risk for late deformities and dynamic relapses. Therefore, this study must be framed as an evaluation of early protocol adherence and short-term maintenance rather than a definitive final clinical outcome.

Based on the short-term outcomes and identified programmatic parameters of this regional report, several key recommendations are proposed to optimize care pathways and future research directions. First, mandatory extended longitudinal surveillance must be actively maintained through the implementation of a strict, active tracking registry to monitor this specific cohort until at least age 5. Because nearly two-thirds of the evaluated feet transitioned to bracing without an Achilles tendon release, continuous clinical vigilance is essential to catch late-stage equinus relapses early. Second, future clinical investigations should expand to well-powered, prospective multicenter studies with extended follow-up periods necessary to evaluate true long-term recurrence rates, joint mobility, and functional patient-reported outcomes within the region.

Third, to bridge the gap between local conservative practice patterns and global protocols, the institution should adopt highly strict, objective indicators for the standardization of tenotomy criteria. Decisions to perform a percutaneous Achilles tenotomy should rely purely on verified mechanical parameters, such as a definitive failure to achieve at least 15 degrees of passive ankle dorsiflexion after full midfoot correction, to actively protect against potential clinical under-treatment. Finally, updating clinical data collection to capture week-by-week serial Pirani scores during the casting phase will optimize future audit quality, allowing clinicians to precisely track and mathematically model the dynamic velocity of deformity correction across different secondary etiologies.

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KPI: Methodology, Writing – original draft and preparation; **JMJ, MJDV, ANB:** Conceptualization; **IG, DB:** Writing – review and editing.

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ORIGINAL ARTICLE

Evaluation of the Efficacy of Intramuscular Immunoglobulin in Treating Post-Chikungunya Arthralgia

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ABSTRACT

Background. Chikungunya virus (CHIKV) infection may be followed by persistent musculoskeletal symptoms, particularly chronic arthralgia and arthritis, causing pain, impairing mobility and function, and reducing quality of life. Conventional management is primarily symptomatic and may include analgesics, non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, selected disease-modifying antirheumatic drugs (DMARDs), and rehabilitation, which often provide incomplete relief and are associated with long-term adverse effects. The evidence supporting specific therapies for persistent chikungunya-related rheumatic disease remains limited. Intramuscular immunoglobulin (IMIG), because of its immunomodulatory properties, may represent a potential therapeutic option.

Objectives. To evaluate the association of intramuscular immunoglobulin (IMIG) therapy with changes in pain, joint arthralgia severity, and joint mobility in patients with post-chikungunya arthralgia, and to document treatment-related adverse effects.

Methodology. This prospective observational study was conducted in a tertiary care hospital over 18 months. Sixty adults with post-chikungunya arthralgia of at least one-month duration were included. IMIG was administered as part of clinical management, and outcomes were prospectively observed before and after treatment. No additional investigational drug was administered. Pain intensity was assessed using the Visual Analogue Scale (VAS), arthralgia severity using the Patient-Reported Arthralgia Inventory (PRAI), and joint mobility by clinical range-of-motion assessment at baseline, one week, one month, and six months. Descriptive statistics, paired comparisons, Repeated measures ANOVA, and multivariable regression were used.

Results. Mean VAS decreased from 7.6 ± 1.1 at baseline to 4.9 ± 1.2 at one week, 3.1 ± 1.0 at one month, and 2.5 ± 0.8 at six months (p <0.001). Mean PRAI score decreased from 6.2 ± 1.0 at baseline to 3.8 ± 1.1 at one week, 2.4 ± 0.9 at one month, and 1.9 ± 0.7 at six months (p <0.001). At baseline, 70.0% of participants had moderate-to-severe restrictions of joint movement; at six months, 80.0% had normal or near-normal mobility. Overall functional improvement was reported by 85.0% of participants. Mild injection-site pain occurred in six patients (10.0%) and transient low-grade fever in four (6.7%); no serious adverse events or allergic reactions were observed. In multivariable analysis, a higher baseline VAS was associated with greater pain reduction, whereas increasing age and longer duration of arthralgia were associated with smaller reductions.

Conclusion. IMIG administration was associated with improvements in pain, arthralgia severity, and joint mobility in this prospective observational cohort. Controlled randomized studies are required to establish efficacy, comparative effectiveness, and safety.

Keywords. chikungunya virus, post-chikungunya arthralgia, intramuscular immunoglobulin, patient-reported arthralgia inventory, immunomodulatory therapy, visual analogue scale

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INTRODUCTION

Chikungunya virus (CHIKV) infection is an arthropod-borne viral illness transmitted primarily by Aedes mosquitoes and is characterized in the acute phase by high-grade fever, polyarthralgia, myalgia, headache, and rash. Although acute illness is usually self-limiting, persistent musculoskeletal manifestations may occur after the acute infection, including arthralgia and inflammatory arthritis. This condition, commonly referred to as post-chikungunya arthralgia, represents the most disabling long-term sequela of CHIKV infection and significantly impairs quality of life, functional capacity, and socioeconomic productivity, particularly among adults in the working-age population.[1-5]

The clinical spectrum of CHIKV infection ranges from uncomplicated febrile illness to atypical and severe manifestations. Severe neurological disease and fatal cases have been reported, particularly in vulnerable populations.[2-4] The chronic rheumatic burden, however, represents an important cause of prolonged morbidity. Prospective and cohort studies have demonstrated persistent arthralgia, arthritis, and rheumatoid-like polyarthritis after CHIKV infection, with disease persistence influenced by factors such as age and severity of the acute illness. [6-11]

The pathophysiology of post-chikungunya arthralgia is complex and involves both persistent viral components and host immune-mediated mechanisms. Clinical and experimental studies have demonstrated evidence of viral persistence in joint tissues together with sustained inflammatory and immune responses.[12,13] In patients with post-chikungunya arthritis, altered cytokine profiles and changes in T-cell subsets have also been reported, including associations between disease activity and inflammatory cytokines such as IL-6 and TNF.[14] These findings support a multifactorial model in which viral persistence, tissue inflammation, and dysregulated host immune responses may contribute to chronic symptoms.

Conventional management of chikungunya is primarily supportive and symptomatic, as no specific antiviral therapy is currently available. Depending on the phase and severity of disease, treatment may include analgesics, antipyretics, and NSAIDs. After excluding dengue, short courses of corticosteroids can be given for selected inflammatory or refractory presentations, and physical therapy or rehabilitation may be initiated. In selected cases of persistent or chronic chikungunya arthritis, disease-modifying antirheumatic drugs (DMARDs), including hydroxychloroquine or methotrexate, may be considered. However, persistent musculoskeletal disease can remain disabling despite commonly used symptomatic treatments, and the evidence supporting specific pharmacological interventions remains limited and heterogeneous.[15-19] Rehabilitation approaches, including kinesiotherapy, may improve pain, mobility, function, and quality of life, although the evidence base remains limited.[20]

Human normal immunoglobulin has immunomodulatory effects and is used in a range of immune-mediated and inflammatory disorders. Proposed mechanisms include modulation of pathogenic antibodies, cytokine networks, complement activation, and immune-cell function.[21] Passive immunotherapy with human antibodies has also been investigated in severe manifestations of CHIKV infection, including neurological complications, with case reports describing clinical responses to immunoglobulin therapy. [22,23] Intravenous immunoglobulin (IVIG), such as Flebogamma®, is a plasma-derived product prepared from pooled human serum and contains immunoglobulin G subclasses in proportions similar to normal human plasma (IgG1 66.6%, IgG2 28.5%, IgG3 2.7%, IgG4 2.2%). While IVIG is primarily indicated for antibody deficiency syndromes at replacement doses, higher doses exert significant immunomodulatory effects and have been successfully employed in various inflammatory and autoimmune conditions, including dermatological and neurological disorders.[21]

Despite its therapeutic potential, its use is limited by high cost, requirement for hospital-based administration, and risk of systemic adverse reactions. In this context, intramuscular immunoglobulin (IMIG) represents a practical and potentially cost-effective alternative, offering ease of administration, better feasibility in outpatient settings, and a lower risk of systemic side effects. Preliminary clinical observations suggest that IMIG may be beneficial in chronic inflammatory and post-viral arthralgia by modulating aberrant immune responses and reducing inflammatory joint symptoms. However, robust clinical evidence evaluating efficacy in post-chikungunya arthralgia remains scarce.

Given the persistent morbidity associated with post-chikungunya musculoskeletal disease, the limitations of the existing evidence for conventional therapies, and the potential immunomodulatory effects of immunoglobulin therapy, the present study was undertaken to prospectively observe changes in pain, arthralgia severity, and joint mobility following IMIG administration in patients with post-chikungunya arthralgia.

METHODOLOGY

Study design and setting

This was a prospective observational study with pre- and post-treatment assessment conducted in the Department of Orthopaedics at MIMER Medical College and Dr. BSTR Hospital over a period of 18 months. The study was designed to prospectively observe outcomes among patients receiving IMIG as part of their clinical management. It was not a randomized controlled clinical trial and did not include a parallel control group.

The decision to use IMIG was made in the context of clinical management, and the study did not administer any additional investigational drug. Patients were counselled regarding the

available treatment options and the potential benefits and risks of immunoglobulin therapy. The study protocol was reviewed and approved by the Institutional Ethics Committee.

Participants

A total of 60 adult patients diagnosed with post-chikungunya arthralgia were enrolled. Sample size was determined using a prevalence-based approach incorporating the anticipated change in pain scores and feasibility within the study period.

Sample size formula

The sample size was calculated using the formula:
$n = [(Z\alpha/2 + Z\beta)^2 \times \sigma^2] / \delta^2$
$Z\alpha/2 = 1.96$,
$Z\beta = 0.84$
$\sigma = 1.5$
$\delta = 2.0$ points.
The calculated sample size was adjusted to 60.
N – 72 were screened
N – 60 were enrolled and completed six-month follow-up with 0% attrition.

Inclusion criteria

- Age ≥18 years.
- History of chikungunya infection confirmed clinically and/or serologically, defined as positive IgM anti-CHIKV ELISA or RT-PCR during acute phase.
- Persistence of joint pain for at least one month following acute chikungunya infection with mono-, oligo- or poly-articular symptoms
- Previous use of analgesic medication with inadequate relief, defined as persistent VAS ≥5 despite ≥4 weeks of optimized NSAIDs.
- Willingness to participate and provision of written informed consent.

Exclusion criteria

- Known autoimmune diseases such as systemic lupus erythematosus.
- Established rheumatoid arthritis, osteoarthritis, or seronegative inflammatory arthritis.
- Arthralgia attributable to active or recent (≤3 months) concurrent dengue, malaria, or COVID-19 confirmed by serology/PCR.
- History of hypersensitivity to immunoglobulin preparations.
- Immunoglobulin therapy within the preceding 6 months.

Intervention

BHARGLOB, a human normal immunoglobulin preparation derived from pooled plasma, was administered intramuscularly under standard aseptic precautions according to the treating physician's clinical protocol.

The specified BHARGLOB dosage was 0.75 mL/kg (total volume, 2.5–5.0 mL) via deep IM injection into the gluteal muscle. The half-life of immunoglobulin is approximately 21–28 days, which justified the 6-month exclusion window.

