

Physiotherapy Management After Clavicle Fracture ORIF: A Case Report

Irsa Leria¹, Yery Mustari², Masfufah³

^{1,2}Professional Physiotherapy Program, Faculty of Nursing, Hasanuddin University, Makassar, Indonesia

³Dr. Tadjuddin Chalid Hospital, Makassar, Indonesia

Corresponding author:

Name: Irsa Leria

E-mail: lerianirsa@gmail.com

Received 11 August 2026; Revised 24 August 2026; Accepted 25 August 2026; Published 30 September 2026.

©2026 The Authors. Published by the Physiotherapy Study Program, Faculty of Medicine, Udayana University, in collaboration with the Indonesian Physiotherapy Association (Ikatan Fisioterapi Indonesia). This is an open-access article distributed under the terms of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

Abstract

Background: Clavicle fractures may require open reduction and internal fixation (ORIF). After surgery, patients may experience pain, restricted shoulder range of motion (ROM), reduced muscle strength, and limitations in daily activities.

Objective: To describe physiotherapy management and clinical changes in a patient following ORIF for a clavicle fracture.

Methods: This case report involved a 49-year-old man with a right clavicle fracture following a traffic accident. Physiotherapy was initiated 9 days after surgery; however, this report analyzed 30 sessions conducted over 19 weeks, from September 16, 2025, to January 26, 2026. The multimodal program included transcutaneous electrical nerve stimulation, passive, active-assisted, and active ROM exercises, stretching, scapular mobilization, isometric shoulder strengthening, and home exercises. Outcomes included pain measured using the Visual Analog Scale, shoulder ROM, muscle strength assessed using Manual Muscle Testing, and the ability to reach the back during bathing.

Results: Flexion increased from 125° to 160°, extension from 30° to 60°, abduction from 110° to 160°, adduction from 20° to 50°, internal rotation from 50° to 70°, and external rotation from 40° to 90°. Muscle strength improved from grade 4- to grade 5. Movement pain decreased from 5 to 2, resting pain from 3 to 1, and tenderness from 3 to 1. The patient independently reached his back during bathing at the final assessment.

Conclusion: Improvements in pain, shoulder ROM, muscle strength, and the observed self-care activity were documented during the observation period. However, a causal relationship between the intervention and these changes cannot be established.

Keywords

clavicle fracture; open reduction and internal fixation; physiotherapy; rehabilitation; case report

Introduction

Clavicle fractures are among the most common fractures of the upper extremity, accounting for approximately 4% of all fractures and occurring predominantly in the midshaft region. They commonly result from direct trauma, including falls, traffic accidents, and sports-related injuries.¹ Displaced midshaft fractures may be associated with pain, restricted shoulder mobility, reduced muscle performance, and limitations in daily activities. Surgical management with open reduction and internal fixation (ORIF) is commonly considered for selected fractures with substantial displacement, shortening, comminution, or other clinical characteristics that increase the risk of adverse healing outcomes.^{1,2} ORIF aims to restore anatomical alignment and provide mechanical stability; however, operative management does not eliminate postoperative impairments that may affect shoulder movement and physical function.²

Rehabilitation is therefore an important component of postoperative care. During recovery, pain, tissue healing, temporary immobilization, reduced use of the upper limb, and alterations in movement patterns may contribute to restricted range of motion (ROM), muscle weakness, and difficulty performing daily activities.^{3,4} A rehabilitation program may include interventions directed at pain management, restoration of shoulder mobility, maintenance of soft-tissue extensibility, optimization of scapular movement, and progressive strengthening. Evidence from postoperative and upper-extremity rehabilitation suggests that these components may address different clinical impairments, although the contribution of each component cannot necessarily be separated when they are delivered as part of a multimodal program.^{3,5-8}

Transcutaneous electrical nerve stimulation (TENS) is commonly used as a non-pharmacological modality for pain management, while therapeutic exercise is used to address movement limitations and reductions in muscle performance.^{3,4} Progressive ROM exercises may help restore shoulder mobility, whereas stretching may address limitations in soft-tissue extensibility.^{6,9} Scapular-focused interventions may also be relevant when altered scapular movement accompanies shoulder dysfunction, and progressive strengthening may support the recovery of muscle performance after periods of reduced activity or immobilization.⁵⁻⁷ However, the timing, content, and progression of rehabilitation after clavicle fracture surgery should be interpreted within the context of tissue healing, clinical symptoms, movement quality, and surgical guidance.^{2,7,10}

