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*Case Report*

# Idiopathic Bilateral HIV-Associated Osteonecrosis of the Femoral Heads: A Case Report

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## Abstract

**Background:** Avascular necrosis (osteonecrosis) is an increasingly recognized complication in patients living with HIV, particularly when weight-bearing joints such as the hip are involved. Although previously attributed primarily to antiretroviral therapy, HIV infection itself may be an independent risk factor.

**Case Report:** A 33-year-old woman with HIV infection diagnosed three years earlier presented with an eight-month history of progressively worsening bilateral hip pain, eventually resulting in an inability to ambulate without assistance. Clinical examination was suggestive of avascular necrosis, which was confirmed by bilateral hip radiographs and magnetic resonance imaging, demonstrating Steinberg Stage IV disease. There was no history of other recognized causes of osteonecrosis. She was compliant with highly active antiretroviral therapy (HAART) consisting of tenofovir, emtricitabine, and efavirenz. The advanced disease at presentation suggests that osteonecrosis may have developed substantially earlier than expected in the course of her HIV infection.

**Conclusion:** Although HAART may be associated with avascular necrosis, HIV infection itself may represent an independent risk factor. This case highlights that severe osteonecrosis may develop early in the course of HIV infection, emphasizing the importance of early recognition of musculoskeletal symptoms in these patients.

## Introduction

Osteonecrosis is increasingly recognized as a debilitating complication among patients with HIV infection. Individuals with HIV are reported to have a 45- to 100-fold greater risk of developing osteonecrosis than the general population.[3,4] In addition to the conventional risk factors observed in the general population, other factors associated with osteonecrosis in HIV-infected patients include intravenous drug use, corticosteroid therapy (typically prescribed for concomitant medical conditions), multiple sexual partners, excessive alcohol consumption, and highly active antiretroviral therapy (HAART). The use of protease inhibitors (PIs) has, over the years, been associated with several bone-related complications, particularly osteoporosis and drug-induced fractures.[5] However, these complications generally occur only after prolonged adherence to HAART. Even if HIV infection itself is considered an independent risk factor for avascular necrosis, as suggested by several authors[4,6,7], clinical manifestations typically develop several years after the initial diagnosis of HIV infection.

Our case is unique because, based on the Steinberg classification[2,8], osteonecrosis appears to have developed much earlier than anticipated, despite the absence of the conventional risk factors commonly associated with its development in HIV-infected individuals.

## Case Report

We report the case of a 33-year-old woman with a three-year history of HIV infection. She had been receiving a daily regimen of tenofovir 300 mg, emtricitabine 200 mg, and efavirenz 600 mg with good treatment adherence. She denied any history of illicit drug use, multiple sexual



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partners, corticosteroid use, alcohol consumption, or smoking. Approximately 2.5 years after her HIV diagnosis, she developed progressively worsening bilateral hip pain over an eight-month period, which eventually rendered her unable to ambulate without assistance

She had no history of opportunistic infections, including *Pneumocystis carinii* pneumonia, and had never received treatment for any opportunistic infection. There was no history of preceding trauma, and she was employed as a production line factory worker. Her family and psychosocial histories were otherwise unremarkable.

On examination, the patient was a lean woman with an estimated body mass index (BMI) of 18.6 kg/m². There were no clinical signs suggestive of underlying opportunistic infection. Both hip joints were tender on palpation, with a reduced range of motion, particularly during internal rotation and adduction. Neurological examination of both lower limbs was unremarkable.

Plain radiographs of the pelvis demonstrated sclerosis and flattening of both femoral heads, consistent with at least Steinberg Stage IV osteonecrosis (Figure 1). These findings were confirmed by magnetic resonance imaging (MRI), which also demonstrated narrowing of both hip joint spaces and mild bilateral hip joint effusions, consistent with bilateral femoral head osteonecrosis (Figure 2).

The results of the patient's laboratory investigations are summarized in Table 1. Notably, she had a subnormal CD4 cell count with an undetectable HIV viral load. Renal and liver function tests were within normal limits. Screening for antiphospholipid antibodies is not routinely performed at our institution and was therefore not undertaken.

The patient was treated conservatively with oral tramadol for pain control and was referred for physiotherapy. Her HAART regimen was subsequently changed to Combivir (lamivudine/zidovudine) and efavirenz. She remains under close clinical surveillance for further deterioration of her hip disease, and surgical intervention is being planned. At the time of writing, her condition remains stable, and she continues to receive conservative management consisting of physiotherapy and oral analgesia.

## Discussion

Osteonecrosis of the hip can have devastating consequences, frequently resulting in the need for surgical intervention, with its associated risks and long-term functional implications. It is a well-recognized complication of various traumatic injuries to the hip, including femoral neck and femoral head fractures, hip dislocations, and acetabular fractures. However, osteonecrosis may also develop insidiously in association with numerous atraumatic conditions, one of which appears to be HIV infection.

The majority of osteonecrosis cases reported in patients with HIV are associated with one or more recognized risk factors. Several studies have demonstrated this association through long-term follow-up of HIV-infected patients presenting with hip pain. Whitlock et al. reviewed 15 HIV-infected patients with osteonecrosis and compared them with 15 unmatched controls, reporting that 80% of affected patients had at least one established risk factor similar to those observed in the general population, including dyslipidaemia, corticosteroid use, smoking, and alcohol consumption.[9] Comparable findings were reported by Borges et al., who additionally identified previous osteonecrosis or fractures and HIV-defining illnesses as independent risk factors.[4] Across published studies, the most frequently reported risk factors for osteonecrosis include smoking, excessive alcohol consumption, and corticosteroid use.[3,4,7,10]

Interestingly, several authors have also described patients who developed osteonecrosis without any identifiable predisposing risk factors, a condition referred to as primary HIV-associated osteonecrosis .[11] In a review of 22 HIV-infected patients with osteonecrosis, Mehta et al. found that no predisposing factors could be identified in 9% of cases.[6] Similarly, Whitlock et al. reported that 20% of their patients had no discernible risk factors.[9] These observations have led some investigators to propose that HIV infection itself may represent an independent risk factor for osteonecrosis.[6,7]

Our patient closely resembles this subgroup. She reported having only a single sexual partner and denied smoking, alcohol consumption, illicit drug use, corticosteroid exposure, and other lifestyle factors known to predispose to osteonecrosis. Throughout the course of her HIV infection, there had also been no indication for corticosteroid therapy or treatment of opportunistic infections that might have contributed to the development of osteonecrosis.

Since her HIV diagnosis, the patient had been treated exclusively with nucleoside and nucleotide reverse transcriptase inhibitors together with a non-nucleoside reverse transcriptase inhibitor. Although tenofovir has been suggested to be associated with osteonecrosis in some reports, this relationship has not been consistently demonstrated after adjustment for other confounding factors.[4,10,12] Furthermore, osteonecrosis is not listed as a recognized adverse effect in the manufacturer's prescribing information or in the HIV treatment guidelines reviewed.[13–15] The principal skeletal adverse effects associated with tenofovir are reduced bone mineral density, osteoporotic fractures, and disturbances of calcium metabolism secondary to proximal renal tubular dysfunction and Fanconi syndrome. None of these complications were evident clinically or biochemically in our patient. Likewise, emtricitabine and efavirenz have not been implicated as causes of osteonecrosis.[14,15] In contrast, protease inhibitors have been more consistently associated with osteonecrosis, possibly through the development

of dyslipidaemia resulting from altered triglyceride and cholesterol metabolism.[5,7] Importantly, protease inhibitors were not included in our patient's antiretroviral regimen.

Another noteworthy aspect of this case is the unusually early onset of osteonecrosis. At presentation, radiographic and MRI findings demonstrated at least Steinberg Stage IV disease following only eight months of progressively worsening bilateral hip pain. It is therefore reasonable to infer that the osteonecrotic process had begun approximately two to two-and-a-half years after the diagnosis of HIV infection. This timeline is considerably shorter than that reported in the literature. Mehta et al. reported a median interval of approximately 13.5 years between HIV diagnosis and the development of clinically apparent osteonecrosis, irrespective of the presence of predisposing risk factors.[6] Similarly, Lawson-Ayayi et al. reported a mean interval of 10.4 years in the French Aquitaine cohort.[10] Our patient's presentation therefore suggests that osteonecrosis may occasionally develop much earlier than is generally anticipated in HIV-infected individuals.

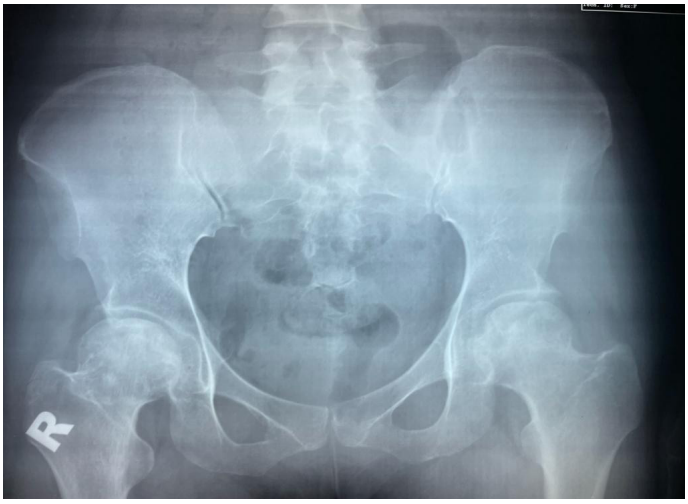


**Figure 1:** Pelvic AP radiograph showing bilateral femoral head sclerosis and flattening of both femoral heads. Findings are similarly seen on MRI examination which additionally shows reduced joint space in both hips.

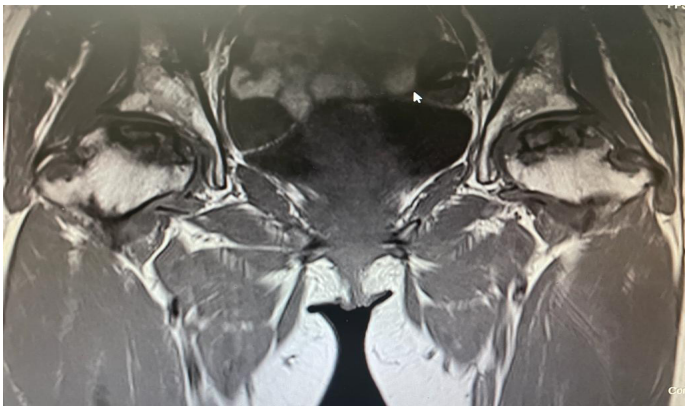

**Figure 2:** T2 image of both hips showing evidence of avascular necrosis bilaterally showing reduction in both hip joint spaces with mild bilateral hip joint effusions.