No additional investigational drug was administered as part of the study.

Primary outcome measures

Change in pain intensity measured using the Visual Analogue Scale (VAS) at baseline, one week, one month, and six months.

Secondary outcome measures

- Change in arthralgia severity measured using the Patient-Reported Arthralgia Inventory (PRAI)[24]
- Improvement in joint mobility evaluated via goniometric range-of-motion (ROM) measurement
- Functional improvement cross-validated using the validated Health Assessment Questionnaire–Disability Index (HAQ-DI).

Data collection

Baseline assessment included demographic characteristics, clinical history, duration of symptoms, pain severity, arthralgia severity, and joint mobility. Follow-up assessments were conducted at 1 week, 1 month, and 6 months after treatment. At each visit, VAS, PRAI, and joint mobility were recorded.

Statistical analysis

Data was entered into Microsoft Excel and analyzed using SPSS version 26. Descriptive statistics were used to summarize demographic and clinical characteristics.

- Paired t-tests were used for pre- and post-treatment continuous variables.
- Repeated measures ANOVA with post-hoc analysis was used to evaluate changes across multiple time points.
- Multivariable linear regression was performed to explore associations between patient characteristics and reduction in VAS score at six months. A p-value <0.05 was considered statistically significant.

Ethical considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants before enrolment. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Paper-based records were stored in a secured and restricted-access location and were accessible only to authorized study personnel. Electronic study files were password protected and secured against unauthorized access. Direct patient identifiers were removed from study datasets whenever feasible and were not included in the analytical dataset. Patients were informed about the nature of the treatment, its potential benefits and risks, and their

right to participate voluntarily and withdraw from the study without affecting their clinical care.

The immunoglobulin used was a commercially available preparation used in clinical practice. No additional payment was made to participants specifically for research participation; patients receiving the medicine bore the relevant treatment cost as part of their clinical care. Clinical consultation and counselling related to the study were provided without additional research-related charges. The study did not administer treatment solely for research purposes; rather, outcomes of patients receiving the treatment as part of clinical management were prospectively observed.

RESULTS

Baseline characteristics

The study included 60 participants with a mean age of 42.6 ± 11.8 years. There were 26 males (43.3%) and 34 females (56.7%). The mean duration of arthralgia before enrolment was 2.8 ± 1.3 months. Fourteen patients (23.3%) had monoarticular involvement, 19 (31.7%) had oligoarticular involvement, and 27 (45.0%) had polyarticular involvement. The knee, ankle, and wrist were the most commonly involved joints (Table 1).

Pain outcomes

The mean VAS score decreased from 7.6 ± 1.1 at baseline to 4.9 ± 1.2 at one week, 3.1 ± 1.0 at one month, and 2.5 ± 0.8 at six months (Table 2). The overall change across time points was statistically significant (p <0.001). The maximum clinical improvement occurred within the first week.

Table 1. Baseline demographic and clinical characteristics

Variable	Value
Age, mean ± SD (years)	42.6 ± 11.8
Male, n (%)	26 (43.3%)
Female, n (%)	34 (56.7%)
Duration of arthralgia, mean ± SD (months)	2.8 ± 1.3
Monoarticular, n (%)	14 (23.3%)
Oligoarticular, n (%)	19 (31.7%)
Polyarticular, n (%)	27 (45.0%)
Most commonly involved joints	Knee (78.3%) Ankle (65.0%) Wrist (51.7%) PIP/MCP (38.3%)

Table 2. Comparison of VAS pain scores

Time point	Mean VAS ± SD	*p* value*
Baseline	7.6 ± 1.1	—
1 week	4.9 ± 1.2	<0.001
1 month	3.1 ± 1.0	<0.001
6 months	2.5 ± 0.8	<0.001

* Repeated measures ANOVA with post-hoc analysis. The largest absolute reduction occurred during the first week (ΔVAS −2.7 points), followed by further gradual improvement through one month and six months.

Arthralgia severity

Mean PRAI score decreased from 6.2 ± 1.0 at baseline to 3.8 ± 1.1 at one week, 2.4 ± 0.9 at one month, and 1.9 ± 0.7 at six months (Table 3). The change across follow-up was statistically significant (p <0.001). Delta PRAI within the first week was 2.4 points.

Joint mobility and functional outcome

At baseline, 12 patients (20.0%) had normal or near-normal mobility, 18 (30.0%) had mild restriction, 21 (35.0%) had moderate restriction, and nine (15.0%) had severe restriction (Table 4). At six months, 48 patients (80.0%) had normal or near-normal mobility, eight (13.3%) had mild restrictions, three (5.0%) had moderate restrictions, and one (1.7%) had severe restrictions. Overall functional improvement was reported by 85.0% of participants in six months.

Adverse effects

IMIG was generally well tolerated. Mild local injection-site pain was reported in six patients (10.0%), and transient low-grade fever occurred in four patients (6.7%). No serious adverse events or allergic reactions were observed during the study period.

Multivariable regression analysis

A higher baseline VAS was independently associated with greater pain reduction at 6 months (β = 0.58, p <0.001) (Table 5). Increasing age (β = −0.07, p = 0.031) and longer

Table 3. Changes in PRAI scores

Time point	Mean PRAI ± SD	*p* value*
Baseline	6.2 ± 1.0	—
1 week	3.8 ± 1.1	<0.001
1 month	2.4 ± 0.9	<0.001
6 months	1.9 ± 0.7	<0.001

*Repeated measures ANOVA
PRAI – Patient-Reported Arthralgia Inventory

Table 4. Distribution of joint mobility status

Joint mobility status	Baseline, n (%)	6 months, n (%)
Normal / near normal	12 (20.0%)	48 (80.0%)
Mild restriction	18 (30.0%)	8 (13.3%)
Moderate restriction	21 (35.0%)	3 (5.0%)
Severe restriction	9 (15.0%)	1 (1.7%)

Table 5. Multivariable linear regression for reduction in VAS at 6 months

Predictor	β	SE	95% CI	*p* value
Age (years)	−0.07	0.03	−0.14 to −0.01	0.031
Duration of arthralgia (months)	−0.19	0.07	−0.33 to −0.06	0.006
Baseline VAS	0.58	0.09	0.41 to 0.75	<0.001
Female vs male	−0.04	0.17	−0.38 to 0.30	0.801

duration of arthralgia before treatment (β = −0.17, p = 0.006) were associated with smaller reductions in pain. Sex was not significantly associated with treatment response (p = 0.801). The regression model was statistically significant (F = 15.4, p <0.001) and explained approximately 52% of the variance in pain reduction (R^2 = 0.52; adjusted R^2 = 0.49).

Model statistics

- R^2 = 0.52
- Adjusted R^2 = 0.49
- F = 15.4
- p <0.001

DISCUSSION

In this prospective observational study of 60 patients with post-chikungunya arthralgia, we observed clinically significant reductions in pain and stiffness following administration of intramuscular immunoglobulin (IMIG). Mean Visual Analogue Scale (VAS) pain scores decreased from 7.6 ± 1.1 at baseline to 4.9 ± 1.2 at one week, 3.1 ± 1.0 at one month, and 2.5 ± 0.8 at six months (p <0.001). Similarly, mean PRAI stiffness scores reduced from 6.2 ± 1.0 to 2.4 ± 0.9 at one month and 1.9 ± 0.7 at six months (p <0.001) (Tables 2 and 3). These findings suggest that IMIG may provide a rapid and sustained improvement in symptom severity among patients with chronic arthralgia following chikungunya infection. Chronic musculoskeletal manifestations, including arthralgia and arthritis, are well-recognized sequelae of chikungunya virus (CHIKV) infection. Nearly 40–60% of patients develop lingering joint symptoms lasting three or more months after acute illness, a condition often described as chronic chikungunya arthritis (CCA) or post-chikungunya arthralgia. In a narrative review, more than 40% of infected individuals had arthritic manifestations >3 months post-infection, with patterns ranging from polyarthritis to nonspecific arthralgia consistent with post-viral arthralgia.[25]

The natural history of chikungunya includes a spectrum of persistent rheumatic manifestations. Previous studies have documented persistent arthralgia and arthritis months to years after acute infection, with substantial effects on function and quality of life.[6-11] The burden is clinically important because persistent joint symptoms may interfere with activities of daily living and may require prolonged treatment and rehabilitation.

The pathogenesis of chronic chikungunya musculoskeletal disease is multifactorial. Persistent viral material has been demonstrated in joint tissues in experimental and human studies, while chronic disease is also associated with sustained inflammatory and adaptive immune responses.[12,13] A cross-sectional study of patients with post-chikungunya arthritis found associations between disease activity and inflammatory cytokines, including IL-6 and TNF, together with alterations in regulatory T-cell populations.[14] These findings provide biological plausibility for investigating therapies that may modify immune pathways, although they do not establish that immune dysregulation is the sole cause of chronic symptoms. These immunological patterns may partly explain why conventional analgesics or NSAIDs often provide only partial or transient relief; they primarily target symptomatic inflammation rather than the underlying immune imbalance.

Conventional management remains largely symptomatic and phase-dependent. National and international guidance describes the use of analgesics, NSAIDs, corticosteroids, selected DMARDs, and physical rehabilitation according to disease severity and chronicity.[15,17] The systematic review by Martí-Carvajal et al. identified randomized trials evaluating chloroquine, NSAIDs, corticosteroids, and DMARDs, but concluded that the overall evidence was of very low quality because of small samples, heterogeneity, and risk of bias.[16] More recent observational data also suggest that DMARD-based treatment may benefit selected patients with chikungunya arthritis, although these data do not establish a standardized treatment regimen.[26]

Published studies on therapeutic strategies for chronic CHIKV-related arthralgia have primarily evaluated symptomatic treatments or repurposed disease-modifying antirheumatic drugs (DMARDs) rather than immunomodulatory therapies. Methotrexate (MTX), a DMARD commonly used in rheumatoid arthritis, has been investigated in some cohorts with chronic chikungunya arthritis and was found to improve pain and disease activity when combined with corticosteroids over four weeks, as measured by VAS and composite disease activity scores.[26] In these cohorts, combination pharmacotherapy produced measurable reductions in pain, though the variability in outcome measures and lack of standardized trials limit direct quantification.

Compared to these published trends, the magnitude of pain reduction observed in our study with IMIG (mean VAS reduction of ~4.5 points at one month) compares favorably with outcomes reported with pharmacologic DMARD-based regimens, where clinical improvements were documented but often required several weeks of therapy.[26] Additionally, IMIG demonstrated rapid onset of benefit, with statistically significant symptom relief by the first week post-treatment. This contrasts with many DMARD regimens, which typically exhibit slower onset of effect due to their mechanisms of action requiring weeks to months to reach maximal immunomodulatory effect.

Non-pharmacologic approaches such as physiotherapy and neuromodulation (e.g., transcranial direct current stimulation) have also shown potential in reducing pain and improving functional outcomes in chronic chikungunya arthralgia, indicating the multifactorial nature of chronic musculoskeletal symptoms and the potential role of multidisciplinary treatment strategies.[20] However, most of these studies did not use standardized immunomodulatory agents like immunoglobulin and were limited by small sample sizes or pilot designs.