Current evidence regarding operative treatment has largely focused on fracture union, complications, and comparisons between surgical and non-surgical management. A recent meta-analysis of randomized controlled trials reported that the early functional advantages associated with operative treatment of midshaft clavicle fractures may be limited, highlighting the importance of examining postoperative recovery beyond surgical outcomes alone.¹¹ At the rehabilitation level, published reports have described physiotherapy management following clavicle fracture surgery, including cases involving additional neurological complications and reports describing multimodal postoperative interventions.^{11,12} These reports provide useful clinical observations; however, detailed documentation of the rehabilitation sequence, timing of the analyzed treatment period, criteria used for progression, and the concurrent changes in pain, ROM, and muscle strength remains limited.

Accordingly, the contribution of the present case report is not to establish the effectiveness of a specific intervention or multimodal protocol. Rather, it provides a detailed clinical description of physiotherapy management during a defined 19-week

observation period involving 30 treatment sessions after ORIF for a clavicle fracture. The report documents the temporal context of rehabilitation, the rationale for combining pain management and exercise-based interventions, the progression of treatment according to clinical response and postoperative recovery, and changes observed between baseline and final assessments. The clinical outcomes include pain intensity, shoulder ROM, muscle strength, and a qualitative self-care activity that was directly assessed. This approach provides a focused description of the rehabilitation process while avoiding attribution of the observed changes to any single intervention component.

Therefore, this case report aimed to describe the physiotherapy management and clinical changes observed in a patient following ORIF for a clavicle fracture during 30 physiotherapy sessions over a 19-week observation period. The report specifically describes changes in pain intensity, shoulder ROM, muscle strength, and the patient's ability to reach the back during bathing.

Methods

This case report was prepared in accordance with the CARE reporting guideline. It describes the physiotherapy management and clinical changes observed in a 49-year-old man following ORIF for a right clavicle fracture sustained in a traffic accident. The patient received outpatient physiotherapy at a hospital physiotherapy department. Relevant clinical information available in the medical record was reviewed for case reporting. Information regarding fracture characteristics before surgery was limited; therefore, no fracture classification, degree of displacement, or preoperative radiographic details were added beyond the available records.

Physiotherapy was initiated on August 8, 2025, which was 9 days after surgery. The period between the initial physiotherapy visit and September 15, 2025, was not included in the present analysis because the standardized baseline assessment used for this case report was conducted on September 16, 2025. The analyzed observation period therefore extended from September 16, 2025, to January 26, 2026, during which the patient completed 30 physiotherapy sessions over approximately 19 weeks. The final assessment was performed on January 26, 2026. This timeline distinguishes the initiation of clinical physiotherapy from the baseline and observation period analyzed in the present report.

At baseline, subjective and objective findings were documented before the analyzed intervention period. The patient reported shoulder pain and difficulty performing activities requiring movement of the affected upper limb, particularly reaching the back during bathing. Objective assessment included pain intensity, shoulder ROM, and muscle strength. The baseline limitations identified in shoulder movement and muscle performance were used to guide the selection and progression of the physiotherapy program.

The intervention was delivered individually. Seven professional physiotherapists were involved in the patient's management according to clinical service scheduling, with professional physiotherapy students participating under direct supervision. Each treatment session lasted approximately 30 minutes and was generally scheduled twice weekly, although the exact interval could vary according to clinical attendance and scheduling. The multimodal program consisted of TENS, passive, active assisted, and active ROM exercises, static stretching, scapulothoracic mobilization, isometric strengthening, and a home exercise program. The intervention components were selected according to the patient's baseline presentation of pain, restricted shoulder movement, and reduced muscle strength.

TENS was applied as a component of pain management. However, the available manuscript records reviewed for this revision did not provide sufficiently verified information regarding stimulation frequency, pulse duration, intensity, or electrode placement. These parameters should therefore not be reconstructed or inferred. They require confirmation from the original treatment documentation before being reported in the final manuscript.