Despite extensive clinical evaluation, we were unable to identify a definitive aetiology for the development of osteonecrosis in this patient. Consequently, this case is most consistent with idiopathic primary HIV-associated osteonecrosis, as previously described by Green et al.[11]

**Table 1.** Table of blood investigations upon admission

| Investigation | Value |
|---|---|
| CD4 | 323 cells/mm$^3$ |
| Viral load | Undetected |
| Haemoglobin | 12.6g/dL |
| Total white cell count | 5.9 x 10$^9$/L |
| Platelet count | 230 x 10$^3$/µL |
| Urea/ Sodium/Potassium/Chloride | 2.2/139/3.9/56 mmol/L |
| Calcium/Phosphate/Magnesium | 2.14/1.08/0.59 mmol/L |
| International Normalized Ratio | 1.03 |
| Total protein/Albumin/Globulin | 69/33/36 g/L |
| ALP/ALT/AST/Bilirubin | 74/7.7/23 U/L /6.0 µmol/L |

## Conclusion

In conclusion, this patient represents a case of primary HIV-associated osteonecrosis as described by Green et al.[11] The absence of conventional predisposing factors makes early recognition particularly challenging. Furthermore, the unusually early onset and advanced stage of disease at presentation suggest that osteonecrosis may develop much earlier in the course of HIV infection than has traditionally been recognized. This case highlights the importance of maintaining a high index of suspicion for osteonecrosis in HIV-infected patients presenting with persistent hip pain, even in the absence of established risk factors. It also serves as a reminder that HIV infection should be considered as a potential underlying diagnosis in patients presenting with apparently idiopathic osteonecrosis, particularly when surgical intervention is being contemplated.

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We thank Dr Mohd Asraf Mohd Aris of Hospital Tuanku Jaafar Seremban for his input in completing this case report.

**CONFLICT OF INTEREST**

No conflict of interest is reported.

**INFORMED CONSENT**

Informed consent from the patient was obtained for case report publication.

**ETHICAL APPROVAL**

Approval for case report applied and approved by hospital

committee

**AUTHORS CONTRIBUTION**

TM – concept, data acquisition
Z-N ZF – literature review, manuscript writing

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*Review Article*

# Outcome Of Minimal Invasive Surgery Approach For Spine Infection: A Systematic Review

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## Abstract

**Introduction:** Minimally invasive surgery (MIS) has gained popularity as an alternative to conventional surgery, with potential benefits including reduced blood loss, faster recovery, and shorter hospital stays. However, evidence regarding its use in tuberculous spondylitis remains limited. This systematic review evaluated the outcomes of MIS for spinal tuberculosis.

**Methods:** PubMed, EMBASE, and the Cochrane Library were searched for studies evaluating MIS for tuberculous spondylitis published up to June 7, 2019. Study selection was performed independently according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. No restrictions were applied regarding patient demographics, MIS technique, or publication status. Data extracted included surgical approach, functional and radiological outcomes, intraoperative outcomes, length of hospital stay, follow-up duration, and complications.

**Results:** Of 81 articles identified, 10 studies involving 431 patients met the eligibility criteria. More than 110 patients underwent conventional open surgery, while more than 321 underwent MIS. MIS techniques included posterior pedicle screw fixation, plate fixation, lateral nail-bar fixation, and bilateral pedicle screw fixation, with C-arm or X-ray fluoroscopy used for intraoperative visualization. Follow-up ranged from 1 to 40 months. Overall, MIS was associated with satisfactory functional outcomes and few reported complications.

**Conclusion:** MIS appears to provide satisfactory outcomes with a low complication rate in patients with tuberculous spondylitis. However, the available evidence is limited, and further long-term, well-designed comparative studies are needed to establish its safety and effectiveness.

## Introduction

In developing countries, spine infection is relatively common and might result in severe reduction of quality of life. The infection might directly damage structures of the spine or compress the spinal cord, resulting in neurological deficits. Recently, the surgical method to treat these conditions has been evolving from open approach to Minimal Invasive Surgery (MIS) approach. The objective is to minimize trauma to the surrounding tissues, minimize intraoperative blood loss, and reduce hospital stay. However, there has been no literature summarizing the current MIS technique used and their outcome.

Spine infection might be caused by M. tuberculosis or other pyogenic bacteria. Spinal tuberculosis is among the most common forms of extrapulmonary tuberculosis. Approximately 10% of patients with tuberculosis have bone involvement, with the spine being the most commonly affected, followed by the hip and the knee.[1] Spinal TB (Pott' disease) is the most common and most dangerous form of musculoskeletal TB; it accounts for 1% of all TB cases and 50% of osseous TB.[2] As for pyogenic spine infection, the incidence was known to increase in the recent years. It also associates with a mortality rate of up to 5% and a morbidity rate of more than 7%.[3,4]



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The typical presentation of spinal TB involves systemic TB symptoms and imaging presentations, including damaged contiguous vertebral bodies and their intervertebral discs without the involvement of the posterior elements, which could be easily recognized and diagnosed.[5] Sequestrum and abscesses can cause vertebral collapse, spinal instability, kyphosis deformity, and alterations in normal physiological curvature and load biomechanics as the condition progresses, or they can penetrate the spinal canal and compress the nerves, resulting in nerve damage or even paralysis.[6] The goals of the management of spinal TB are to eradicate infection, prevent or treat neurologic deficits, and correct and avoid spinal deformity progression. Current surgical methods include anterior debridement, decompression, fusion followed by ventral or posterior decompression with fixation.[7,8]

Conventional spine surgery approaches to the ventral aspect are considered to be extensive and have associated morbidities. Therefore, MIS approaches are increasingly used in managing various spinal disorders, such as degenerative disorders, trauma, and tumors, with advantages including minimal trauma, less blood loss, and a shorter recovery time. In order to be widely accepted as the common treatment for spine infection, MIS should be comparable to gold standard treatment, that is the open surgery. This study will discuss previous studies investigating the use of MIS for spine infection treatment in terms of outcomes and complications.

## Methods

*Search strategy*

This systematic review was conducted based on PRISMA guideline. Literature research was primarily performed using the Pubmed, EMBASE, and Cochrane Library to search for studies about minimally invasive surgery as management of tuberculous spondylitis up to June 7th, 2019 with the keywords "minimally invasive spine surgery") OR "minimally invasive") OR "percutaneous") AND "tuberculosis") OR "spine infection") OR "tuberculous spondylitis". We filtered the search to include only studies in human, published in the last 5 years, and ones written in English. After that, we combed through all articles cited and citing the articles so as not to miss any relevant articles.

*Inclusion criteria*

The inclusion criterias were tuberculous spondylitis, with the intervention of minimally invasive surgery as compared to standard open surgery, and neurological and functional outcome as the main outcome. Case report and case series were also included. Given the limited number of studies, there was no restriction in terms of patient's demographics, though case reports and literatures not in English were excluded. Study that focus in diagnosis biopsy, consecutive therapy and tuberculous spondylitis after spine surgery is excluded from this review.

*Quality evaluation*

First, all authors screened eligible studies through the titles and abstracts based on inclusion criteria. Then, all authors screened the full articles of all the collected studies. The authors had a meeting and agreed on highly relevant publications to be included in this study. All authors performed appraisal of study quality independently and any disagreement was resolved through discussion.

All inherent aspects of the studies, including study quality, variables for which data were sought, and assessment of risk of bias, were appraised by all authors independently by filling up forms. The forms were collected by the first author and the contents were scanned for any disagreement. The authors then gathered again for discussing any contradicting points.

## Results

The electronic search resulted in 81 records, after elimination of duplicate results. On the basis of titles and abstracts screening, a total of 72 records and 1 article on the basis of assessment of full text article were excluded. The remaining articles were subsequently studied by two independent investigators based on the full text extracted. A list of inclusion and exclusion criteria previously agreed by the authors were utilized for screening the full text. This selection process yielded 10 final articles to be included in the systematic review and was depicted in Figure 1.[6,9–16]

All articles were of level III-IV evidence (Table 1) and, in total, 431 patients were eventually included in the analysis. Among these patients, more than 110 patients were treated with open spine surgery, while more than 321 patients were treated using minimally invasive spine surgery. The mean age of the samples ranges from 17-85 years old, and male counts for the majority of samples (Table 2).

There are several ethnic of minimally invasive surgery that used on this study, that is mini-open anterior TL corpectomy using extreme lateral interbody fusion (XLIF), extreme lateral channel (XLIF) combined with lateral or percutaneous posterior pedicle screw fixation, local chemotherapy combined with percutaneous pedicle screw, one-stage posterior debridement and single-segment interbody fusion, minimally invasive far lateral debridement and posterior instrumentation (MI-FLDPI), and computer navigation-assisted minimally invasive direct lateral interbody fusion. All of the studies mentioned that patient have regimen of anti-tuberculosis drug 2 weeks preoperatively continued post operatively for 12-18 months (Table 3). Only 2 study have comparison group with the open surgery (Table 4).