Physical therapy and musculoskeletal rehabilitation are important components of management for persistent symptoms. A 2023 systematic review found that rehabilita-

tion approaches, particularly kinesiotherapy with or without electrothermophototherapy and other functional rehabilitation strategies, may improve pain, quality of life, and functional outcomes, although the evidence remains limited.[20]

Against this background, immunoglobulin therapy represents a biologically plausible but insufficiently studied therapeutic approach. Human immunoglobulin has multiple immunomodulatory actions, including effects on antibody-mediated inflammation, cytokine networks, complement activation, and immune-cell function.[21] Human immunoglobulin has also been reported in severe CHIKV-associated neurological disease, including chikungunya encephalitis and Guillain-Barré syndrome.[22,23,27]

Immunoglobulin therapy has long been used in immune-mediated and inflammatory disorders for its multimodal immunomodulatory effects, including neutralization of pathogenic autoantibodies, modulation of cytokine networks, Fc receptor blockade, and regulatory effects on immune cell function. Although intravenous immunoglobulin (IVIG) has been more extensively studied, its use is limited by cost, accessibility, and systemic adverse effects. IMIG, as used in the present study, offers a practical outpatient-friendly alternative that demonstrated symptomatic improvement with a favorable safety profile.

The significant reductions in VAS and PRAI scores observed in our cohort suggest that IMIG may act on underlying immune pathways that contribute to chronic pain and stiffness in post-CHIKV arthralgia. Unlike purely symptomatic treatments (e.g., NSAIDs), the immunomodulatory effects of IMIG may contribute to more durable symptom relief. This is particularly relevant given the lack of standardized, high-quality randomized trials on immunomodulatory therapies in this condition, as noted in previous literature reviews where no consensus exists on optimal chronic treatment strategies for CCA.[20] In contrast to published studies that primarily emphasize DMARDs like MTX and supportive measures, the results from our study suggest an additional therapeutic avenue that merits further investigation. Importantly, IMIG was well tolerated; no serious adverse events were reported, and minor local reactions were the only side effects observed. This safety profile is favorable compared to potential systemic adverse effects associated with long-term steroid or DMARD therapy. The regression analysis showed that patients with higher baseline pain scores experienced greater reductions in VAS, whereas increasing age and longer duration of arthralgia were associated with smaller improvements. These associations may help identify clinical factors related to recovery, but they should not be interpreted as predictors of IMIG efficacy without validation in controlled studies.

The favorable short-term safety profile observed in this cohort is encouraging. Only mild injection-site pain and transient low-grade fever were reported, and no serious adverse events or allergic reactions were observed. However, the sample size was small, and the absence of serious adverse events in this cohort does not establish the overall safety profile of IMIG. Larger studies with systematic adverse-event surveillance are necessary.

The present findings therefore support further investigation rather than definitive therapeutic recommendations. In particular, randomized controlled trials comparing IMIG with conventional management or placebo, with standardized diagnostic criteria, validated outcomes, adequate sample size, and longer follow-up are required.

Strengths and limitations

The strengths of this study include its prospective design, predefined follow-up intervals, repeated assessment of pain and arthralgia severity, assessment of joint mobility, and prospective recording of adverse effects. The use of multivariable regression also allowed exploration of factors associated with change in pain.

The principal limitation is the absence of a randomized control group. Therefore, causal efficacy of IMIG cannot be established. Additional limitations include the relatively small sample size, single-center design, potential selection bias, possible confounding by the natural history of post-chikungunya disease and concurrent care, and follow-up limited to six months. The observational pre-post design may overestimate treatment-associated improvement. The study also did not compare IMIG directly with NSAIDs, corticosteroids, DMARDs, or rehabilitation alone. Future studies should address these limitations through randomized controlled designs with adequate sample size and longer follow-up.

CONCLUSION

In this prospective observational cohort, intramuscular immunoglobulin administration was associated with significant reductions in pain and arthralgia severity and improvement in joint mobility among patients with post-chikungunya arthralgia. The treatment was generally well tolerated, with no serious adverse events observed in this cohort. However, because the study lacked a randomized control group, the observed improvements cannot be attributed definitively to IMIG. The findings should therefore be regarded as preliminary and hypothesis-generating. Well-designed randomized controlled trials are required to determine the efficacy, comparative effectiveness, optimal dosing strategy, and long-term safety of IMIG in post-chikungunya arthralgia.

STATEMENT OF AUTHORSHIP

All authors certified fulfilment of ICMJE authorship criteria.

CREDIT AUTHOR STATEMENT

SSD: Conceptualization, Investigation, Data curation, Writing – original draft preparation, Writing – review and editing, Visualization, Project administration; **SSB:** Methodology, Resources, Writing – original draft preparation, Writing –

review and editing, Visualization; **SRS:** Conceptualization, Formal analysis, Investigation, Data curation, Visualization, Writing – original draft preparation, Writing – review and editing; **SK:** Validation, Supervision, Project administration; **RT:** Software, Resources; **VP:** Formal analysis, Investigation, Supervision, Project administration; **AG:** Investigation, Supervision, Project administration.

AUTHOR DISCLOSURE

The authors declared no conflict of interest.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed in this study are included in the published article.

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None.

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CASE SERIES

Achilles Tendon Rupture Repair Using Knotless Unidirectional Absorbable Barbed PDS Suture: A Prospective Case Series of Five Patients

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ABSTRACT

This was a case series of five patients with closed Achilles tendon rupture between 2023 and 2024, with a mean follow-up of six months. The objective was to evaluate the applicability of knotless absorbable barbed sutures in the management of Achilles tendon rupture through short- to mid-term clinical and functional outcomes. All patients underwent open end-to-end tendon repair using the modified Bunnell technique with a total of six cores, with a size 1 knotless, unidirectional, absorbable barbed PDS suture, via the posteromedial approach. Surgeries were performed by multiple surgeons at Jose R. Reyes Memorial Medical Center, a tertiary hospital. Post-operative American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score and 36-Item Short Form Health Survey (SF-36) score were monitored. All five patients were satisfied, did not have wound complications or re-operations, and had negative Thompson and Matles tests with no limitation in ankle range of motion at six months. AOFAS score showed a mean difference of 62 at six months post-operative, indicating better foot and ankle function, reduced pain, and improved overall mobility. The SF-36 score showed a mean difference of 46, indicating better overall health-related quality of life, reflecting improvements in physical functioning, mental health, social functioning, and overall well-being. Knotless, unidirectional, absorbable barbed PDS suture using the modified Bunnell stitch is a novel and reproducible treatment option for closed Achilles tendon ruptures, providing good clinical and functional outcomes.

Keywords. Achilles tendon rupture, open tendon repair, absorbable barbed suture, modified Bunnell, suture techniques, treatment outcome

INTRODUCTION

The Achilles tendon is the largest and strongest tendon in the human body. It enables the triceps surae to plantarflex the foot, allowing locomotion and propulsion, such as in walking, running, and jumping. Despite its size and strength, it is susceptible to damage and rupture with repetitive use.[1]

Surgery is the gold standard of treatment for patients with Achilles tendon rupture, involving the re-approximation of ruptured tendon ends using various suture materials and techniques. The goal is to restore the resting and proper tension length of the triceps surae to allow return to pre-injury state. Deng et al. demonstrated higher rates of re-rupture with conservative management when compared with both open and minimally invasive repair.[2] Furthermore, when conservative treatment is delayed, or the patient is non-adherent, surgery may still be needed.[3] Traditionally, non-absorbable sutures are used with interlocking techniques for cost-effective and reliable management.[4] In our institution, Ethibond and Fiberwire are most commonly used. However, these have shown an increased incidence of surgical site infections in the

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form of suture granulomas during short- to mid-term follow-up, requiring readmission and/or re-operation.

Kanz et al. evaluated the biomechanical parameters of a knotless absorbable barbed PDS suture in human cadaveric Achilles tendon models.[5] The barbed design prevented gap formation, with significantly less failure strength and similar stiffness to a conventional Fiberwire repair. It is absorbable after 180 to 210 days, theoretically preventing long-term complications such as infection from suture granulomas, as observed with non-absorbable sutures.

OBJECTIVES

To evaluate the short- to mid-term clinical and functional outcomes of open Achilles tendon repair using an absorbable barbed PDS suture with the modified Bunnell technique. To assess the clinical application of Kanz et al.'s innovative biomechanical study on knotless absorbable barbed sutures for the treatment of Achilles tendon rupture in a tertiary hospital setting.

METHODOLOGY

Research design

This was a prospective case series evaluating the effectiveness of knotless, unidirectional, absorbable barbed PDS suture in open repair of closed Achilles tendon rupture seen in a tertiary hospital between 2023 and 2024.

Subject recruitment

Purposive sampling was utilized in the recruitment of the patients. Informed consent was obtained from all prospective participants. The inclusion and exclusion criteria are shown in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion	Exclusion
• Conscious patients, GCS 15 • Adult (Age >18 years and <65 years old) • Closed Achilles tendon rupture with surgical indication	• Polytrauma or multiply injured patient • Open wounds or ongoing infection • Amenable for conservative management

Procedure

Approval from the Institutional Review Board was obtained. After initial evaluation through history, physical examination, and imaging, consent and assent were secured before undergoing surgery. Patients were informed thoroughly regarding the new technique. All the possible risks and complications were explained. For patients who met the inclusion criteria, consent to participate in this study was obtained.

Patients were admitted and scheduled for elective surgery for open Achilles tendon repair using absorbable barbed PDS suture. Multiple surgeons performed the procedures at Jose R. Reyes Memorial Medical Center, a tertiary hospital. All five patients were followed up every two to four weeks, up to six months.

Data analysis

The patients' gait, ankle range of motion, and ability to do squats, jump, and tip-toe were assessed. The mean functional outcome scores using the AOFAS hindfoot score and SF-36 score were recorded pre-operatively, at four weeks post-operatively, and six months post-operatively.

The American Orthopaedic Foot and Ankle Society (AOFAS) score is a clinical scoring system used to evaluate foot and ankle function. It assesses pain, function, and alignment, with scores ranging from 0 to 100 points, with higher scores indicating better outcomes. The Short Form Health Survey (SF-36) is a widely used questionnaire measuring overall health-related quality of life. It evaluates the domains of physical functioning, role limitations (physical and emotional), bodily pain, general health, vitality, social functioning, and mental health. Scores range from 0 to 100, with higher scores indicating better health status. The mean difference between pre-operative and six months post-operative scores was computed.

Case 1

KR was a 24-year-old male who sustained a left closed Achilles tendon rupture two weeks prior while playing basketball. The patient was running on the court, and upon push-off to initiate a jump, he suddenly felt a pop in his left ankle, resulting in immediate pain and swelling. He consulted at a different institution where a musculoskeletal ultrasound showed complete separation of the Achilles tendon with a gap measuring 1.1 cm. On physical examination, the patient's left ankle was tender and swollen, with a palpable gap. The Thompson and Matles tests were positive (Figure 1). Radiographs were normal. The pre-operative AOFAS hindfoot score was 34% at the time of first consult (Table 2), with an SF-36 mean score of 55%.