ROM exercises included shoulder flexion, extension, abduction, adduction, internal rotation, and external rotation. Exercises were initially performed passively and with active assistance under therapist guidance and were progressively advanced toward active movement according to the patient's ability and movement quality. Each movement was performed for 3 sets of 8 repetitions within the patient's tolerance. Progression was considered when the patient could perform the prescribed movement without marked pain aggravation, excessive compensatory movement, or deterioration in movement control. Exercise intensity was reduced or progression postponed when symptoms increased beyond the patient's tolerance, sharp pain occurred, or movement quality deteriorated.

Static stretching was applied to the pectoralis major, pectoralis minor, anterior deltoid, latissimus dorsi, upper trapezius, and levator scapulae when clinically indicated by postoperative soft tissue tightness and movement restriction. Each stretch was performed slowly and maintained for 20 to 30 seconds, with 3 repetitions per muscle group. Stretch intensity was maintained within tolerance and the procedure was discontinued if sharp pain developed around the surgical or fixation area.

Scapulothoracic mobilization was performed with the patient in a side lying position facing the therapist. The scapula was mobilized passively through elevation, depression, retraction, and protraction to address restricted scapular movement and coordination. Mobilization was performed for 2 to 3 sets, each lasting approximately 30 to 60 seconds. Isometric strengthening targeted the shoulder flexors, extensors, abductors, adductors, internal rotators, and external rotators because muscle strength was graded as 4– at baseline. Each contraction was held for 5 to 10 seconds for 3 sets of 8 repetitions, with manual resistance provided by the therapist. The exercise was progressed or modified according to pain response, movement control, tolerance, clinical evidence of postoperative recovery, and medical or surgical instructions.

A structured home exercise program included active and active assisted shoulder movements consisting of pendular exercises, flexion, extension, abduction, adduction, internal rotation, and external rotation. Each movement was prescribed for 3 sets of 8 repetitions according to tolerance. Home exercise adherence was not systematically recorded or quantified during the observation period. Consequently, the contribution of home exercise to the observed clinical changes could not be determined and should be considered when interpreting the findings.

Outcome assessments were performed at two time points: baseline on September 16, 2025, and final assessment on January 26, 2026. Pain intensity was assessed using the Visual Analog Scale (VAS).¹⁴ Shoulder ROM was measured in degrees using a universal goniometer, with consistent measurement procedures and the same examiner at both assessment points.¹⁵ Muscle strength was assessed using Manual Muscle Testing (MMT). Grade 4– represented movement against gravity with resistance below the level expected for grade 4, whereas grade 5 represented normal strength against maximal manual resistance within the limits of the test procedure. The same examiner assessed the selected muscle groups at baseline and final evaluation using consistent testing positions and resistance procedures.¹⁶

Functional status was assessed qualitatively through the patient's ability to reach the back during bathing. No standardized upper extremity functional instrument, such as the Disabilities of the Arm, Shoulder and Hand or Shoulder Pain and Disability Index, was available for this case. Therefore, the functional finding was interpreted only in relation to the observed self care activity and was

not considered representative of overall upper extremity function. Adverse events were monitored throughout the treatment period. No skin irritation related to TENS, swelling, or other unexpected events were documented during the 30 physiotherapy sessions.

Data were analyzed descriptively by comparing baseline and final assessment values for pain intensity, shoulder ROM, muscle strength, and the qualitative self care activity. Inferential statistical analysis was not performed because this report involved a single patient and only two formal assessment time points. The absence of serial assessments also precluded characterization of the pattern or trajectory of clinical changes throughout the 19 week observation period.

Written informed consent for publication of this case report was obtained from the patient. The available documentation did not identify a formal institutional ethical determination or a specific institutional policy confirming that ethical approval was not required for this case report. Therefore, no such determination is claimed in this manuscript. The patient perspective was not available for inclusion and is acknowledged as a limitation of CARE reporting.

Results

The clinical timeline was structured to distinguish the date of surgery, the initiation of physiotherapy services, and the observation period analyzed in this case report. The patient underwent open reduction and internal fixation (ORIF) for a right clavicle fracture on July 30, 2025. Physiotherapy services were initiated on August 8, 2025, corresponding to 9 days after surgery. However, the present report analyzed the period beginning with the standardized baseline assessment on September 16, 2025. The interval between the first physiotherapy visit and the baseline assessment was not included in the outcome analysis because the formal baseline measurements reported in this case were obtained on September 16, 2025. The analyzed observation period included 30 physiotherapy sessions conducted over approximately 19 weeks and ended with the final assessment on January 26, 2026.