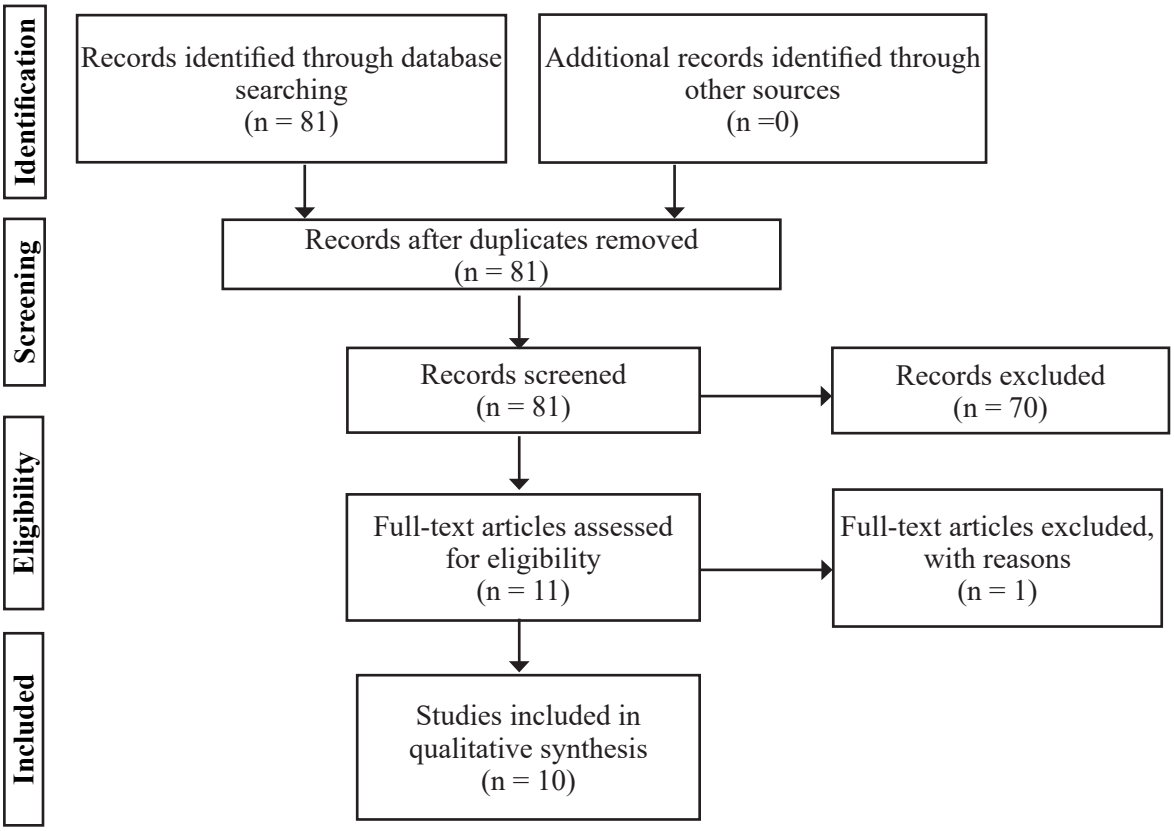


**Figure 1.** Flow diagram describing the strategy for conducting this study based on PRISMA guideline.

**Table 1.** Study Characteristic

| No | Reference | Journal | Study Design | Level of Evidence |
|---|---|---|---|---|
| 1 | Guo S. Et al (2019) | Medical Science Monitor | Retrospective | III |
| 2 | Jiang et al (2018) | Medicine Journal | Retrospective | III |
| 3 | Gan et al. (2018) | BMC Musculoskeletal Disorders | Retrospective | III |
| 4 | Viezens L, et al (2017) | World Neurosurgery | Retrospective | III |
| 5 | Wang *et al.*, (2016) | Journal of Musculoskeletal and Neuronal Interactions | Retrospective | III |
| 6 | Wang, *et al.* (2016) | Medicine | Case report | IV |
| 7 | Yang *et al.*, (2016) | Spine Surgery | Retrospective | III |
| 8 | H. Yang et al. (2016) | Journal of Clinical Neuroscience | Retrospective | III |
| 9 | Xiong W. (2020) | Journal of Orthopaedic Surgery and Research | Prospective cohort | III |
| 10 | Xu Z. (2020) | Journal of Orthopaedic Surgery and Research | Prospective cohort | III |

**Table 2.** Summary of total sample, demographic data, site of infection and preoperative spinal status

| No | Reference | Total Sample Size | Group | | Age | Gender | | Spinal Level | Preoperative Neurological Status |
|---|---|---|---|---|---|---|---|---|---|
| | | | Control | Intervention | | Male | Female | | |
| 1 | Guo S. Et al (2019) | 42 | 22 | 20 | 26-67 | 23 (54.7) | 19 (45.3) | Thoracolumbar | N/A |
| 2 | Jiang et al (2018) | 33 | 15 | 18 | 26–85 | 17 (51.5%) | 16 (48.5) | L1-L5 | N/A |
| 3 | *Gan et al.* (2018) | 35 | N/A | 35 | 25–83 | 16 (45.7%) | 19 (54.3%) | Thoracolumbar | Frankle C,D,E |
| 4 | Viezens L,et al (2017) | 148 | 73 | 75 | MIS (64.1±13.7); Open surgery (64.1±13.7) | 85 | 63 | Thoracolumbar | N/A |
| 5 | Wang *et al.*, (2016) | 22 | N/A | 22 | 28–79 | 12 (54.5%) | 10 (45.5%) | L2-L5 | Frankle C,D,E |
| 6 | Wang, *et al.* (2016) | 1 | N/A | 1 | 68 | 0 (0%) | 1 (100%) | L1-L2 | Frankle E |
| 7 | Yang *et al.*, (2016) | 34 | N/A | 34 | Mean 59 | 17 (50%) | 17 (50%) | Thoracolumbar | ASIA B,C,D |
| 8 | H. Yang et al. (2016) | 31 | N/A | 31 | 33–78 | 19 (61.3) | 12 (38.7) | Thoracolumbar | ASIA C |
| 9 | Xiong W. (2020) | 23 | NA | 23 | 17–71 | 13 (56,52%) | 10 (43,48%) | Thoracolumbar | ASIA C, D, E |
| 10 | Xu Z. (2020) | 62 | NA | 62 | 33.5-61.5 | 33 (53,23%) | 29 (46,77%) | L2-S1 | N/A |

**Table 3.** Minimally invasive surgery technique

| No | Reference | Antimicrobial | Surgical Technique | | | | |
|---|---|---|---|---|---|---|---|
| | | | Imaging Guidance | Approach | Internal Fixation Type | Incision Length (cm) | Decompression Method |
| 1 | Jiang et al (2018) | Isoniazid (300 mg/d), rifampicin (450mg/d), ethambutol (750 mg/d), and streptomycin (750 mg/d) or pyrazinamide (15–30mg/kg/d) | C-arm fluoroscopy and non C-arm fluoroscopy | Lateral | N/A | 5 | Navigation probes were used to identify the range of lesion debridement and decompression |
| 2 | Wang et al (2016) | Rifampicin (450 mg per day, PO), isoniazid (300 mg per day, PO), pyrazinamide (750 mg per day, PO), and Streptomycin, (75 mg per day, IM) for 12-18 months | X-ray fluoroscopy | Lateral | Posterior pedicle screws fixation | 3-4 | Debridement of necrotic tissues, including nucleus pulposus, adjacent end plate and vertebra, and abscess |
| 3 | Gan et al. (2018) | Isoniazide (300 mg/d), rifampicin (450 mg/d), ethambutol (750 mg/d), streptomycin (750 mg/d) or pyrazinamide (15~ 30 mg/kg/day) for 12-18 months | C arm fluoroscopy | Direct lateral | Plate fixation, posterior pedicle screw fixation and lateral nail bar fixation | 6-8 | Lesions removal of intervertebral disc and necrosis of bone by spatula, rongeur and chisel. |
| 4 | Wang et al (2016) | Streptomycin 75mg/day IM, rifampicin 450mg/day PO, isoniazid 300mg/day PO, and pyrazinamide 750mg/day PO) for 2 weeks continued for 12-18 months postoperatively | X-ray fluoroscopy | Lateral | Percutaneous pedicle screws | 2-3 | Cutting the annulus of the object intervertebral disc through this surgical channel under the direct vision. |
| 5 | Yang et al (2016) | HRZE (which is composed of isoniazid, rifampicin, pyrazinamide and ethambutol) for at least 2 weeks before the surgery and continued for 12-18 months | C arm fluoroscopy | Lateral | Bilateral pedicle screw fixation | 1 cm | No decompression needed |
| 6 | H Yang et al (2016) | INH (300 mg), rifampicin (450 mg), ethambutol (750 mg) and pyrazinamide(1500 mg) | C-arm fluoroscopy | Posteromedial | N/A | 5 | Opening the laminae to expose the dural sac |
| 7 | Xiong W (2020) | Isoniazid (5 mg/kg, 300 mg/day), rifampicin (15 mg/kg, 600 mg/day), pyrazinamide (25 mg/kg/, 2 g/day), and ethambutol (15 mg/kg, 750 mg/day). | Fluoroscopy | Lateral | Unilateral pedicle screw fixation | 3 cm | Nerve hook or a small curved curet |
| 8 | Xu Z (2020) | Isoniazid (300 mg/day), rifampicin (450 mg/day), and pyrazinamide (750 mg/day), and ethambutol (750 mg/day). | C-arm fluoroscopy | One-stage posterior | Pedicle screws fixation | N/A | Curettes of varying angles |

**Table 4.** Comparison of Minimal Invasive Approach and Open Approach

| No | Reference | Antimicrobial | Group | Intervention | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Imaging Guidance | Approach | Incision Length (cm) | Internal Fixation Type | Decompression method |
| 1 | Guo S. Et al (2019) | Isoniazid 300 mg/day, rifampin 600 mg/day, pyrazinamide 1500 mg/day, ethambutol 1000 mg/day | MIS Group | C-arm fluoroscopic | Transverse | 1.0 cm | Percutaneous Pedicle Screw (VIPER ® 2 MIS Spine Screws System) and pre-bent titanium rods | N/A |
| | | | Open Group | C-arm fluoroscopic | Posterior | N/A | Pedicle screws (MOSS MIAMI System) | A bilateral hemilaminectomy, or total laminectomy, according to the extent of spinal canal stenosis, and debridement of the affected intervertebral discs and the vertebral bodies |
| 2 | Viezens L,et al (2017) | Intravenous antbiotic therapy (>14 days) and oral (10 weeks) based on microbiological findings | MIS Group | Fluoroscopic | Percutaneous | 1.0-1.5 cm (additional 3-5 cm if additional decompression is needed) | Pedicle screws (XIA precision implant and MANTIS spinal system) | Insertion of tubular/ microlumbar discectomy retractor and uni-/bilateral laminotomy or laminectomy |
| | | | Open Group | Fluoroscopic | Posterior midline | At least one adjacent vertebral body cranial and caudal to the infected vertebrae | Pedicle screws (Xia implant and Universal Spinal System) | Uni-/bilateral laminotomy or laminectomy |