Case 2

JA was a 29-year-old male, production staff, who sustained a right closed Achilles tendon rupture while playing basketball. He pivoted on his right foot and felt a pop, resulting in sudden pain and inability to ambulate. He consulted at a local center, where radiographs showed no fractures. The patient was sent home without immobilization. Persistence of symptoms prompted a consult at our institution at one week post-injury. On physical examination, there was bruising and tenderness. The Thompson test was positive (Figure 2). The pre-operative AOFAS hindfoot score was 13% at the time of first consult, with an SF-36 mean score of 28%.

Case 3

JD was a 45-year-old male who sustained a left closed Achilles tendon rupture while playing badminton. The patient was running towards the shuttlecock when he had an error in his footwork, causing him to fall on his right side. He heard a pop with immediate pain in his left ankle. On physical examination, the patient had a palpable gap on his posterior ankle, with positive Thompson and Matles tests. The pre-operative AOFAS hindfoot score was 37% at the time of first consult, with an SF-36 mean score of 40% (Table 3).

Case 4

RR was a 46-year-old male, a radiology technician, who sustained a right closed Achilles tendon injury during a basket-

Table 2. Case 1 Pre-operative AOFAS Score Breakdown

AOFAS Ankle-Hindfoot Score Summary

Section 1: Pain Moderate, daily	(20 points)
Section 2: Activity limitations, support requirements Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace	(0 points)
Section 2: Maximum walking distance, blocks Less than one	(0 points)
Section 2: Walking surfaces Severe difficulty on uneven terrain, stairs, inclines, ladders	(0 points)
Section 2: Gait abnormality Marked	(0 points)
Section 2: Sagittal motion (flexion plus extension) Severe restriction (less than 15 degrees)	(0 points)
Section 2: Hindfoot motion (inversion plus eversion) Normal or mild restriction (75% - 100% normal)	(6 points)
Section 2: Ankle-hindfoot stability (anteroposterior, varus-valgus) Stable	(8 points)
Section 3: Alignment Poor, nonplantigrade foot, severe malalignment, symptoms	(0 points)

Pertinent Negative | Pertinent Positive | Pertinent Positive

AOFAS Ankle-Hindfoot Score: 34/100 points or 34 percent.

Graphical AOFAS Ankle-Hindfoot Score

Table 3. Case 3 Pre-operative SF-36 Score Breakdown

Physical functioning	10%
Role limitations due to physical health	0%
Role limitations due to emotional problems	0%
Energy/ fatigue	55%
Emotional well-being	60%
Social functioning	62.5%
Pain	55%
General health	70%
Health change	50%
Mean	40.3%



Figure 1. Positive Matles test on the left ankle of Case 1 (posterior view, patient prone with knees flexed to 90 degrees).



Figure 2. Positive Thompson test on the right ankle of Case 2 before **(A)** and during **(B)** calf compression, showing no ankle plantarflexion (lateral view, patient prone with knee flexed).

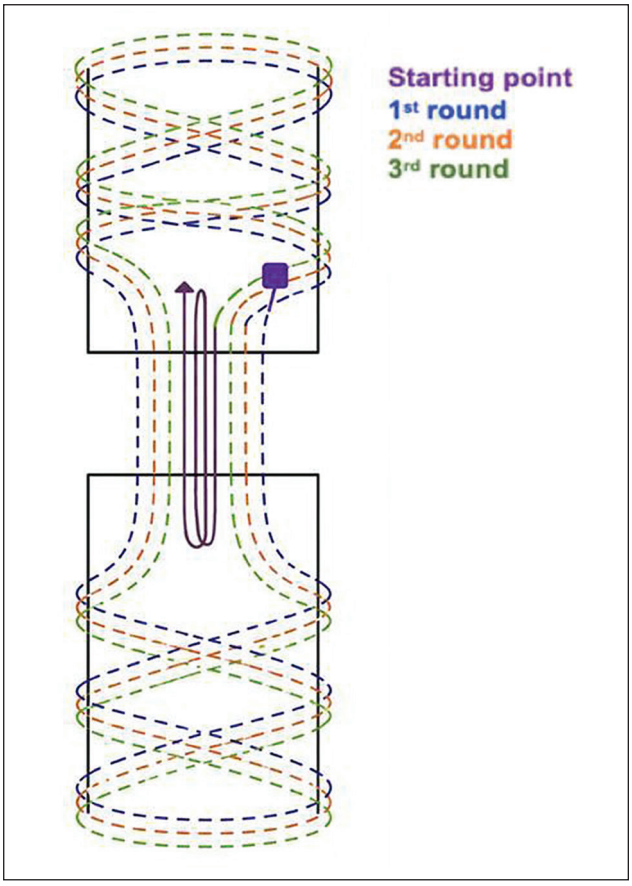


Figure 3. Schematic of the modified Bunnell repair technique showing the starting point and the first, second, and third suture rounds.

ball game. He suddenly felt a popping sensation in his right ankle while landing from a jump after a shot. He was unable to ambulate afterwards. He consulted with a general physician three days post-injury. The patient consulted at our institution at three weeks post-injury for a second opinion. Physical examination showed positive Thompson and Matles tests with ankle plantarflexion limited to 30 degrees. The pre-operative AOFAS hindfoot score was 41% at the time of first consult, with an SF-36 mean score of 46%.

Case 5

BB was a 37-year-old male, seaman, known case of left closed Achilles tendon rupture s/p open Achilles tendon repair using Fiberwire via Krakow technique. At one week post-operatively, the patient was going down the stairs when he lost balance and fell, landing on his operative foot. He noted a popping sensation on his left ankle. The patient was referred to our institution, where physical examination showed a palpable gap and a positive Thompson test. The patient was admitted for re-operation. The pre-operative AOFAS hindfoot score was 32% at the time of first consult, with an SF-36 mean score of 30.8%.

Surgical technique

Open Achilles tendon repair was done in the operating room. Patients were under spinal anesthesia and placed in a prone position with a bolster on the anterior distal leg to position the ankle in neutral. The repair technique is illustrated in Figure 3.

Skin surgical markings were placed outlining the Achilles tendon, the rupture site, and planned incision site on the posteromedial aspect of the ankle (Figure 4A). Upon incision and surgical exposure, the completely transected Achilles tendon was visualized. Tendon debridement was done, making sure that no fibrous tissue was interposed during suture repair of the tendon ends.

The modified Bunnell technique was performed using a size 1 knotless, unidirectional, absorbable barbed PDS suture to anastomose and repair the ruptured Achilles tendon ends. The starting point was made from the proximal tendon end, traversing the rupture and engaging on the distal tendon end (Figure 4B). A modified Bunnell stitch was done, crossing five times on each tendon end, with a total of ten per round. A total of three rounds with six suture cores were achieved with two throws traversing the rupture site (Figure 3), finally ending the repair by cutting the suture near the surface of the Achilles tendon (Figure 4C).

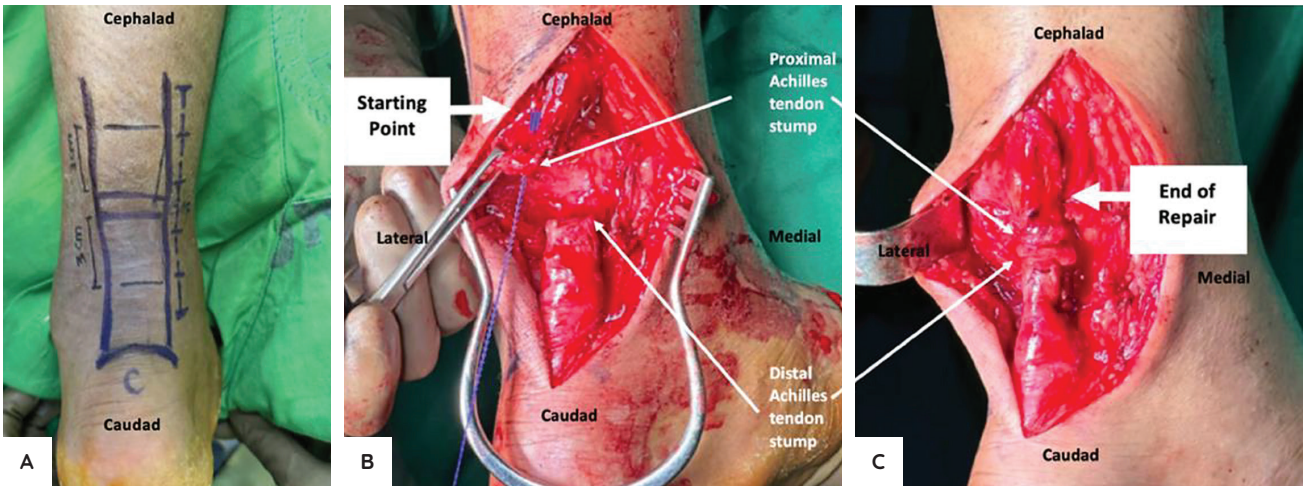


Figure 4. Skin markings **(A)**, starting point of suture repair **(B)**, and end of repair **(C)** for Case 1 (posterior view).

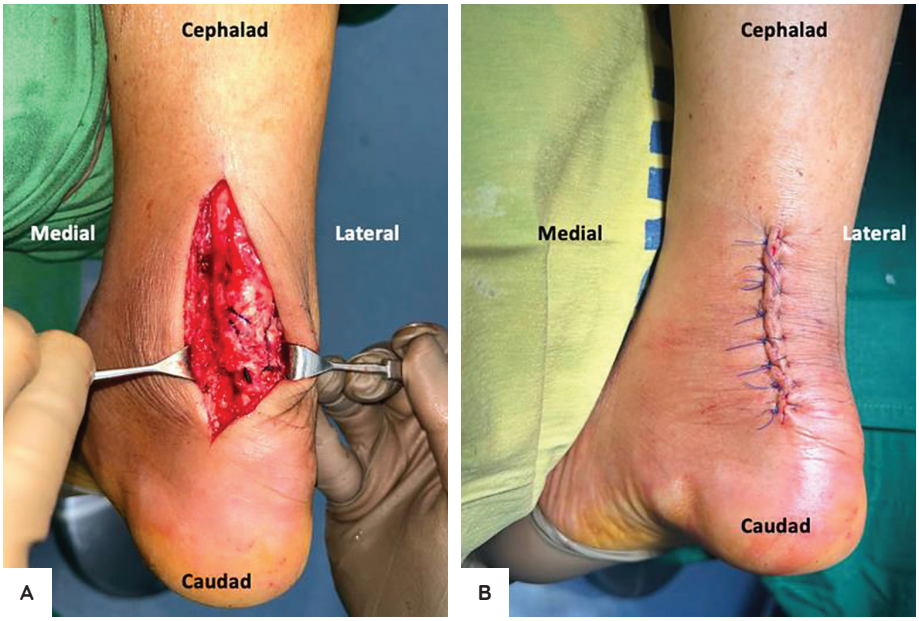


Figure 5. Intra-operative gross appearance after open repair **(A)** and closure **(B)** for Case 4 (posterior view).