The sequence of clinical management and physiotherapy observation is presented in Table 1. This timeline clarifies that the initiation of physiotherapy occurred before the baseline assessment used for the present analysis and that the reported clinical changes represent differences between the baseline and final assessments within the defined 30-session observation period.

Table 1. Timeline of clinical management and physiotherapy observation

Date/Period	Clinical event
July 30, 2025	ORIF performed for the right clavicle fracture
August 8, 2025	First physiotherapy service initiated, 9 days after surgery
August 8 to September 15, 2025	Physiotherapy services continued before the standardized baseline assessment; this period was not included in the present outcome analysis
September 16, 2025	Baseline assessment and beginning of the analyzed observation period
September 16, 2025 to January 26, 2026	Thirty physiotherapy sessions conducted over approximately 19 weeks
January 26, 2026	Final clinical assessment

Following the baseline assessment, clinical outcomes were formally evaluated at two time points: September 16, 2025, and January 26, 2026. The assessed outcomes included pain intensity, shoulder range of motion (ROM), muscle strength, and a qualitative self-care activity. Because serial assessments between these two time points were not available, the results describe the observed differences between baseline and final assessment and do not characterize the pattern, rate, or trajectory of recovery during the entire observation period.

At baseline, the patient reported pain in the affected shoulder during movement and at rest, as well as tenderness on palpation. The patient also experienced difficulty reaching the back during bathing. Objective assessment showed restricted shoulder ROM and reduced muscle strength in the assessed shoulder muscle groups. The baseline and final clinical findings are summarized in Table 2.

Table 2. Clinical findings at baseline and final assessment

Outcome	Baseline	Final assessment	Observed change
Pain intensity, VAS			
Movement pain	5	2	-3
Resting pain	3	1	-2
Tenderness	3	1	-2
Shoulder ROM			
Flexion	125°	160°	+35°
Extension	30°	60°	+30°
Abduction	110°	160°	+50°
Adduction	20°	50°	+30°
Internal rotation	50°	70°	+20°
External rotation	40°	90°	+50°
Muscle strength, MMT			
Assessed shoulder muscle groups	Grade 4-	Grade 5	Higher grade at final assessment
Qualitative self-care activity			
Ability to reach the back during bathing	Unable to reach the back independently	Able to reach the back independently	Qualitative change observed

VAS, Visual Analog Scale; ROM, range of motion; MMT, Manual Muscle Testing.

As presented in Table 2, lower pain scores were recorded at the final assessment than at baseline. Movement pain decreased from 5 to 2, while resting pain decreased from 3 to 1. Tenderness also decreased from 3 to 1. These findings represent the differences in pain scores observed between the two formal assessment points.

Changes were also observed across all assessed shoulder movements. Flexion increased from 125° to 160°, representing a difference of 35°, while extension increased from 30° to 60°, representing a difference of 30°. Abduction increased from 110° to 160°, and external rotation increased from 40° to 90°, corresponding to differences of 50° for both movements. Adduction increased from 20° to 50°, whereas internal rotation increased from 50° to 70°. All ROM findings are reported as numerical values in degrees, and no movement was classified as achieving full ROM.

Muscle strength was graded as 4- at baseline and grade 5 at the final assessment in all assessed shoulder muscle groups. Therefore, the final assessment demonstrated higher MMT grades than those recorded at baseline. The reported findings reflect the

comparison between the two assessment points and do not provide information regarding the timing or progression of strength changes during the intervening sessions.

A qualitative change was also documented in the self-care activity assessed in this case. At baseline, the patient was unable to reach the back independently during bathing. At the final assessment, the patient was able to reach the back independently during the same activity. Because a standardized upper-extremity functional outcome measure was not available, this observation is limited to the specific self-care activity assessed and should not be interpreted as representing overall upper-extremity functional recovery. No adverse events, treatment-related complications, or unexpected events were documented during the 30 physiotherapy sessions included in the analyzed observation period. In addition, serial measurements between the baseline and final assessments were not available. Consequently, the reported findings cannot establish a continuous recovery trajectory or determine when the observed changes occurred during the 19-week observation period.