**Table 5.** Outcome Characteristic of Minimally Invasive Surgery

| No | Reference | Functional | | | Intraoperative | | Radiological | Length of stay | Follow up period | Complication |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Neurological | ODI | VAS | EBL (ml) | Duration (minutes) | | | | |
| 1 | Guo S. Et al (2019) | N/A | N/A | Preop PPS 7.64±0.95 , postop 2.45±1.22<br>Preop Hybrid 7.75±1.07 , Post op 2.65±1.79 | PPS 73.05±36.78<br>Hybrid 310.75±65.84 | PPS 121.86±24.94<br>Hybrid274.95±32.70 | N/A | PPS 8.05±1.70<br>Hybrid 16.75±4.51 | 1, 6, 12, and 18 months<br>1, 6, 12, and 18 months | No complication |
| 2 | Jiang et al (2018) | N/A | N/A | N/A | NAV : 316±65.3<br>Non NAV 344±48.8 | NAV :69.1±1.9<br>Non NAV :75.5±4.4 | N/A | NAV :9.9±1.8<br>Non NAV :10.1±1.5 | 1, 3, 6, and 12 months<br>1, 3, 6, and 12 months | N/A |
| 3 | Gan et al. (2018) | FRANKEL E | N/A | Preoperative grade: 8.2±0.7 and postoperative: 2.8±0.5 | 200-600 (average of 320) | 79-129 (average of 94) | N/A | N/A | 7 to 40 months with an average of 18.5 months | 5 cases occurred with transient numbness in one side of the thigh or inguinal region and 10 cases suffered from flexion hip weakness. |
| 4 | Viezens L,et al (2017) | Improvement preoperative Frankel Grade post operative | N/A | N/A | N/A | N/A | N/A | MIS 23.9±18.0<br>Open surgery : 29.1±25.7 | N/A<br>N/A | Wound-healing difficulties or screw misplacement |
| 5 | Wang et al., (2016) | FRANKEL E | Preoperative grade: 57.2±6.1 and postoperative: 23.0±3.1 | Preoperative grade: 6.4.2±1.2 and postoperative: 0.6±0.7 | 249.8.2±27.8 | 347.5±20.7 | Cobb angle (L1-L5) --> preoperative grade: 23.9±1.9 and postoperative: 24.5±1.4 | 25.8±1.9 | 12.4±1.1 months (11 to 15 months) | Psoas abscess in 1 patient |
| 6 | Wang, et al. (2016) | FRANKEL E | Preoperative grade: 56 and postoperative: 22 | Preoperative grade: 4 and postoperative: 0 | 500 | 220 | Kyphosis angle --> preoperative grade: 33.5 and postoperative: 14.8 | 8 | 12 months | No complication |
| 7 | Yang et al., (2016) | ASIA D, E | N/A | N/A | 20-150 | 90-160 (average of 125) | As for kyphosis deformity, there was no Cobb angle loss. | 3 to 5 | 18 (range 12–52) months | Soft tissue abscess in 1 patient |
| 8 | H. Yang et al. (2016) | ASIA E | N/A | Preoperative : median 5.8, postoperative : median 1.2 | 90 | 80 | Average Cobb angle increased $8.6^0$ | N/A | 0.5, 1, 2, 3, 6, 12 and 18 months | No |
| 9 | Xiong W. (2020) | Complete recovery at the last follow-up | Pre-operative: 4.2 ± 6.7<br>Post-operative: 26.5 ± 6.8 (p<0.05) | Pre-operative: 7.6 ± 0.9<br>Post-operative: 1.5 ± 0.7 (p<0.05) | 223 ± 97 | 165 ± 42 | Cobb's angle improved significantly from preoperative 23.2 to 13.2° and maintained at 13.5° | N/A | 12 to 36 months | No complication |
| 10 | Xu Z. (2020) | JOA score from 18.3 ± 3.7 to 26.9 ± 2.2 (p<0.05) | Pre-operative: 42.6 ± 6.2<br>Post-operative:10.2 ± 1.6 (p<0.05) | Pre operative: 6.9 ± 1.1<br>Post-operative:1.0 ± 0.8 (p<0.05) | N/A | N/A | Correction rate of lordosis angle 37.8 ± 4.5% Correction of lumbosacral angle 34.1 ± 6.1% | N/A | 75.0 ± 11.5 months | • Superficial wound infection: 2 patients<br>• Hypostatic pneumonia: 4 patients<br>• Local abscess recurrence: 1 patient |

In all ten literatures mentioned patient that have been treated with minimally invasive surgery have good functional, neurological, intraoperative and radiological outcome with minimal complication. (Table 5).

## Discussion

The conventional surgical method involves prolonged exposure of the affected areas, with significant morbidity and mortality rates. Prolonged surgery, higher blood loss, significant iatrogenic paraspinal muscle damage, a lengthier hospital stay, and rehabilitation time are all potential risks.[16] Minimal Invasive Surgery (MIS) has been gaining interests in recent years, including in the field of spine surgery. In order to be a routine procedure, this novel procedure should be comparable to established surgical techniques in terms of outcomes and risks. The purpose of our investigation is to summarize the current evidence of MIS usage for spine infection surgeries. We collected the patient demographics, including preoperative neurological status and the spine level involved, the surgical techniques performed including the compared open surgery approach, and the outcomes and complications.

The patients from the 10 studies presented herein are of similar baseline characteristics regarding age, sex, involved spinal level, and preoperative neurological status. As for the treatment, all patients receive appropriate antimicrobial regimen, that is anti-tuberculosis regimen for TB cases and antibiotic for non-TB cases. The procedures performed ranged from debridement to internal fixation. As expected, incision in MIS is reduced, with the range of 1-5 cm. This is as compared to open surgery which might need incision as long as at least one adjacent vertebral body cranial and caudal to the infected vertebrae.[17]

The MIS itself can also be greatly aided with the use of visualization instrument such as computer navigation system. Intraoperative C-arm fluoroscopy risks increased radiation exposure in both surgical staff and patients in order to ensure channel establishment and the accuracy of screw and cage implantation, while avoiding nerve damage and achieving general surgical safety. Therefore, the use of computer navigation might increase the benefit of MIS in spine surgery even more.[18]

Objectively, all literature reported a functional improvement with mostly normal postoperative neurological status as assessed by FRANKEL or ASIA classification. The pain level also improved significantly. These show that MIS approach give satisfactory outcome to treat spine infection conditions. There are other certain intraoperative benefits as well: considerably reduced blood loss and shorter operation duration using MIS approach. Less morbidity also showed in terms of shorter length of stay in comparison to open surgery.[4]

However, there are still possible complications associated with minimally invasive spine surgery. These include violation of the cranial (non-fused) facet joint during placement of percutaneous pedicle screws, non-union related to inadequate discectomy and bone grafting during minimally invasive transforaminal lumbar interbody fusion, and nerve injury related to inadequate visualization during decompression. Several complications noticed were transient numbness, wound healing difficulties, and abscess.[7,19]

The future of minimally invasive spine surgery continues to be bright. The coming technological and procedural advances will certainly include the minimally invasive philosophy. The future will inevitably continue to incorporate less invasive techniques.

Nevertheless, this systematic review can only describing literature level III and level IV based on strength of evidence of each literature. We cannot find any randomized controlled trial study regarding minimally invasive surgical approach in patient with pyogenic spine infection or systematic review that reviewing the randomized controlled trial study regarding those patient in last 5 years of published study. This can be happened because of this minimally surgical approach is a new surgical approach for management of patient with pyogenic spine infection that met indication of surgical procedure. So, it is can demonstrated why we find only a few literature that met our inclusion criterias of this systematic review.

## Conclusion

MIS yielded satisfactory result in comparison to conventional open surgery for spine infection. More long term future studies should be conducted to in order to search for more solid evidence regarding this claim.

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### CONTRIBUTIONS

All authors contributed to data analysis, drafting, and revising of the article and agreed to be responsible for all aspects of this work.

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*Review Article*

# Conservative Management and Surgical Indications for Rotator Cuff Tears: Review

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## Abstract

**Introduction:** Shoulder pain is a common musculoskeletal complaint with various causes, including rotator cuff injuries. Conservative management is generally considered the first-line treatment for many patients with rotator cuff tears and includes physical therapy, activity modification, analgesic medications, subacromial corticosteroid injections, and other emerging therapies. This literature review aimed to evaluate the effectiveness and mechanisms of currently available conservative treatment options for rotator cuff injuries.

**Methods:** A literature search was conducted for studies evaluating conservative management of rotator cuff injuries. Data regarding treatment modalities, clinical outcomes, pain reduction, functional improvement, and adverse effects were extracted and reviewed qualitatively.

**Results:** The reviewed literature suggests that conservative management can provide meaningful improvements in pain and shoulder function in patients with rotator cuff injuries. Physical therapy remains a cornerstone of treatment, particularly exercises aimed at restoring shoulder strength, mobility, and function. Analgesics and subacromial corticosteroid injections may provide short-term symptom relief, while emerging biological and nonoperative therapies show varying degrees of efficacy. Treatment outcomes may depend on factors such as tear characteristics, patient age, symptom duration, and adherence to rehabilitation.

**Conclusion:** Conservative management is an effective initial treatment strategy for many patients with rotator cuff injuries. A multimodal approach combining rehabilitation, symptom control, and appropriate patient monitoring may improve pain and functional outcomes while potentially reducing the need for surgical intervention.

## Introduction

Rotator cuff injuries are one of the most common causes of shoulder pain in all age groups. The degree of injuries affecting the rotator cuff varies from mild conditions, like acute reversible tendinitis, to more severe issues such as massive tears.[1] Rotator cuff tears can be evaluated radiographically based on factors like the size of the tear, the number of tendons involved, and the degree of retraction and atrophy. Since 1990, the Hamada classification has been widely used for the radiographic classification of massive rotator cuff tears.[2,3] Depending on the severity, it can affect the patient's functional activities and quality of life. When choosing a therapy, it's crucial to consider various factors impacting therapeutic outcomes, such as the duration of symptoms, the type of tear, the patient's age, any comorbidities, and their activity level.[4] Conservative management is usually the first option in treating rotator cuff tears until conservative management is considered unsuccessful and surgical management is chosen.



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Other indications for surgical management of rotator cuff tears, aside from the failure of conservative management, remain controversial.