Table 4. AOFAS Mean Score pre-operatively, 4 weeks post-operatively, and 6 months post-operatively

	Pre-operative	4 weeks post-operative	6 months post-operative
Case 1	34%	57%	100%
Case 2	13%	56%	95%
Case 3	37%	48%	91%
Case 4	41%	53%	86%
Case 5	32%	63%	96%
Mean	31.4%	55.4%	93.6%

Table 5. SF-36 Mean Score pre-operatively, 4 weeks post-operatively, and 6 months post-operatively

	Pre-operative	4 weeks post-operative	6 months post-operative
Case 1	55%	72%	90%
Case 2	27.8%	51%	78.5%
Case 3	40.3%	74.7%	83.3%
Case 4	46%	69%	86.6%
Case 5	30.8%	66.7%	89.7%
Mean	40%	66.7%	85.6%

Postoperative Thompson tests were negative (presence of ankle plantarflexion with calf compression). Closure was done (Figure 5), and the ankles were immobilized in an anterior blocking splint in gravity equinus. Patients were sent home with strict instructions on post-operative rehabilitation.

Post-operative rehabilitation

For each patient, an anterior blocking splint immobilized the ankle in gravity equinus for four weeks. The splint was converted into a more plantigrade position from the fourth to the sixth week post-operatively. Ambulation was not allowed for a total of six weeks. After six weeks, the ankle was placed in a plantigrade position in an Aircast and ambulation was allowed. Unrestricted ambulation without immobilization was achieved by eight weeks post-operatively.

RESULTS

This was a case series of five patients between 2023 and 2024 with a mean follow-up of six months. All patients presented with a chief complaint of ankle pain secondary to sports injury. Patients experienced immediate ankle pain, a popping sensation, and inability to ambulate while landing from a jump or due to an error in footwork during recreational sports (four basketball, one badminton). Consults were delayed between one and three weeks. All patients underwent open Achilles tendon repair and strict post-operative rehabilitation. The AOFAS hindfoot and SF-36 functional scores were documented at the fourth week and sixth month post-operatively. The assessment of the patients' gait, range of motion, ability to do squats, jumps, and calf raises was recorded at six months post-operatively.

American Orthopaedic Foot and Ankle Society (AOFAS) Hindfoot Score

The mean AOFAS hindfoot score was 31.4% pre-operatively, 55.4% at four weeks post-operatively, and 93.6% at six months post-operatively (Table 4). The mean difference in scores at six months post-operative was 62.

Short Form Health Survey (SF-36) Score

The mean SF-36 score was 40% pre-operatively, 66.7% at four weeks post-operatively, and 85.6% at six months post-operatively (Table 5). The mean difference in scores at six months post-operative was 46.

At the sixth month of follow-up, all five patients were ambulatory without assistance and were satisfied with their gait. All surgical sites healed uneventfully, with no signs of

infection or other subjective complaints. By this time, the suture had likely undergone complete absorption, thereby reducing the risk of long-term infection compared with non-absorbable sutures. Focused physical examination of the ankle showed negative Thompson and Matles tests, confirming that the Achilles tendon had healed. There was no limitation in ankle range of motion with dorsiflexion, plantarflexion, adduction, abduction, inversion, and eversion. All patients were able to do squats, jumps, and calf raises (Figures 6 and 7) without pain, apprehension, or ankle stiffness. Patients were able to resume their activities of daily living and were advised to follow up as needed for new complaints.

DISCUSSION

The Achilles tendon is the most common tendon to rupture despite being the strongest tendon in the body. Surgical repair remains the gold standard of management, involving direct anastomosis of ruptured tendon ends using non-absorbable sutures to provide support during the healing process. This has shown lower re-rupture rates compared to conservative treatment;[2] however, it has increased risk for complications such as infection, scarring, and sural nerve injury.[6]

The knotless, unidirectional, barbed suture is an absorbable suture device that eliminates the need for tying. Its fixating barbs maintain tension on each pass when compared with traditional sutures, eliminating weaker spots from slippage or higher-tension spots, which are prone to disruption.[7] This study was able to translate Kanz et al.'s biomechanical findings into a clinical setting at a tertiary hospital.[5]

Karasu et al. identified a minimum clinically important improvement of more than 38 points in the AOFAS score following Achilles tendon repair.[8] This threshold was exceeded by the 62-point improvement observed in this study. To our knowledge, no published study has reported the mean improvement in SF-36 scores after open Achilles tendon repair, regardless of suture used, against which to compare our mean difference of 46. Further investigation with larger populations and longer follow-up will help validate the results from this pilot study.

LIMITATIONS

The barbed suture had a tendency to coil on each pass, adding difficulty to the surgery. This was resolved by having the surgical assistant hold onto the remaining suture and prevent coiling. The surgical assistant must also make sure that the ends of the tendons are opposed properly with tension comparable to the contralateral ankle before traversing the tendon ends with the barbed suture. A mistake in the entry can be redone with the same suture, but may decrease the strength of the tendon or the strength of the repair. This procedure is fairly



Figure 6. Left ankle plantarflexion **(A)** and dorsiflexion **(B)** (lateral view), squatting, posterior view **(C)**, jumping, anterior view **(D)**, and calf raises, lateral view **(E)** at the 6-month follow-up for Case 1.



Figure 7. Squatting, lateral view **(A)**, jumping, posterior view **(B)**, and calf raises, lateral view **(C)** and posterior view **(D)** at the 6-month follow-up for Case 3.

easy to follow even for new surgeons unfamiliar with the suture technique, although practice can be beneficial.

The suture was 45 centimeters long, adequate to span and repair the ruptured Achilles tendon in all five Filipino patients. However, it is possible that more than one suture will be required to repair the Achilles tendon of larger patients, which may result in inconsistencies in the repair.

Although a non-absorbable barbed suture could have been a direct comparison, it is not readily available in our institution.

Ultrasound was not performed at the end of the study to check for suture resorption. We had no re-operations due to suture granuloma, which may be because the absorbable nature of the suture prevents granuloma formation. Other factors that could have contributed to the uneventful post-operative course were proper patient education, wound care, and rehabilitation.

Although the sample size was small, the findings provide valuable information and may encourage further investigation through larger-scale studies on this topic. Readers may use the current data at their own discretion and with appropriate consideration of the associated risks and limitations.

CONCLUSION

All five patients had unremarkable post-operative courses with return to activities of daily living on par with traditional repair. All patients were ambulatory with no complaints about their gait. They had good ankle range of motion and function with no difficulty doing jumps, squats, and calf raises by six months post-operatively. The AOFAS score showed a mean difference of 62 at six months post-operative, indicating improved foot and ankle function, reduced pain, and improved overall mobility. The SF-36 score showed a mean difference of 46, indicating better overall health-related quality of life, reflecting improvements in physical functioning, mental health, social functioning, and overall well-being.

In conclusion, the use of knotless, unidirectional, absorbable barbed suture is a novel and reproducible treatment option for closed Achilles tendon ruptures, providing good clinical and functional outcomes.

ETHICAL CONSIDERATIONS

Patients' consent was obtained before the submission of the manuscript.

STATEMENT OF AUTHORSHIP

All authors certified fulfilment of ICMJE authorship criteria.

CREDIT AUTHOR STATEMENT

GSBC: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Writing – original draft preparation, Writing – review and editing, Visualization, Project administration; **ECT:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing – original draft preparation, Visualization, Supervision, Project administration; **DTDJ:** Methodology, Validation, Formal analysis, Resources, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision, Project administration.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed in this study are included in the published article.

AUTHOR DISCLOSURE

The authors declared no conflict of interest.

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None.

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The Philippine Journal of Orthopaedics

CASE REPORT

Reconstruction of a Chronic Distal Biceps Tendon Rupture Using an Iliotibial Band Autograft and Endobutton Fixation: A Case Report

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ABSTRACT

This paper presents a surgical technique using an autologous iliotibial band (ITB) graft combined with Endobutton fixation for reconstructing a chronic distal biceps tendon rupture. The technique addresses the often-seen challenges of tendon retraction, tissue compromise, and stability of bony insertion. A 57-year-old male with a chronic distal biceps tendon rupture underwent surgery using a 16 x 2 cm ITB autograft, resulting in significant improvement in range of motion, functional scores (Filipino version of the Disabilities of the Arm, Shoulder and Hand [Fil-DASH] questionnaire), and resolution of pain at 18-month follow-up. The authors conclude that the combined use of autologous ITB graft and Endobutton fixation led to excellent outcomes in this case of chronic distal biceps tendon rupture.

Keywords. chronic distal biceps tendon rupture, iliotibial band autograft, Endobutton, cortical button fixation, tendon reconstruction

INTRODUCTION

Chronic distal biceps tendon ruptures present a distinct surgical challenge due to tendon retraction, fibrosis, and muscle atrophy, which often preclude primary repair. Because of these challenges, autograft or allograft tendon reconstruction is often necessary to bridge the gap and restore function. While various graft choices and fixation methods such as suture anchors and interference screws have been described in the literature, there remains an ongoing debate regarding the optimal reconstruction strategy. This case report details our approach using iliotibial band (ITB) autograft secured with an Endobutton to provide a highly stable and anatomically robust reconstruction that requires only brief postoperative immobilization and allows early range of motion.

CASE

A 57-year-old male consulted due to limited range of motion, inability to use his left forearm because of pain, and a gross deformity of his biceps. The patient had a known comorbidity of stage 2 hypertension and a 40 pack-year history of smoking. A focused examination of the patient's left upper extremity showed a positive Popeye sign, limited supination with associated pain, and a palpable gap at the antecubital fossa. He tested positive for the hook test and exhibited weakness in supination and flexion compared to the contralateral arm. His Fil-DASH score was 50.6, indicating severe disability, and surgical reconstruction

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was recommended. Notably, the patient suffered a similar injury to the right (contralateral) elbow 10 years prior and was treated acutely with direct end-to-end tendon repair.

Surgical technique

Patient positioning and exposure

The patient, under axillary block and general anesthesia, was positioned supine with the left arm extended and the forearm supinated on a radiolucent table. A 10-cm anterior lazy-S incision was made over the antecubital fossa, and blunt dissection was carried down to expose and release the bicipital aponeurosis. Grossly, we found an avulsed biceps tendon with the stump retracted 8 cm proximal to the radial tuberosity (Figure 1).