Discussion

This case report described the physiotherapy management and clinical changes observed in a 49-year-old man following ORIF for a right clavicle fracture. During the analyzed 19-week observation period, which included 30 physiotherapy sessions, lower pain scores, increased shoulder ROM, higher MMT grades, and improved ability to reach the back during bathing were documented at the final assessment compared with baseline. These findings should be interpreted as clinical changes observed during a multimodal rehabilitation period rather than evidence of the independent effectiveness of any specific intervention. Because this report involved a single patient, a combination of interventions, and only two formal assessment points, the relative contribution of physiotherapy, postoperative healing, home exercise, and other individual factors cannot be separated.

The reduction in pain scores was observed alongside improvements in shoulder movement. At baseline, movement pain, resting pain, and tenderness were present, whereas lower scores were recorded at the final assessment. The rehabilitation program included TENS as a component of pain management, together with progressive movement and exercise-based interventions. TENS has been used as a non-pharmacological approach to pain management in rehabilitation settings, although the effect observed in this case cannot be attributed specifically to this modality because it was delivered as part of a multimodal program.^{3,8} The reduction in pain may have been influenced by the overall postoperative recovery process during the 19-week observation period. However, the contribution of tissue healing, rehabilitation, changes in activity, or other individual factors cannot be determined from this case.⁴ Therefore, the present findings should not be interpreted as demonstrating that TENS or any other individual intervention was solely responsible for the observed reduction in pain.

Shoulder ROM increased across all movements assessed, with the largest numerical differences observed in abduction and external rotation, both increasing by 50°. Improvements were also documented in flexion, extension, adduction, and internal rotation. These changes occurred during a program that included passive, active-assisted, and active ROM exercises, stretching, and scapulothoracic mobilization. Such interventions were selected to address the baseline presentation of movement restriction and were progressed according to pain response, tolerance, movement quality, postoperative recovery, and clinical instructions. The observed ROM changes are clinically relevant to the description of this patient's recovery; however, they cannot establish the extent to which each intervention component contributed to the final values. Previous rehabilitation literature supports the use of progressive exercise and movement-based approaches to address postoperative shoulder impairment, although the specific timing and progression of rehabilitation after clavicle fracture surgery should remain individualized.^{4-7,9}

Muscle strength increased from grade 4- at baseline to grade 5 at the final assessment in all assessed shoulder muscle groups. This change occurred during a rehabilitation program that included isometric strengthening and progressive active movement. Reduced muscle performance after surgery may be associated with pain, reduced limb use, immobilization, and avoidance of movement. Progressive strengthening may therefore be incorporated into rehabilitation when clinically appropriate and consistent with postoperative recovery.^{4-7,17} However, MMT provides an ordinal clinical estimate of muscle strength and is influenced by examiner technique and the patient's ability to tolerate resistance. Although the same examiner and consistent procedures were used at both assessment points, the absence of repeated measurements and the inherent limitations of MMT should be considered when interpreting the change from grade 4- to grade 5.^{16,18}

The observed change in the patient's ability to reach the back during bathing provides a limited functional context for the impairment-level findings. At baseline, the patient was unable to perform this activity independently, whereas independent performance was reported at the final assessment. The patient's ability to reach the back during bathing improved during follow-up, indicating an improvement in the performance of this self-care activity. Nevertheless, this outcome was assessed qualitatively and was not derived from a validated upper-extremity functional questionnaire. Consequently, the finding should be interpreted only in relation to the specific self-care activity assessed and should not be generalized as evidence of overall upper-extremity functional recovery. The absence of a standardized functional outcome instrument, such as the Disabilities of the Arm, Shoulder and Hand (DASH) or Shoulder Pain and Disability Index (SPADI), limits the comprehensiveness of the functional evaluation in this case.^{19,20}

An important feature of the present report is the distinction between the initiation of physiotherapy and the formal observation period analyzed for outcome comparison. Physiotherapy was initiated on August 8, 2025, 9 days after surgery, whereas the baseline assessment used in this report was performed on September 16, 2025. Consequently, physiotherapy exposure before the formal baseline assessment was not captured within the reported baseline-to-final comparison. This temporal structure must be considered when interpreting the findings because clinical changes occurring before September 16, 2025, may have influenced the patient's baseline status. In addition, the 30 analyzed sessions were delivered over approximately 19 weeks, during which treatment progression was individualized rather than standardized as a fixed protocol. This approach reflects routine clinical rehabilitation but further limits causal attribution to specific treatment components.