**Conservative Management for Rotator Cuff Tears**

Conservative management for rotator cuff tears itself consists of non-pharmacological and pharmacological therapies. Non-pharmacological therapy consists of physical therapy and surveillance, while pharmacological treatment consists of administering non-steroidal anti-inflammatory drugs (NSAIDs) and steroid injections. As a first-line treatment, conservative management can also affect the clinical outcome of postoperative patients. Certain therapies administered before surgery can yield positive effects. In contrast, others might negatively impact postoperative clinical outcomes, potentially leading to the progression of a partial-thickness tear into a full-thickness tear.[5,6] A study identified several factors that are correlated with a successful outcome following conservative treatment, such as preserved range of motion in external rotation, absence of impingement signs, minimal or no atrophy of the supraspinatus muscle, and preserved intramuscular tendon of the supraspinatus.[7] Understanding the effect and mechanism of action of existing conservative management can prevent patients from experiencing recurrence and complications from rotator cuff tears.

**Physical Therapy**

Physical therapy is the mainstay of conservative management of rotator cuff tears, focusing on preventive measures and restoring rotator cuff function. Prevention is being carried out by modifying activities, namely avoiding excessive activity on the shoulder joint, particularly the repetitive overhead movements. Modifying activities can prevent additional rotator cuff injuries or tears, potentially avoiding the need for surgery. In addition to preventive measures, focusing on recovering rotator cuff function is essential. The program of rotator cuff recovery is carried out on the principles of (1) stretching the anterior and posterior shoulder joint capsules, (2) exercises using elastic bands and light weights, and (3) plyometric shoulder exercises. Shoulder joint capsule stretching aims to restore the mobility of the shoulder joint to that of the healthy contralateral shoulder. Exercises using elastic bands and light weights aim to restore the strength and endurance of the muscles involved in moving and stabilizing the shoulder joint. Shoulder plyometric aims to restore proprioception and coordination of the shoulder joint.[8]

Patients with rotator cuff tears who underwent physical therapy experienced significant improvements in shoulder joint pain and function if compared to patients who did not undergo physical therapy.[9] Valencia et al. showed that preoperative physical therapy does not contribute to the postoperative recovery process.[10] In contrast, a recent randomized controlled study showed that preoperative physical therapy could positively affect postoperative recovery from pain, joint movement, and quality of life.[11] A multicenter prospective cohort study by Kuhn et al. shows that the success rate of physical therapy programs with or without an intraarticular injection is 90% at six weeks and 80% at two years.[12]

**Surveillance**

Surveillance aims to determine the progress of rotator cuff damage and is carried out by performing a physical examination and imaging of the shoulder joint every 6-12 months. The examination can also be done earlier or frequently if a patient with no symptoms suddenly experiences pain and a significant decrease in shoulder function. Physical examination was performed to assess the strength and movement of the shoulder joint. Imaging techniques such as MRI or ultrasound can be utilized to visualize the size of the tear. A significant increase in the size of the rotator cuff tear or decreased shoulder function is an indication of surgery. Effective surveillance measures can help prevent muscle atrophy and tendon retraction, reducing the risk of intraoperative complications.[5]

**Oral Analgesics**

The chief complaint of patients with rotator cuff tears is pain. Hence, pain management remains the key element of conservative treatment.[13] Ruthia et al. showed that oral analgesics combined with physical therapy relieve pain in as many as 50-90% of rotator cuff tear cases.[14] The available analgesic options include NSAIDs, paracetamol, and opioids. NSAIDs work by inhibiting cyclooxygenase (COX), which inhibits the production of prostaglandins and reduces inflammatory reactions such as pain. However, decreased plasma levels of prostaglandins can delay tendon-to-bone recovery and impede recovery of rotator cuff tears. In addition, NSAIDs can cause side effects on the cardiovascular, cerebrovascular, and gastrointestinal systems.[14]

The use of paracetamol can also be a therapeutic option. It can even be used as a first-line analgesic because it does not interfere with the tendon-to-bone recovery process. Paracetamol induces analgesia by minimally inhibiting COX and directly affecting the brain and spinal cord to impede the transmission of nociceptive stimuli.[15] With this property, paracetamol has milder side effects compared to NSAIDs. The use of oral opioids as analgesics in rotator cuff tears is not recommended due to the risk of opioid abuse.[16] Chronic use of preoperative opioids can also give a poor prognosis on the functional score, shoulder range of motion (ROM), shoulder strength, and visual analog scale compared with non-opioid analgesic users after arthroplasty.[17]

**Subacromial Injections**

Various regimens injected into the subacromial space are thought to alleviate shoulder pain caused by rotator cuff

tears. These include corticosteroid injections, platelet-rich plasma therapy, dextrose prolotherapy, and local anesthetic injections.

Subacromial bursa steroid injection is a common intervention for the treatment of shoulder pain.[18] Steroid injections can control pain in a relatively short time and are often used as an initial aid in rotator cuff tear patients with severe pain. However, there is a debate on whether corticosteroid injections are more beneficial compared to NSAIDs alone.[19,20] A study found that subacromial corticosteroids appear to have an additional benefit when used with NSAIDs and exercise regimens in the acute or subacute phase.[21] Although long-term steroid injections can cause a decrease in tendon durability, inhibit collagen healing, increase collagen necrosis, and inhibit the proliferation of fibroblasts. It can lead to recurrent tears in postoperative patients, increasing the risk of revision surgery.[22,23] Long-term subacromial steroid injections are not recommended unless the patient is not able to undergo surgery or in cases of chronic rotator cuff tears.[5] A study also found that patients will have a higher hazard ratio (HR) of 7.44 to develop RCT after steroid injections for a shoulder condition within a mean duration of 39 months.[24]

Platelet-rich plasma is a natural concentration of growth factors, and secretory proteins have shown an essential role in the healing of damaged tissue.[25-27] Injection to the subacromial bursa can decrease pain and improve patients' outcomes.[28] A double-blinded randomized control trial showed that platelet-rich plasma injection improved pain and function at three three-month follow-ups. However, a sustained benefit at 12 months of follow-up was not found.[29] Rossi et al. evaluated 150 patients who underwent platelet-rich plasma injections. The result showed a significant improvement in shoulder function, pain, and sleep disturbances that were maintained at the 12-month follow-up, and most patients returned to the same level of the sport before the injury.[30,31] Although platelet-rich plasma has been gaining interest because of its abundance of growth factors and ease of performing procedures, there is a lack of standardized protocols for platelet-rich plasma preparation and clinical applications.[32]

Prolotherapy with hyperosmolar dextrose solution is a potentially effective adjuvant to physical therapy for patients with rotator cuff tendinopathy. Since the 1950s, Prolotherapy has been used to treat ligament laxity and related musculoskeletal conditions due to its ability to stimulate healing.[33,34] Lately, prolotherapy has been used to treat chronic pain of musculoskeletal disorders such as chronic groin pain and chronic lower back pain.[35,36] Further studies need to be done to better understand the subpopulation with rotator cuff tendinopathy that benefits from prolotherapy, as well as to optimize the technique, including the number and period of repeat injections, volume and concentration of dextrose solution, and location of injection.[37]

Subacromial local anesthetic injections, such as lidocaine injections, can improve patients' comfort. A study that evaluated 40 subjects showed a significant improvement in patient comfort, which resulted in an increased range of motion, strength, and Constant-Murley score compared to the group injected with a placebo.[38,39]

**Other Therapies**

Other therapeutic modalities for rotator cuff tears include topical agents, massage, acupuncture, shock-wave therapy, and viscosupplementation.[5] Topical agents such as glyceryl trinitrate patches are more effective than placebo for rotator cuff disease among patients with short-term symptoms. Still, there needs to be more sufficient evidence regarding this statement.[40] The safety of acupuncture remains unknown due to a lack of research regarding acupuncture for patients with rotator cuff diseases.[41] Extracorporeal shock wave therapy (ESWT) gives therapy by sending shock waves through positioning and movement of the treatment probe, which is then transmitted to the pain point and produces mechanical stress and biological effects, thus promoting blood and lymphatic return, increasing metabolism, and blocking pain. ESWT is a non-invasive, easy-to-perform, cost-effective treatment.[42-45]

**Surgical Indications for Rotator Cuff Tears**

In addition to the failure of conservative management, other indications for operative treatment of rotator cuff tears are still controversial in various studies. In some cases, surgical management can be done immediately without prior conservative management, such as in full-thickness tears that occur acutely in healthy young individuals. In addition, an acute-on-chronic tear, when the patient suddenly loses the ability to abduct or flex the shoulder, is also an indication for surgery because this condition indicates a significant progression from a partial-thickness tear to a full-thickness tear.[46] A study demonstrated that early operative intervention (within less than three weeks) in acute traumatic full-thickness tear resulted in better improvement in active abduction motion and total active abduction compared to later surgical intervention.[47] Therefore, a systematic review suggests early surgical intervention should be performed on active people to restore their rotator cuff strength and motion.[48] A complete understanding of how the conservative treatment works, its effect, and the success rate of conservative therapy can help clinicians counsel the right time to move to surgical management in dealing with patients with rotator cuff tears.

Factors generally believed to affect the outcome and thus become indications to perform elective rotator cuff surgeries, including tear size, duration of symptoms, failure of nonoperative treatment, nocturnal pain, history of trauma, and limitations of activities of daily living.[48] According to Marx et al. although full-thickness rotator cuff tears are common, there is no definitive consensus regarding the

criteria for rotator cuff surgery. After reviewing approximately 86 papers meeting the study criteria, it was concluded that limitations in daily living activities, nonoperative treatment failure, a history of nocturnal pain, and the duration of nonoperative therapy could be considered as surgical indications for rotator cuff tears.[49] Many recommendations are available regarding the timing of surgical intervention on persistent symptoms cases after conservative measures have been done. Yet, only limited evidence-based data support those recommendations. Consequently, the timing of surgery is mainly determined by clinicians' preferences.

## Conclusion

Rotator cuff tears can be challenging to manage, and identifying the appropriate treatment can be complex. However, it is essential to note that therapy can significantly determine the optimal time for surgical management. By collaborating with a skilled clinician, individuals with rotator cuff tears can gain valuable insights into their condition, allowing them to make informed decisions regarding their treatment options. Therefore, it is recommended that patients consider scheduling a therapy session, as it can be a crucial step toward achieving a successful recovery.

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*Clinical Research*

# Functional Outcomes of Closed Reduction Versus Open Reduction and Internal Fixation for Distal Radius Fractures

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## Abstract

**Introduction:** Distal radius fractures are common wrist injuries, with treatment ranging from conservative casting to operative fixation. Treatment outcomes can be assessed using objective measures, such as range of motion (ROM), and patient-reported outcome measures, such as the QuickDASH score. This study compared outcomes following open reduction and internal fixation (ORIF) with plates and screws versus closed reduction and casting at 6 months.