Harvesting ITB autograft

An autologous iliotibial band (ITB) graft was harvested from the left thigh. After marking the skin, a 10-cm incision was made on the direct lateral thigh 15 cm distal to the anterior superior iliac spine (ASIS), at the beginning of the confluence of the tensor fasciae latae (TFL) and ITB. The ITB normally runs ~50 cm from the iliac crest down to its insertion with a width of 5 cm at the mid-thigh and a thickness of 2 to 3 mm. After exposing the ITB, we harvested a 16 x 2 cm graft to span the 8-cm gap with extra length for proximal juncture and distal juncture repair of at least 4 cm each (Figure 2). The distal biceps tendon exhibits considerable anatomical variability. A three-dimensional cadaveric study reported a mean total tendon length of 126.7 ± 10.7 mm, with an internal width of 12.0 ± 4.2 mm and an external width and thickness of 6.0 ± 1.0 mm and 3.0 ± 0.5 mm, respectively.[1]

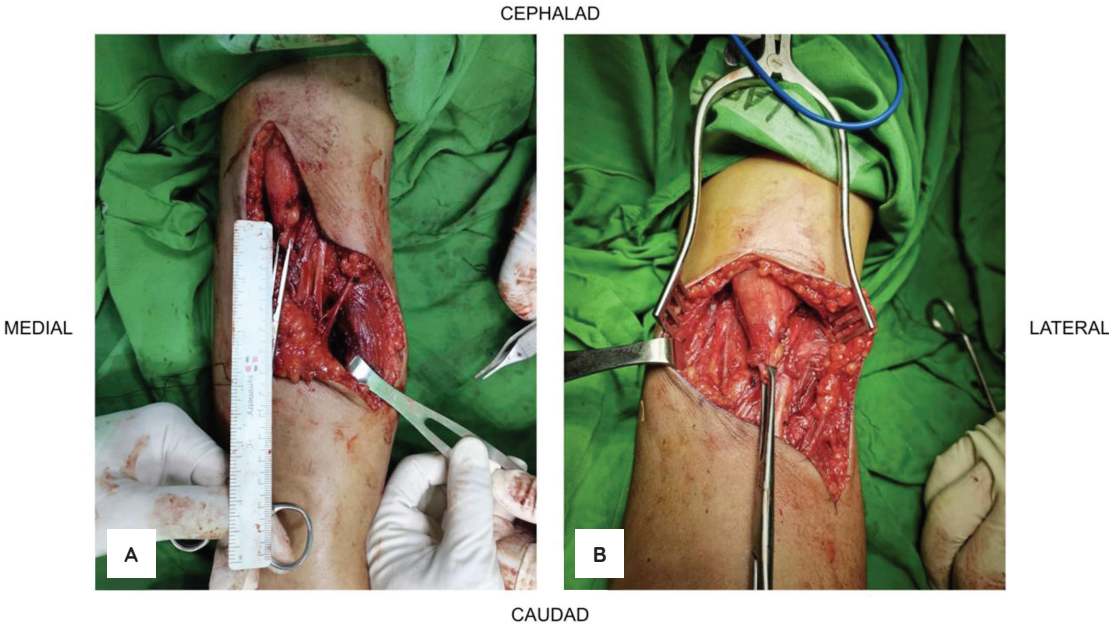


Figure 1. Volar aspect of the left forearm showing an almost 8-cm gap from the distal biceps tendon stump to the bicipital tuberosity of the radius **(A)**. Muscle belly of biceps showing remnant biceps tendon stump **(B)**.

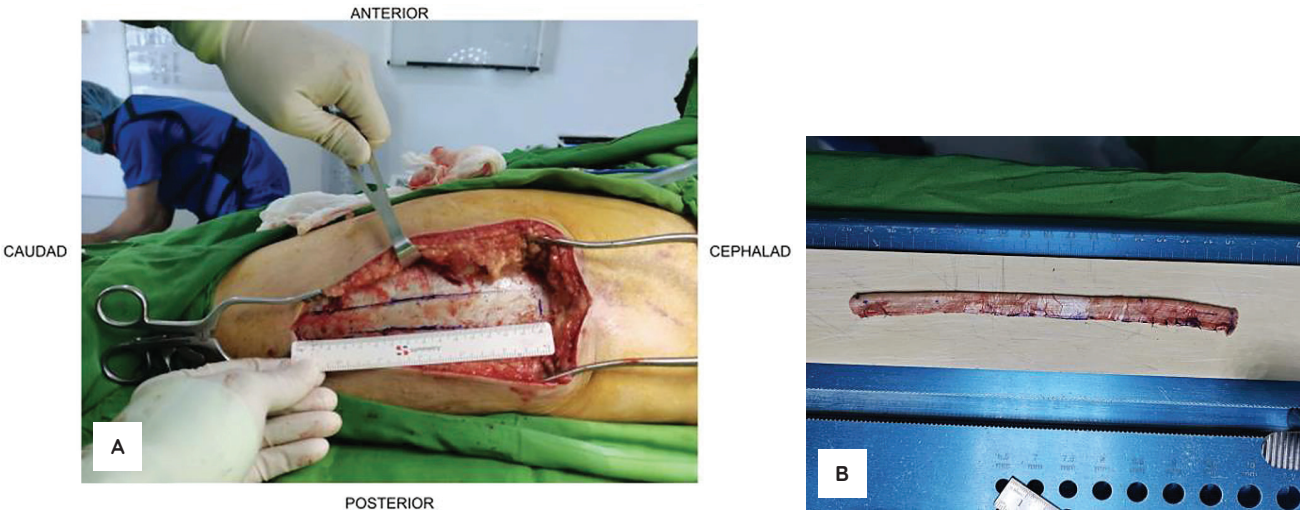


Figure 2. Incision on the direct lateral thigh exposing the ITB **(A)**. Harvested graft from the anterolateral ITB measuring 16 x 2 cm (L x W) **(B)**.

Folding a 2-cm-wide graft longitudinally yielded a 1-cm wide autograft. A longer open incision to the ITB allowed direct visualization and protection of the lateral femoral cutaneous nerve, and ensured a uniform width of the graft.

Preparation of radial tuberosity and tendon reconstruction and fixation

The radial tuberosity was located and decorticated. A bicortical drill hole was created with a 5-mm drill bit for later passage of the Endobutton (ConMed, 15-mm XO Endobutton). Three whipstitches were applied to the distal juncture of the ITB graft and the suture ends were passed through the Endobutton. While keeping the suture ends tensioned outside the bone, the Endobutton was passed through the drill hole longitudinally and flipped after it went past the distal cortex. The suture ends were sutured to the graft itself just proximal to its bony insertion. With the elbow in 90 degrees of flexion and neutral forearm rotation, the proximal juncture was repaired with a Pulvertaft weave of the ITB graft with the biceps muscle, reinforced with a figure-of-eight suturing technique using Ethibond 2-0 (Figure 3).

Closure

Fixation was confirmed intraoperatively under the image intensifier (Figure 4). The wound was closed in layers. The elbow was kept in an arm sling in 90 degrees of flexion and neutral forearm rotation.

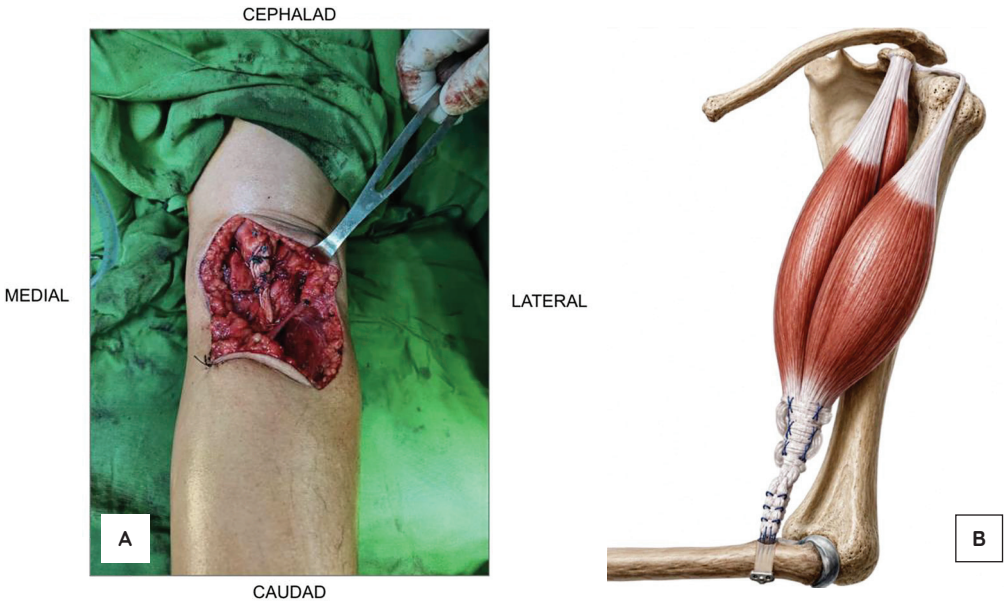


Figure 3. Reconstruction of the distal biceps tendon is shown **(A)**. Diagram of the proximal juncture Pulvertaft weave and figure-of-eight suturing, and distal juncture repair with Endobutton fixation **(B)**.

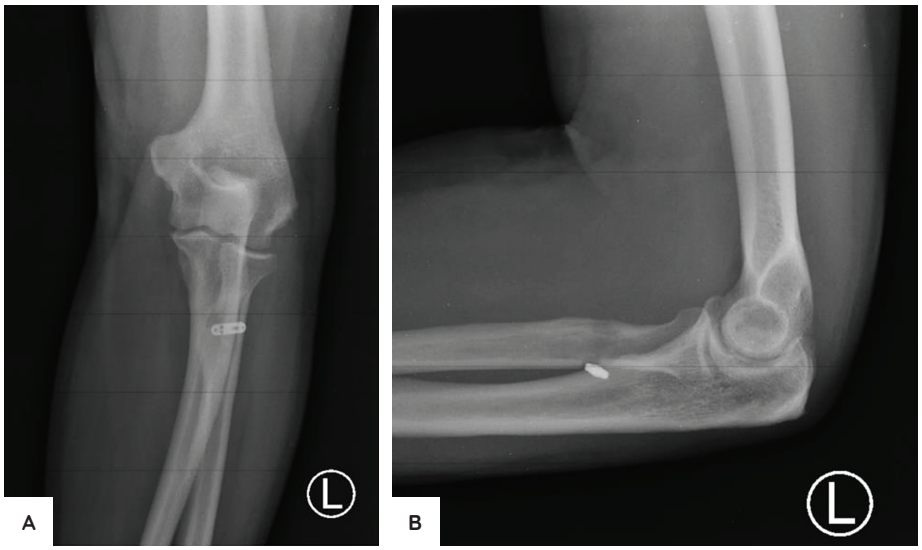


Figure 4. Elbow AP/L radiographs presenting an intact construct with the Endobutton. AP view shows the position of Endobutton at native insertion of biceps **(A)**. Lateral view shows Endobutton anchored at the distal cortex with adequate tension **(B)**.

Postoperative rehabilitation and outcomes

The patient was discharged one day postoperatively without complications. A progressive rehabilitation protocol was started (Table 1).

At 18 months follow-up, the surgical site was completely healed with no Popeye sign. The patient demonstrated a functional arc of motion of the forearm (supination 78°; pronation 75°; total arc 153°) and elbow (20–140° extension/flexion) (Figure 5). The Fil-DASH score improved to 19, indicating minimal disability, and the patient reported high satisfaction with the procedure.