Several limitations should therefore be acknowledged. First, this report describes a single patient and cannot provide estimates of treatment effectiveness or generalizability to other patients following clavicle fracture ORIF. Second, the intervention was multimodal, making it impossible to isolate the contribution of TENS, ROM exercise, stretching, scapular mobilization, strengthening, or home exercise. Third, natural postoperative recovery and other individual factors may have contributed to the observed changes; therefore, the specific contribution of the physiotherapy intervention cannot be determined from this case.⁴ Fourth, formal outcome assessments were conducted only at baseline and the final assessment, preventing evaluation of the timing or trajectory of clinical improvement. Fifth, adherence to the home exercise program was not systematically quantified. Sixth, functional status was evaluated through one qualitative self-care activity rather than a standardized patient-reported outcome measure. Finally, the patient's perspective was not available for inclusion, representing an additional limitation in relation to comprehensive CARE reporting.

Despite these limitations, this case provides a detailed clinical description of a defined rehabilitation period following ORIF for a clavicle fracture. The report documents the distinction between the initial physiotherapy service and the analyzed observation period, describes the multimodal intervention and its progression, and presents numerical changes in pain, shoulder ROM, and muscle strength without attributing these changes to a single intervention. This level of clinical documentation may assist clinicians in understanding how rehabilitation was organized and progressed in this individual case. However, the findings should be interpreted as descriptive observations and not as evidence establishing the effectiveness, safety, superiority, or optimality of the reported rehabilitation approach.

Conclusion

This case report described the physiotherapy management and clinical changes observed in a 49-year-old patient following ORIF for a right clavicle fracture. During the analyzed observation period of 19 weeks and 30 physiotherapy sessions, lower pain scores, increased shoulder ROM, higher MMT grades, and improved ability to reach the back during bathing were documented at the final assessment compared with baseline.

The rehabilitation program consisted of a multimodal approach including TENS, progressive ROM exercises, stretching, scapulothoracic mobilization, isometric strengthening, and a home exercise program. The intervention was individualized and progressed according to pain response, movement quality, clinical tolerance, postoperative recovery, and relevant clinical instructions. However, because multiple intervention components were delivered concurrently, their individual contributions to the observed changes cannot be determined.

The findings should also be interpreted in light of the single-case design, the absence of serial outcome assessments, unquantified home exercise adherence, the lack of a standardized upper-extremity functional outcome measure, and the potential contribution of natural postoperative recovery. Therefore, this report does not establish the effectiveness, safety, superiority, or optimality of the described physiotherapy program.

Nevertheless, the case provides a detailed clinical description of rehabilitation following clavicle fracture ORIF, including a clearly defined observation period, intervention components, progression principles, and changes in pain, shoulder ROM, muscle strength, and a specific self-care activity. Future studies using standardized functional outcome measures, serial assessments, and more rigorous study designs are needed to further evaluate postoperative rehabilitation following clavicle fracture ORIF.

Author Contribution

Irsa Leria: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing Original Draft, Visualization.

Yery Mustari: Supervision, Conceptualization, Methodology, Writing Review and Editing.

Masfufah: Supervision, Investigation.

Acknowledgments

The authors would like to express their sincere appreciation to the Professional Physiotherapy Program, Faculty of Nursing, Hasanuddin University, for providing academic support and institutional resources. The authors also thank the patient for his participation and cooperation throughout the rehabilitation process.

Conflict of Interest Statement

The authors declare that they have no competing interests.

Funding Sources

This study received no external funding.

Ethics Statement

Written informed consent for publication of this case report and the associated clinical information was obtained from the patient. All procedures were conducted in accordance with applicable ethical principles, patient confidentiality requirements, and standards of clinical practice. No formal statement regarding the requirement or exemption of institutional ethical approval was available in the documentation; therefore, no claim of ethical exemption is made in this manuscript.