**Materials and Methods:** This cross-sectional comparative study was conducted at KRT Setjonegoro General Hospital and included 30 patients aged 18–50 years with distal radius metaphyseal fractures treated between July 2023 and March 2024. Twenty patients underwent ORIF with plates and screws, while 10 underwent closed reduction and casting. Fractures were classified according to the Frykman classification based on radiographic findings. Functional outcomes were evaluated at 6 months using the QuickDASH score and wrist ROM measurements.

**Results:** At 6 months, the ORIF group demonstrated significantly better QuickDASH scores and ROM measurements than the closed reduction and casting group ($p<0.001$).

**Conclusion:** ORIF with plates and screws resulted in significantly better functional outcomes and wrist ROM at 6 months compared with closed reduction and casting in patients with distal radius fractures.

## Introduction

A radius distal fracture is one of the common injuries that can be found in orthopedic surgery. This injury forms 8% - 15% of all adult bone injuries.[9] In his book, Solomon et al. (2010) mentioned that bones are fragile in general but they have enough strength and endurance to support the body weight. Fractures can occur due to trauma, repetitive stress, and bones abnormal weakness.[1] According to basic health research in 2013, fracture prevalence reached 5,8%. The highway is the most frequent place for injuries (42,8%). Meanwhile, the most common cause of injury is dominated by motorbike accidents (40,6%) and falls (40,9%).[11]

The fracture treatments can be conservative or surgery. The surgical procedure consists of open reduction, internal fixation, and closed reduction.[13] The treatment of patients with distal radius metaphyseal fractures greatly affects the upper extremity function during recovery. Therefore, the appropriate treatment choice will affect the function of the upper extremity.[2] The basic principle of fracture treatment is to achieve accurate reduction and then use immobilization methods that will maintain and hold that reduction.[10]

To strive for optimal bone healing, it's important to understand the factors that influence it. Four principles of fracture fixation (AO principles) are an integral part of optimal fixation and fracture healing. The first is fracture reduction to restore anatomical relationships. The second principle is fracture fixation to provide absolute or relative stability. The third principle is preserving blood supply to



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the soft tissue and bone. The last principle is early and safe mobilization.[3]

Until now, several scoring methods have been published for clinical assessment of upper extremity function, one of them is the QuickDASH score. DASH is a responsive, valid, and reliable clinical measurement tool for assessing the upper extremity. This questionnaire consists of 30 questions answered by the patients. QuickDASH is a shortened version of the DASH score measurement. from 30 items, QuickDASH uses 11 items to measure function and physical symptoms in individuals with one or several musculoskeletal disorders of the upper extremities. These 11 items are used to measure the level of difficulty in performing various physical activities due to issues with the shoulder, arm, or hand (6 items); the severity of pain and paresthesia (2 items); and the impact of the problem on social activities, work, and sleep (3 items). In this study, the Quick DASH items responses were extracted from the subjects' responses to the complete questionnaire. If at least 10 out of 11 items have been completed, the responses to these items are summed to form a raw score, then converted to a scale from 0 to 100 using the same formula used to calculate the DASH score, with higher scores reflecting greater disability.[8]

ROM is the extent of movement that occurs at a joint. The starting position for measuring all ROM, except rotation, is the anatomical position. A goniometer is used to measure the active range of motion (ROM) which includes wrist flexion, extension, radial and ulnar deviation, as well as supination and pronation of the injured forearm. Wrist flexion and extension are measured by placing the forearm in a neutral position on a stable surface, and the goniometer is placed on the radial side of the wrist, aligned along the third metacarpal. Wrist radial and ulnar deviation is measured by positioning the forearm in a pronated position on a flat surface with the elbow slightly bent. The goniometer measurement is done along the line of the third metacarpal and the radius bone. The measurement of forearm supination and pronation is done with the elbow bent at 90 degrees, beside the body, and the goniometer reading aligned with an imaginary line between the radial and ulnar styloids.[17]

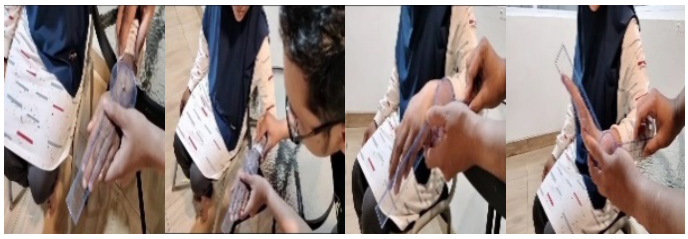
## Methods

This study adopts a descriptive cross-sectional methodology and inferential analysis. In this study, the researcher compares the outcomes of surgical treatment with plate & screw fixation and non-surgical treatment involving the application of a cast for distal radius fractures.

The research was conducted at KRT Setjonegoro General Hospital on patients with distal radius metaphyseal fractures who underwent treatment with a plate & screw fixation and the application of a cast from July 2023 to March 2024, who met the inclusion and exclusion criteria. The inclusion criteria are all patients with distal radius metaphyseal fractures who have received treatment with plate and screw fixation or the application of a cast and patients aged between 18-50 years. Classification of distal radius fracture by looking at the result of X-rays and classified using the Frykman Classification, patients residing in Wonosobo, and those willing to participate as respondents. The exclusion criteria include distal radius metaphyseal fractures that are comminuted and open fractures, along with patients who are unwilling to participate as respondents.

In sampling, the Lemeshow formula was used due to the unknown size of the population previously, resulting in a total of 30 samples being obtained. This study used medical record data of patients with distal radius metaphyseal fractures at KRT Setjonegoro General Hospital from July 2023 to March 2024.

A clinical measurement tool to assess the upper extremity using the quick DASH score questionnaire, which contains 11 questions with scores ranging from 1 to 5 for each question, and ROM measurement using a goniometer, which is used for clinical assessment.[16]



(A) (B) (C) (D)

**Figure 1.** Figure A and B shows the ROM measurement of dorso / plantar flexion and Figure C and D shows the ROM measurement of radial / ulna deviation

## Results

*Patient Demographics*

Among patients with distal radius fractures treated at KRT Setjonegoro General Hospital, 19 (63.33%) were male and 11 (36.67%) were female. Regarding the mechanism of injury, 14 patients (46.67%) sustained fractures in motorcycle accidents, 9 (30.00%) sustained injuries from falls from a height, 5 (16.67%) from slipping and falling, and 2 (6.67%) were struck by a vehicle while walking. Based on fracture location, 14 patients (46.67%) had extra-articular fractures, while 16 (53.33%) had intra-articular fractures.

*QuickDASH Score Results for Patients with Distal Radius Metaphyseal Fractures*

According to the results presented in Table 2, there was a significant association between treatment type and QuickDASH category. In the plate-and-screw group, 14 patients had normal functional status and 6 had mild disability, with no patients classified as having moderate or severe

disability. In the cast group, 5 patients had normal functional status and 5 had mild disability, with no patients classified as having moderate or severe disability. The difference between the treatment groups was statistically significant ($p<0.001$). These findings indicate that treatment with plates and screws was associated with better functional outcomes than treatment with casting.

According to the results presented in Table 3, there was a significant association between treatment type and wrist range of motion (ROM). The difference between the plate-and-screw and casting groups was statistically significant ($p<0.001$). These findings indicate that patients treated with plate-and-screw fixation had better ROM outcomes than those treated with casting alone.

**Table 1.** Respondent Demographics

| Characteristics | Respondents | Percentage |
|---|---|---|
| *Gender* | | |
| • Male | 19 | 63.33% |
| • Female | 11 | 36.67% |
| *Injury Mechanism* | | |
| • Motorcycle accident | 14 | 46,67% |
| • Fall from height | 9 | 30 % |
| • Slip and fall | 5 | 16,67% |
| • Struck while walking | 2 | 6,67% |
| *Fracture Type* | | |
| • Extra-articular | 14 | 46,67% |
| • Intra-articular | 16 | 53,33% |

**Table 2.** QuickDASH score results for patients with distal radius metaphyseal fractures

| No | Quick DASH | Treatment | | Total | P-value |
|---|---|---|---|---|---|
| | | Plate & Screw | Cast | | |
| 1 | Normal | 14 | 5 | 19 | <0.05 |
| 2 | Mild | 6 | 5 | 11 | |
| 3 | Moderate | 0 | 0 | 0 | |
| 4 | Severe | 0 | 0 | 0 | |
| | Total | 20 | 10 | 30 | |

**Table 3.** ROM measurement results for patients with distal radius metaphyseal fractures

| No | ROM | Treatment | | Total | P-value |
|---|---|---|---|---|---|
| | | Plate & Screw | Cast | | |
| 1 | Normal | 16 | 3 | 19 | <0.05 |
| 2 | Abnormal | 4 | 7 | 11 | |
| | Total | 20 | 10 | 30 | |

## Discussion

Distal radius fractures are a common type of fracture, accounting for 17% of emergency room cases.[4] According to the gender distribution in this research, males are more prevalent than females, comprising 63,33% of cases. Dwi Krisna, Putu Prabhawati, et al. (2020) in their research also found similar results, where males outnumbered females.[5] This is due to the higher level of mobility in males compared to females.

Based on the etiology of this research, the most common cause of distal radius metaphyseal fractures was motorcycle accidents, accounting for 46,67%, followed by other causes including falls from a height at 30%, slipping falls at 16,67%, and being struck while walking at 6,67%. According to the Basic Health Research results in 2013, highways rank number one as the most frequent location for injuries, accounting for 42,8%, with the majority of injuries equally dominated by motorcycle accidents.11 Research conducted by Fares, et al. (2021) also stated that the most frequent cause of distal radius fractures is due to falls or motorcycle accidents.7 This can be caused by the very high level of motorcycle usage as well as the low compliance and caution among motorcycle riders.