Bilateral elbow MRIs were performed to assess the status of the biceps tendons and the integrity of the surgical construct of both elbows (Figures 6 to 8). This evaluation compared an acutely repaired biceps tendon rupture in the right elbow 10 years postoperatively to a reconstructed chronic biceps tendon rupture in the left one year postoperatively. Imaging revealed no significant differences in the structural integrity

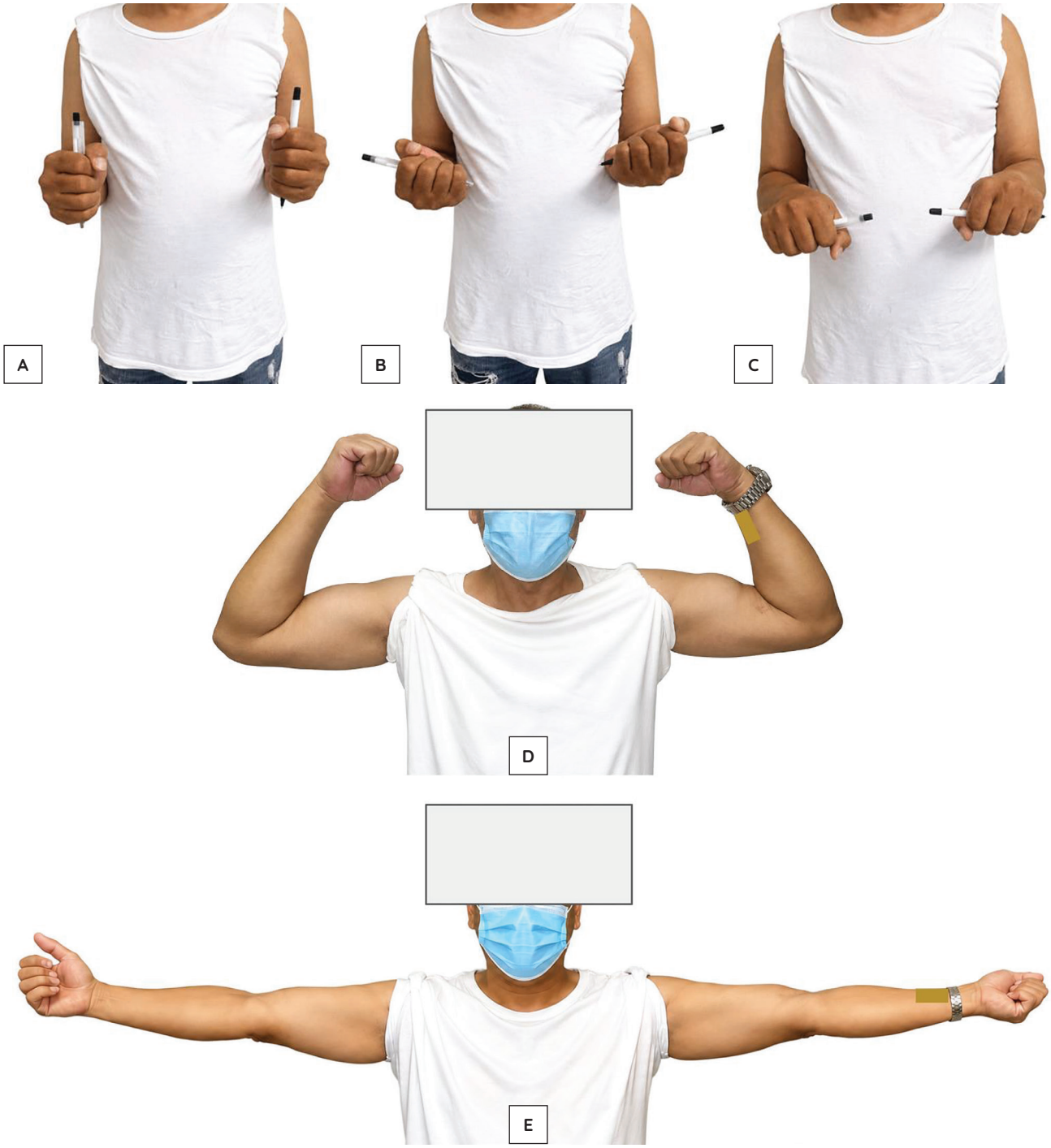


Figure 5. Assessment of range of motion. Neutral forearm **(A)**, supinated forearm **(B)**, pronated forearm **(C)**, with a total arc of motion of 153° on the left side (pronation: 75°; supination: 78°) compared to 167° on the contralateral right side (pronation: 82°; supination: 85°). Flexed elbows **(D)**, extended elbows **(E)**. The elbow total arc was 120° (extension: 20°; flexion: 140°).

Table 1. Postoperative Rehabilitation Protocol

Postoperative Timeframe	Immobilization Status	Range of Motion (ROM) Guidelines	Strengthening and Activity
Day 1 to Week 1	Bulky dressing with armsling in 90 degrees of elbow flexion and neutral forearm rotation	Immobilized	Rest; refrain from lifting weights
Weeks 1 to 4	Bulky dressing with armsling in 90 degrees of elbow flexion and neutral forearm rotation	Active ROM exercises as tolerated Weekly increase in elbow extension by 20 degrees until 0 degrees of extension Weekly increase in pronation and supination from neutral by 20 degrees until 90 degrees	Refrain from lifting weights
Weeks 4 to 8	None	Passive ROM exercises to reach functional elbow flexion and extension and forearm pronation and supination arc of motion	Isometric strengthening
Weeks 8 to 12	None	Full functional arc of motion	Strength training and full resistance exercises

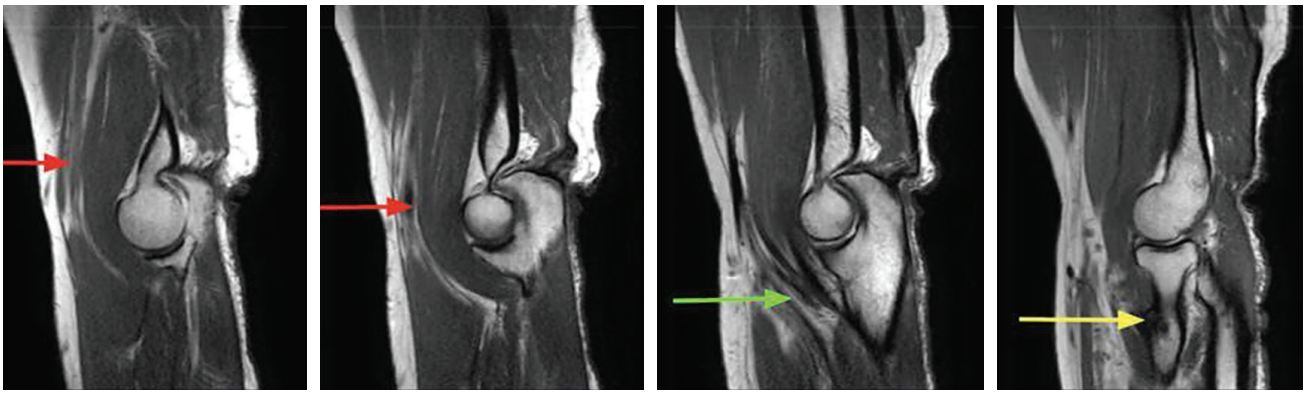


Figure 6. Right elbow MRI taken 10 years postoperatively showing intact biceps brachii tendon with diffuse thickening likely due to post-surgical changes (s/p distal biceps tendon repair) *(red arrow: biceps; green arrow: biceps tendon; yellow arrow: bicipital tuberosity).*

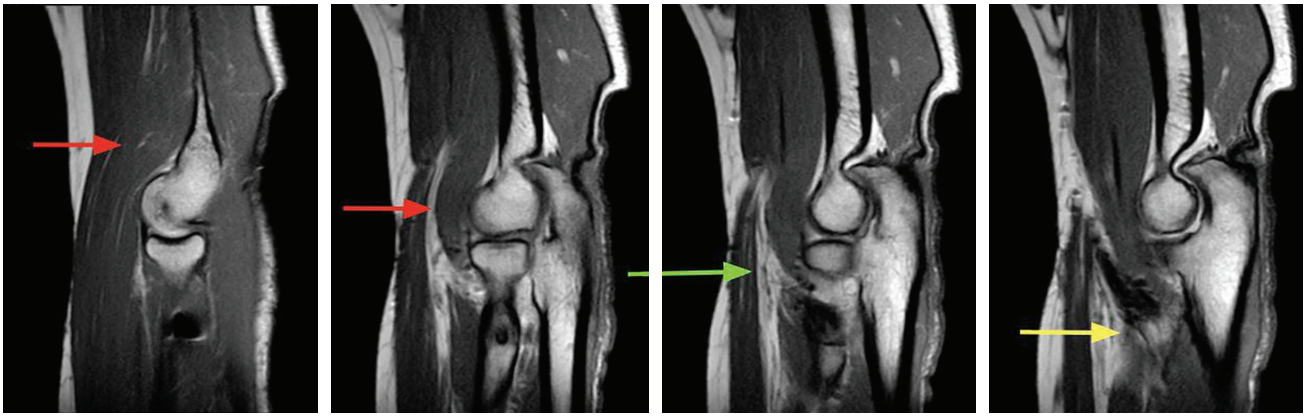


Figure 7. Left elbow MRI taken one year postoperatively showing intact biceps brachii tendon with diffuse thickening likely due to post-surgical changes (s/p reconstruction with ITB and Endobutton) *(red arrow: biceps; green arrow: biceps tendon; yellow arrow: bicipital tuberosity).*

of the constructs. The right elbow demonstrated post-operative scar tissue within the previously repaired biceps tendon. In the left elbow, the reconstructed biceps tendon remained intact, secured by the ITB autograft and Endobutton.

DISCUSSION

Chronic distal biceps tendon ruptures present a unique reconstructive challenge because delayed presentation results in proximal tendon retraction, fibrosis, and poor tissue elasticity, making primary repair difficult or impossible.[2] Consequently, tendon reconstruction using a biological graft is often required to restore the native tendon length and optimize elbow flexion and forearm supination.[2,3] The choice of graft and fixation method therefore becomes critical in achieving a durable reconstruction with satisfactory functional outcomes.

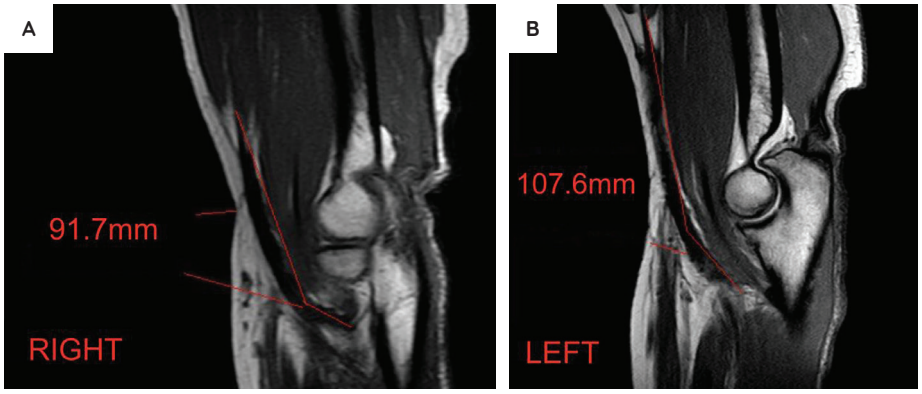


Figure 8. Postoperative MRIs of both elbows, comparing the lengths of the distal biceps tendon of 91.7 mm on the right **(A)** and 107.6 mm on the left **(B)**.