Reference

1. Irfan SA, Ali AA, Ashkar A, Akram U, Fatima S, Baig MMA, et al. Predictors requiring special attention to prevent clavicle fracture nonunion: a systematic review of literature. *Trauma Surg Acute Care Open*. 2023;8(1):e001188.
2. Song HS, Kim H. Current concepts in the treatment of midshaft clavicle fractures in adults. *Clin Shoulder Elb*. 2021;24(3):189-198.
3. Viderman D, Nabidollayeva F, Aubakirova M, Sadir N, Tapinova K, Tankacheyev R, et al. The impact of transcutaneous electrical nerve stimulation (TENS) on acute pain and other postoperative outcomes: a systematic review with meta-analysis. *J Clin Med*. 2024;13(2):427.
4. Ldermann A, Abrassart S, Denard PJ, Tirefort J. Functional recovery following early mobilization after middle third clavicle osteosynthesis for acute fractures or nonunion: a case-control study. *Orthop Traumatol Surg Res*. 2017;103(6):885-889.
5. Zhang M, Zhou J, Zhang Y, Zhang X, Chen J, Chen W. Influence of scapula training exercises on shoulder joint function after surgery for rotator cuff injury. *Med Sci Monit*. 2020;26:e925758.
6. Howell AJ, Burchett A, Heebner N, Walker C, Baunach A, Seidt A, et al. Effectiveness of scapular stabilization versus non-stabilization stretching on shoulder range of motion, a randomized clinical trial. *Int J Sports Phys Ther*. 2022;17(4):695-706.
7. Campbell M, Varley-Campbell J, Fulford J, Taylor B, Mileva KN, Bowtell JL. Effect of immobilisation on neuromuscular function in vivo in humans: a systematic review. *Sports Med*. 2019;49(6):931-950.
8. Vance CGT, Dailey DL, Chimenti RL, Van Gorp BJ, Crofford LJ, Sluka KA. Using TENS for pain control: update on the state of the evidence. *Medicina (Kaunas)*. 2022;58(10):1332.
9. Ingram LA, Tomkinson GR, D'Unienville NMA, Gower B, Gleadhill S, Boyle T, et al. Mechanisms underlying range of motion improvements following acute and chronic static stretching: a systematic review, meta-analysis and multivariate meta-regression. *Sports Med*. 2025;55(6):1449-1466.

10. Wright M, Della Rocca GJ. American Academy of Orthopaedic Surgeons clinical practice guideline summary on the treatment of clavicle fractures. *J Am Acad Orthop Surg*. 2023;31(18):977-983.
11. Qvist AH, Jensen SL. Minimal early functional gains after operative treatment of midshaft clavicular fractures: a meta-analysis of 10 randomized controlled trials including 1333 patients. *JSES Int*. 2024;8(3):400-406.
12. Rai A, Sharath H, Raghuveer R, Qureshi MI. The physiotherapy management of postoperative mid-shaft clavicular fracture with brachial plexus injury: a case report. *Cureus*. 2024;16(8):e66461.
13. Chiarotto A, Maxwell LJ, Ostelo RW, Boers M, Tugwell P, Terwee CB. Measurement properties of visual analogue scale, numeric rating scale, and pain severity subscale of the Brief Pain Inventory in patients with low back pain: a systematic review. *J Pain*. 2019;20(3):245-263.
14. Hanks J, Myers B. Validity, reliability, and efficiency of a standard goniometer, medical inclinometer, and builder's inclinometer. *Int J Sports Phys Ther*. 2023;18(4):989-996.
15. Soares JR, Stieven FF, Rocha CDS, Miranda IF. Reliability of manual muscle testing in applied kinesiology: a systematic review. *J Manipulative Physiol Ther*. 2025;48(6-9):862-870.
16. Guo X, Zhou Y, Li X, Mu J. Resistance exercise training improves disuse-induced skeletal muscle atrophy in humans: a meta-analysis of randomized controlled trials. *BMC Musculoskelet Disord*. 2025;26(1):134.
17. Bohannon RW. Reliability of manual muscle testing: a systematic review. *Isokinet Exerc Sci*. 2018;26(4):245-252.
18. Brindisino F, Venturin D, Bartoli M, Caselli S, Pellicciari L, Poser A. Psychometric properties of the Disability of Arm Shoulder and Hand (DASH) in subjects with frozen shoulder: a reliability and validity study. *BMC Musculoskelet Disord*. 2024;25(1):260.
19. Deviadri R, Daud A, Utami TN, Octarina P, Aminata IW, Alkaff FF. Translation, validity, and reliability of the Indonesian version of the Shoulder Pain and Disability Index (SPADI). *Orthop J Sports Med*. 2025;13(1):23259671241304656.