In this study, the most common type of fracture was the intra-articular type, accounting for 53,33%, and the most frequently used therapy in this study was ORIF with the installation of plate & screw, involving 16 patients. The type of fractures observed may be caused by the differences in hand position at the time of falling, and the treatment of fractures depends on the type of fracture and the consideration of the professional who will perform the therapy. In the research conducted by Johanna Rundgren (2020), it is mentioned that fractures were classified as AO-23-A extra-articular, 12% as AO-23-B intra-articular partial, and 23% as AO-23-C intra-articular. The primary treatment was non-surgical for 74% and surgical for 26% of all fractures. Only 18% of AO-23-A fractures were treated surgically, compared with 48% of AO-23-C fractures. The most frequently used surgical method was plate fixation (82%), followed by pin/wire fixation (8,2%), external fixation (4,8%), and other methods (4,0%).[14]

The statistical result in this study is showing result that there is a significant difference between the functional outcomes of closed reduction therapy and ORIF in patients with distal radius fractures, where the functional outcome is clinically assessed through ROM measurement and based on the patient's perspective with the QuickDASH score. The ROM values and QuickDASH scores in distal radius fracture patients treated with plate & screw fixation have a p-value of 0,00, which is less than the significance level of 5% (0,05). By seeing this value, it can be determined that treatments involving plate & screw fixation gives better results compared to treatments involving the application of a cast in patients with distal radius fractures.

The selection of therapy between closed reduction or open reduction is based on considerations of the patient's age, fracture type, and the degree of displacement and angulation. In the research conducted by Edi Burhan, et al. (2014), it is also stated that there is a significant difference between young patients with intra-articular distal radius metaphyseal fractures who received surgical treatment in the ORIF form and those who received non-surgical treatment in the form of cast.[2] Another study conducted by Jian Song, Ai-Xi Yu, and Zong-Huan Li (2015) also mentions that surgical therapy appears to be more effective for distal radius fractures compared to conservative treatment based on the radiographic analysis. A similar study is done by Cenk Ermutlu, et al. (2020) which states that the choice of surgical therapy using VPL, EF, and K-wires provides adequate fixation, good radiological results, and favorable functional outcomes for distal radius fracture therapy.[6,15] Meanwhile, there is a difference in the research conducted by Mulders, et al. (2017), which states that non-surgical treatment in patients with distal radius fractures with adequate closed reduction and radiographic outcomes provides acceptable functional results after 12 months, measured by the DASH score.[12] The difference in research outcomes can be influenced by many factors, such as the factors of age in sampling, factors that can impede fracture healing, factors of post-treatment care, and the facts that the healing process varies from person to person.

## Conclusion

Open reduction and internal fixation (ORIF) with plates and screws resulted in better upper-extremity functional outcomes than closed reduction and casting in patients with distal radius fractures, as assessed using the QuickDASH score and wrist range of motion (ROM). These findings may support the consideration of ORIF as an appropriate treatment option for distal radius fractures and may contribute to reducing post-traumatic functional impairment and complications.

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*Clinical Research*

# Comparison of Functional Outcomes With and Without Knee Bracing After Arthroscopic Anterior Cruciate Ligament Reconstruction Using a Quadriceps Tendon Autograft

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## Abstract

**Introduction:** Knee bracing after anterior cruciate ligament (ACL) reconstruction aims to maintain range of motion (ROM), provide knee stability, and protect the reconstructed ligament. However, evidence regarding the routine use of knee braces after ACL reconstruction remains limited, and no study has evaluated this practice in Indonesia. This study aimed to compare functional outcomes between patients who used a knee brace and those who did not after arthroscopic ACL reconstruction using a quadriceps tendon autograft.

**Methods:** This randomized controlled trial included patients undergoing arthroscopic ACL reconstruction at a tertiary hospital in Jakarta between February 2022 and February 2023. Patients were randomized to postoperative knee bracing or no bracing. Clinical outcomes were assessed preoperatively and at 1, 3, and 6 months postoperatively using the International Knee Documentation Committee (IKDC) score, Lysholm score, Knee Injury and Osteoarthritis Outcome Score (KOOS), ACL Return to Sport after Injury (ACL-RSI) score, and Rollimeter measurement.

**Results:** There were no significant differences between groups in sex, injured knee side, or concomitant meniscal injury. No significant between-group differences were observed in IKDC, Lysholm, or KOOS scores at any assessment point ($p>0.05$). Rollimeter measurements showed significantly greater anterior translation in the bracing group at 1 and 3 months postoperatively ($p=0.001$ and $p=0.003$, respectively). A significant between-group difference in ACL-RSI scores was observed at 3 months postoperatively ($p=0.004$).

**Conclusion:** Knee bracing after arthroscopic ACL reconstruction using a quadriceps tendon autograft did not improve functional outcomes compared with no bracing. Routine postoperative bracing may therefore not provide additional functional benefit.

## Introduction

Anterior cruciate ligament (ACL) injuries are the most common ligament injuries in the knee region with an incidence of over 120,000 per year and resulting in 129,000 - 400,000 reconstructive surgeries in the United States and 400,000 reconstructive surgeries worldwide.[1] Anterior cruciate ligament (ACL) injuries are the most common ligament injuries in the knee region with an incidence of over 120,000 per year and resulting in 129,000 - 400,000 reconstructive surgeries in the United States and 400,000 reconstructive surgeries worldwide.[2]

Management of ACL injuries must be done holistically and comprehensively. Management is carried out starting from the time of ACL reconstruction surgery, graft selection during reconstruction to postoperative including brace use and rehabilitation methods used postoperatively. There are 2 types of graft that can be used Autograft and Allograft, several sources of Autograft that have been commonly



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used in ACL reconstruction namely (1) Bone Patellar Tendon Bone (BPTB) which is still the gold standard of ACL reconstruction graft, (2) Hamstring, (3) Bone Quadricep Tendon (BQT) and (4) Peroneus longus can be an alternative graft.[3,4]single bundle hamstring tendon (SBHT Andri and Demy in their study stated that the use of BQT grafts had better functional outcomes when compared to Single Bundle Harmstring.[3] Previous meta-analysis studies by Mouarbes et al and Zhoumao et al also stated that BQT has a lower risk of rerupture and donor-site morbidity than hamstring tendon. This could be due to the better union of the graft with the bone given its superior bone-to-bone healing properties compared to tendon-to-bone healing.[5,6]

Postoperative management (including brace wear) to rehabilitation is as important a part of the surgery as the surgery itself. During surgery, patients should have minimal knee effusion and full extension to prevent the risk of postoperative arthrofibrosis. Patients should take the time to prepare for surgery and postoperative rehabilitation equally well. Shelbourne and Koltz explained that regaining symmetrical Range of Motion (ROM) of the knee joint is patient satisfaction.[7]

There is much debate and controversy in the use of knee brace after ACL reconstruction. In Indonesia, there is currently no research that examines the use of knee braces after ACL reconstruction. Based on this, this study examines whether there are differences in functional outcomes between patients who use a knee brace and without using a knee brace after ACL reconstruction.

## Methods

The study used a randomized controlled trial design and was conducted at a tertiary hospital in Jakarta, Indonesia, from February 2022 to February 2023. The target population comprised all patients who underwent arthroscopic anterior cruciate ligament (ACL) reconstruction using a quadriceps tendon autograft during the study period. Patients who met the predefined inclusion and exclusion criteria were eligible for enrollment.

The inclusion criteria were patients aged 18–50 years with an ACL rupture without concomitant injury to other knee ligaments, including the posterior cruciate ligament (PCL), lateral collateral ligament (LCL), or medial collateral ligament (MCL), who underwent arthroscopic ACL reconstruction using a quadriceps tendon autograft. Patients with generalized joint hypermobility (Beighton score >4), a history of ACL re-rupture, or previous revision ACL reconstruction were excluded.

Participants were randomly allocated into two groups: a knee-bracing group and a non-bracing group. Randomization was performed using a computerized random-number generator (Random.org) by an independent third party, and the allocation sequence was concealed from the researchers.

In the bracing group, an adjustable knee brace was applied after ACL reconstruction performed by an orthopedic surgeon or orthopedic resident under specialist supervision. During the first postoperative week, the brace was locked in full extension (0°). During the third week, the target range of motion was 0°–90°, and full flexion was permitted from the fourth week onward. The brace was worn continuously during the first postoperative week, except during physical therapy sessions, according to the rehabilitation protocol.

Subjective knee function was assessed using the International Knee Documentation Committee (IKDC), Lysholm, Tegner, and Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaires. The questionnaires were administered through face-to-face interviews by an orthopedic surgeon or orthopedic resident. Clinical assessments were performed at four time points: preoperatively and at 1, 3, and 6 months postoperatively.

Knee stability was assessed using a Rolimeter. The patient was examined in the supine position, with the Rolimeter positioned over the patella and centered along the patellar level according to the manufacturer's recommended technique. Rolimeter measurements were obtained at the same four time points: preoperatively and at 1, 3, and 6 months postoperatively.Data were analyzed using the SPSS 25 program. This study was only conducted by obtaining ethical clearance from the Health Research Ethics Committee, Jakarta, before the study was carried out. This study has been registered on ClinicalTrials.gov under registration number NCTO5457452.

## Results

A total of 24 patients who underwent anterior cruciate ligament (ACL) reconstruction were included in the study and divided into two groups: a knee-bracing group and a non-bracing group. Most patients were male (20/24, 83.3%). The baseline characteristics of the study participants are presented in Table 1. There were no statistically significant differences in baseline characteristics between the two groups ($p>0.05$).

The most common activity associated with ACL rupture was soccer (42%), followed by basketball (25%). The interval between injury and surgery ranged from 1 to 48 months. During the follow-up period, no cases of infection or ACL re-rupture were observed. The mean preoperative IKDC score was 46.7 ± 20.4 in the knee-bracing group and 52.8 ± 20.5 in the non-bracing group. A comparison of IKDC scores between the two groups is presented in Table 2.