Numerous graft options have been described for chronic distal biceps reconstruction, including semitendinosus autograft, Achilles tendon allograft, peroneus longus autograft, and fascia lata grafts.[3] In the present case, an iliotibial band (ITB) autograft was selected because it provides several advantages relevant to chronic reconstruction. The ITB offers adequate graft length to bridge large tendon defects, possesses high tensile strength suitable for load-bearing reconstruction, and has low donor-site morbidity without significantly compromising lower extremity function. Furthermore, as an autologous biological graft, it eliminates the risks of disease transmission and host rejection associated with allografts while providing favorable biological incorporation into host tissue.

Although fascia lata grafts have previously been reported for distal biceps reconstruction,[4] literature specifically describing the use of an ITB autograft remains limited. Morrell et al reported excellent restoration of elbow flexion and forearm supination using fascia lata autografts with suture anchor fixation,[5] while more recent work by Fawzy et al demonstrated durable long-term functional outcomes using fascia lata allografts despite a small incidence of transient neuropraxia.[6] These studies support the biological suitability of fascia lata-derived grafts for chronic distal biceps reconstruction and provide the foundation for the present technique.

The fixation method is equally important in determining the success of tendon reconstruction. Biomechanical studies consistently demonstrate that cortical button fixation provides one of the highest load-to-failure strengths among available distal biceps fixation techniques, exceeding that of isolated suture anchors and interference screw fixation.[7] The bicortical Endobutton provides secure tendon-to-bone fixation while preserving bone stock through a relatively small bone tunnel.[8] This robust fixation permits early controlled rehabilitation, minimizes the risk of graft pullout, and facilitates biological incorporation at the radial tuberosity.

The novelty of this case lies not only in the use of an ITB autograft but also in its method of reconstruction. Proximally, the graft was integrated into the native musculotendinous unit using a Pulvertaft weave combined with figure-of-eight Ethibond suturing to maximize tendon-to-muscle contact and distribute tensile forces. Distally, fixation was achieved using a bicortical Endobutton secured to the ITB autograft with whipstitches, creating a construct that combines biological reconstruction with strong biomechanical fixation.[9] To our knowledge, reports describing this specific combination of ITB autograft reconstruction with Endobutton fixation remain scarce in the literature.

Our patient demonstrated satisfactory restoration of elbow function following reconstruction, supporting previous reports that biological graft reconstruction can successfully restore strength and stability in chronic distal biceps tendon ruptures.[3] While this single case cannot establish superiority over other reconstructive techniques, it demonstrates that ITB autograft combined with Endobutton fixation is a feasible and reproducible option when primary repair is not possible.

The principal limitation of this report is its nature as a single-case experience with limited follow-up. Larger comparative studies with longer-term functional evaluation are necessary to determine whether ITB autograft reconstruction offers clinical or biomechanical advantages over other established graft choices. Nevertheless, this case adds to the growing body of evidence supporting biological graft reconstruction for chronic distal biceps tendon ruptures and highlights ITB autograft with bicortical Endobutton fixation as a promising reconstructive technique.

CONCLUSION

This case highlights a highly effective technique for chronic distal biceps tendon reconstruction combining ITB autograft with bicortical Endobutton fixation. This combined method addresses both the gap created by tendon retraction and the need for immediate structural stability, serving as a durable alternative to traditional graft and anchor techniques that allows early range of motion.

ETHICAL CONSIDERATION

Patient's consent was obtained before submission of the manuscript.

STATEMENT OF AUTHORSHIP

All authors certified fulfillment of ICMJE authorship criteria.

CREDIT AUTHOR STATEMENT

EFH: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft preparation, Writing – review and editing, Visualization, Project administration, Funding acquisition; **RLS:** Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision, Project administration, Funding acquisition.

DATA AVAILABILITY STATEMENT

No datasets were generated or analyzed for this study.

AUTHOR DISCLOSURE

The authors declared no conflict of interest.

FUNDING SOURCE

None.

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INSTRUCTIONS TO AUTHORS

The **Philippine Journal of Orthopaedics** (PJO) accepts manuscripts relevant to orthopaedic surgery, musculoskeletal health, trauma, rehabilitation, and related clinical, surgical, educational, and research disciplines. Authors should select the article type that best reflects the purpose, design, and scope of their submission.

The Editorial Board reserves the right to determine the appropriate article classification and to recommend revisions to meet the journal's editorial and scientific standards.

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PJO accepts submissions only through its online portal (https://philjorthopaedics.org/index.php/pjo/about/submissions). Hard copies will not be accepted.

Each submission must include (1) the manuscript, (2) the cover letter, (3) the Author Form, and (4) other relevant forms, such as the Informed Consent Form. Submissions are screened for completeness and correctness before review by the editors.

1.2 Cover Letter

A cover letter addressed to the Editor-in-Chief should state the complete title of the work, the final list of all authors, and the intention to submit.

The corresponding author and his or her complete contact information (institutional mailing address, work telephone number, and work e-mail address) should be clearly indicated.

Any previous presentation of the study findings as an abstract or poster at a conference should be mentioned in the letter, including the title and dates of the conference and any awards received.

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The Author Form includes the following:

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The complete name of each author (first name, middle initial, last name), with the title indicating his or her highest educational or professional attainment (e.g., MD, MSc, PhD), and the name and location of not more than one institutional affiliation should be indicated.

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For Case Reports and Case Series, authors must submit a scanned copy of the written informed consent for publication obtained from the patient or subject involved.

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Original Articles report original clinical, epidemiological, laboratory, biomechanical, surgical, or health services research that contributes new knowledge to orthopaedics and musculoskeletal health.

The manuscript should follow the Introduction, Methods, Results, and Discussion (IMRAD) format.

- **Abstract:** Structured, maximum 500 words.
- **Required headings:** Objectives, Methodology, Results, and Conclusions.
- **Main manuscript:** Maximum 6,000 words, including tables, figures, illustrations, and references.
- **Keywords:** At least five Medical Subject Headings (MeSH) terms.

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Review Articles provide a critical synthesis of published evidence relevant to orthopaedic practice, research, education, or policy. Systematic reviews and meta-analyses must describe their search strategy, eligibility criteria, methods of evidence appraisal, and synthesis of findings, as applicable.

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Case Reports describe clinically significant or educationally valuable cases that provide insights into diagnosis, treatment, complications, unusual presentations, or clinical decision-making. Case Series describe a group of patients with a relevant clinical characteristic, condition, or intervention.

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- Letters should identify the article being discussed, when applicable, and maintain a scholarly and professional tone.

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Special Announcements may include information about upcoming orthopaedic conventions, conferences, seminars, professional activities, and other announcements relevant to the journal's readership.

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- **Authors:** The name of each author with his or her highest academic degree(s) and the complete address of one institutional affiliation.
- **Presentations:** Any meeting(s) or conference(s) where the material is under consideration for presentation, has been previously presented, and/

or has received an award, indicating the title, place, month, and year of the meeting or conference.

- **Corresponding author:** The name, mailing address, telephone number, and e-mail address of the corresponding author, who will be responsible for all questions about the manuscript. Only one author should be designated as corresponding author, and he or she need not be the first author.
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Structured abstracts are required for Original Articles, Review Articles, and Systematic Reviews. Authors should use the following headings:

- **Objectives:** State the primary purpose or research question.
- **Methodology:** Describe the study design, setting, participants or data sources, interventions or exposures, outcome measures, and principal analytical methods, as applicable. Additional modifiers may be stated (e.g., consecutive, non-consecutive, retrospective, prospective, observational, or interventional).
- **Results:** Present the principal findings, including relevant numerical data, effect estimates, confidence intervals, and exact *p*-values where appropriate.
- **Conclusions:** State the principal conclusions and their implications, ensuring that they are directly supported by the findings.

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Unstructured abstracts are required for Case Reports, Case Series, Brief Communications, and Feature Articles. They should present a concise narrative summary without section headings.

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The manuscript word limits stated above include tables, figures, illustrations, and references where indicated. Authors should not assume that supplementary materials are exempt from editorial assessment. The Editorial Board may require shortening or restructuring of manuscripts that exceed the applicable limits.

5. Keywords

Authors must provide at least five keywords immediately after the abstract, except for article types for which an abstract and keywords are not required. Keywords should be selected from the Medical Subject Headings (MeSH) database of the US National Library of Medicine (https://www.ncbi.nlm.nih.gov/mesh/) whenever suitable terms are available.

6. Body of the Text

The manuscript should be written in IMRAD format (Introduction, Methodology, Results, and Discussion), followed by the Conclusion(s). Organize and prepare the manuscript to include the sections described below.

6.1 Introduction

The Introduction should refer only to the most pertinent past publications and should not be an extensive review of the literature. Include a brief background, the research question and/or rationale, the objectives or purposes of the study, and the major hypothesis to be tested, if any.

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Methods should be written in sufficient detail to permit others to duplicate the work. Include the following, as applicable:

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- **Setting:** For example, multicenter, institutional, or clinical practice.
- **Participants, patients, or study population:** Number of patients, selection procedures, inclusion and exclusion criteria, randomization procedure, and masking.
- **Interventions or observations:** The intervention or observation procedure(s).
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For Original Articles, statements regarding adherence to the Declaration of Helsinki, approval by the Institutional Review Board (IRB) or Ethics Committee, and a description of the informed consent process should be included.

6.3 Results

Results must be concise. Provide demographic data of the study population. Describe outcomes and measurements in an objective sequence with minimal discussion. Data should be accompanied by confidence intervals (usually at the 95% level) and exact *p*-values or other indications of statistical significance.

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The Discussion should be restricted to the significant findings presented. Avoid excessive generalization and undue speculation. Elucidate on (but do not reiterate) the results, respond to other and contradictory literature, identify the limitations or qualifications of the study, and state the conclusions that are directly supported by the data. Give equal emphasis to positive and negative findings, indicate whether and what additional study is required, and conclude with the clinical applications or implications supported by the study.

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- Quote from the entire study, not the abstract.
- Authors may acknowledge unpublished data or submitted articles within parentheses in the text.
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All measurements and weights should be expressed in SI units.

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Use only generic drug names in the body of the text. When a particular drug is first mentioned, state its trade name in parentheses, including the manufacturer's name, city, state, and/or country.

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Include a statement disclosing any existing conflicts of interest, the source(s) of funding for the study and the manuscript, and acknowledgments to individuals, groups of persons, or institution(s).

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State the funding source(s) for the study on which the manuscript is based, including the writing of the manuscript.

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Tables should follow the references. Each table must be titled and numbered consecutively in Arabic numerals in the order in which it is mentioned in the text. The title should be brief and fully understandable without reference to the text. Each table column and row must have a heading. Tables that report means should include the corresponding standard deviations. Legends must identify all symbols that appear in the tables and graphs. A maximum of five tables may be included in the manuscript.

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Appendices should be used sparingly. They are appropriate for survey forms, lists of the members of a study group, or explanations of complex formulas or information. In studies involving a study group, the writing group authors should be listed with the group name on the title page, and the other group members should be listed in an appendix.

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(Date)

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Subject: **SUBMISSION OF MANUSCRIPT FOR PUBLICATION**

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