KOOS scores were assessed preoperatively and at 1, 3, and 6 months after ACL reconstruction. At 1 month post-

**Table 1.** Research Subject Charateristics

| Characteristics | Group | | P-value |
|---|---|---|---|
| | Knee Brace (n=12) (%) | No Knee Brace (n=12) (%) | |
| Gender* | | | |
| -Male | 9 (75%) | 11 (91,7%) | 0,590 |
| -Female | 3 (25%) | 1 (8,3%) | |
| Age (years)** | 25.5 (17-35) | 23.5 (18-48) | 0,191 |
| Knee* | | | 0,408 |
| -Left | 6 (50%) | 4 (33.3%) | |
| -Right | 6 (50%) | 8 (66.7%) | |
| Involvement meniscus injury* | | | 0,371 |
| -Yes | 10 (83.3%) | 7 (58.3%) | |
| -No | 2 (16.7%) | 5 (41.7%) | |
| Location of meniscus injury | | | |
| Lateral | 7 (70%) | 3 (42.8%) | |
| Medial | 3 (30%) | 4 (57.2%) | |

*Significance values were obtained with the Fisher test
**Significance values were obtained with the Mann-Whitney test

**Table 2.** IKDC values of patients with or without using a knee brace

| IKDC Score | Brace Group N = 12 | Non-Brace Group N= 12 | Difference(CI 95%) | P-value |
|---|---|---|---|---|
| Preoperative | 46.7±20.4 | 52.8±20.5 | 6.03 (-11.3 – 23.4) | 0.479 |
| Postoperative 1 month | 42.8±19.1 | 37±18.7 | -5.83 (-21.8 – 10.2) | 0.459 |
| Postoperative 3 months | 59.1±13.5 | 60.8±12.0 | 1.75 (-9.1 – 12.6) | 0.742 |
| Postoperative 6 months | 84.91±14.8 | 75.75±17.8 | 9.15 (-4.71 – 23.03) | 0.185 |

*Significance value obtained by independent T-test

operatively, the median KOOS score was higher in the knee-bracing group than in the non-bracing group (56.55 [range, 13.7–82.1] vs. 42.2 [range, 15.5–84.5]); however, the difference was not statistically significant (p=0.443). Comparisons of KOOS scores between the two groups are presented in Table 3.

Clinical outcomes were assessed using the Lysholm score preoperatively and at 1, 3, and 6 months after ACL reconstruction. At 3 and 6 months postoperatively, there were no significant differences in Lysholm scores between the knee-bracing and non-bracing groups (p=0.847 and p=0.663, respectively). Comparisons of Lysholm scores between the knee-bracing and non-bracing groups (p=0.847 and p=0.663, respectively). Comparisons of Lysholm scores between the two groups are presented in Table 4.

Rolimeter measurements were obtained preoperatively and at 1, 3, and 6 months postoperatively. At 1 month, the mean anterior translation was greater in the knee-bracing group than in the non-bracing group (2.42 ± 0.515 mm vs. 1.50 ± 0.674 mm; p=0.001). At 3 months, the mean translation remained greater in the knee-bracing group (1.92 ± 0.669 mm vs. 1.17 ± 0.389 mm; p=0.003). A significant between-group difference was also observed at 6 months postoperatively (p=0.024). The results of the Rolimeter measurements are presented in Table 5.

ACL-RSI scores were assessed preoperatively and at 1, 3, and 6 months postoperatively. Preoperatively, the mean ACL-RSI score was 24.75 (18.4–30.4) in the knee-bracing group and 27.0 (24.2–45.3) in the non-bracing group, with no significant between-group difference (p=0.143). At 1 month, the mean scores were 51.2 (43.5–54.2) and 52.85 (43.5–55.4) in the knee-bracing and non-bracing groups, respectively, with no significant difference (p=0.311). At 3 months, a significant between-group difference was observed (p=0.004). At 6 months, the difference was no longer statistically significant (p=0.355). The ACL-RSI results are presented in Table 6.

## Discussion

This study involved 24 subjects divided into two groups: those using post-operative braces (12 subjects) and those

**Table 3.** KOOS value of patients with or without using a knee brace

| KOOS | Brace Group N = 12 | Non-Brace Group N= 12 | Differences | P-value |
|---|---|---|---|---|
| **Preoperative** | | | | |
| Symptoms | 66.3 (22.7) | 57.7 (21.5) | 8.62 (-10.1 - 27.3) | 0.350 |
| Pain | 68.5 (21.4) | 62.2 (22.5) | 6.24 (-12.4 - 24.8) | 0.494 |
| ADL | 66.2 (22.5) | 62.0 (22.0) | 4.28 (-14.6 - 23.1) | 0.642 |
| Exercise | 60.8 (29.8) | 50.4 (32.1) | 10.4 (-15.8 - 36.6) | 0.419 |
| Quality of life | 63.0 (27.3) | 51.5 (21.1) | 11.4 (-9.25 - 32.1) | 0.264 |
| Total | 65.2 (20.3) | 59.2 (21.4) | 5.99 (-11.7 - 23.7) | 0.489 |
| **Postoperative 1 month** | | | | |
| Symptoms | 53.8 (20.3) | 53.5 (18.5) | 0.29 (-16.2 - 16.7) | 0.970 |
| Pain | 52.4 (27.3) | 45.6 (20.2) | 6.80 (-13.6 - 27.2) | 0.496 |
| ADL | 50.7 (19.8) | 44.3 (16.0) | 6.37 (-8.90 - 21.6) | 0.396 |
| Exercise | 37.5 (26.4) | 22.5 (28.5) | 15 (-8.29 - 38.2) | 0.195 |
| Quality of life | 48.9 (23.6) | 41.1 (23.9) | 7.81 (-12.3 - 27.9) | 0.429 |
| Total | 52.4 (22.2) | 44.7 (17.8) | 7.73 (-9.36 - 24.8) | 0.358 |
| **Postoperative 3 months** | | | | |
| Symptoms | 81.5 (11.8) | 78.5 (14.4) | 2.97 (-8.22 - 14.1) | 0.587 |
| Pain | 73.3 (16.3) | 72.7 (12.1) | 0.65 (-11.5 - 12.8) | 0.911 |
| ADL | 75.8 (8.08) | 74.1 (7.86) | 1.71 (-5.04 - 8.46) | 0.604 |
| Exercise | 60 (28.6) | 48.3 (22.7) | 11.6 (-10.2 - 33.6) | 0.282 |
| Quality of life | 65.6 (11.1) | 66.1 (13.1) | -0.5 (-10.8 - 9.81) | 0.917 |
| Total | 73.7 (10.2) | 70.9 (9.64) | 2.78 (-5.65 - 11.2) | 0.501 |
| **Postoperative 6 months** | | | | |
| Symptoms | 94.04 (4.3) | 91.96 (8.4) | 2.08 (-3.64 – 7.81) | 0.458 |
| Pain | 91.66 (11.8) | 91.20 (6.3) | 3.88 (-7.58 – 8.50) | 0.907 |
| ADL | 92.89 (11.4) | 92.64 (6.2) | 3.75 (-7.53 – 8.02) | 0.948 |
| Exercise | 81.66 (20.0) | 68.33 (29.1) | 10.2 (-7.82 – 34.4) | 0.205 |
| Quality of life | 87.14 (12.2) | 76.56 (26.3) | 8.39 (-6.83 – 27.9) | 0.221 |
| Total | 89.48 (11.4) | 84.14 (13.8) | 5.19 (-5.45 – 16.1) | 0.351 |

*Significance values were obtained with the Mann Whitney test

not using braces (12 subjects). The majority of participants were male, with an average age of 23-25 years, reflecting the population of previous ACL injury patients, typically adolescents or young adults engaged in competitive sports. The research highlighted that knee injuries, particularly ACL injuries, play a significant role in sports-related injuries. While previous studies suggested a higher incidence of ACL injuries in females, more males undergo ACL surgery possibly due to the lower participation rate of females, especially in competitive sports, compared to males. The study also emphasized that there was no significant difference in the location of ACL injuries between the left and right sides, with meniscus injuries often accompanying ACL injuries, predominantly affecting the lateral meniscus. Meniscus injuries were more common in ACL injuries lasting over 8 weeks, signifying an increased risk associated with ACL rupture.[8-10]

Clinical outcome assessment in this study was conducted through rolimeter testing, indicating anterior translation of the knee joint, signaling joint laxity due to ACL damage. The research revealed significant differences in rolimeter measurements between the brace and non-brace groups at the 1-month and 3-month evaluations following the ACL injury. Initially, both groups showed considerable anterior translation of around 8.92 mm in the brace group and 8.58 mm in the non-brace group. However, statistically, no significant differences in anterior translation were observed preoperatively, indicating a comparable baseline between the two groups. At the 1-month evaluation, a significant difference in translation was noted with a mean difference of 0.9 mm between the brace and non-brace groups. Interestingly, the brace group exhibited significantly higher translations than the non-brace group. Despite the significant differences, postoperative rolimeter measurements in this study showed average anterior translations of 2.42 mm and 1.50 mm in both groups, within normal limits compared to prior research. A study by Lubis et al. in Indonesia displayed a larger postoperative anterior translation of 3.12 mm following cruciate ligament reconstruction with bone quadriceps tendon, further emphasizing the satisfactory outcomes of this study within a normal range.[3,11]

**Table 4.** Tegner Lysholm score value of the patient with or without using a knee brace

| Tegner Scale | Brace Group N = 12 | Non-Brace Group N= 12 | P-value |
|---|---|---|---|
| **Preoperative** | | | |
| Bad | 3 (25) | 7 (58) | 0.518 |
| Average | 8 (66) | 2 (16) | |
| Good | 1 (8) | 3 (25) | |
| Very good | 0 (0) | 0 (0) | |
| **Postoperative 1 month** | | | |
| Bad | 6 (50) | 8 (66) | 0.996 |
| Average | 5 (41) | 4 (33) | |
| Good | 1 (8) | 0 (0) | |
| Very good | 0 (0) | 0 (0) | |
| **Postoperative 3 month** | | | |
| Bad | 3 (25) | 0 (0) | 0.847 |
| Average | 4 (33) | 9 (75) | |
| Good | 4 (33) | 3 (25) | |
| Very good | 0 (0) | 0 (0) | |
| **Postoperative 6 month** | | | |
| Bad | 0 (0) | 0 (0) | 0,663 |
| Average | 1 (8.3) | 3 (25) | |
| Good | 6 (50) | 4 (33.3) | |
| Very good | 5 (41.7) | 5 (41.7) | |

*Significance values were obtained with the Mann Whitney test

**Table 5.** Rollimeter examination in patients with or without using a knee brace

| Rollimeter (mm) | Brace Group N = 12 | Non-Brace Group N= 12 | Mean difference (95% IK) | P-value |
|---|---|---|---|---|
| Preoperative | 8.92 (1.929) | 8.58 (1.505) | 0.33 (-1.1 - 1.79) | 0.642 |
| Postoperative 1 month | 2.42 (0.515) | 1.50 (0.674) | 0.91 (0.40 - 1.42) | 0.001 |
| Postoperative 3 month | 1.92 (0.669) | 1.17 (0.389) | 0.75 (0.28 - 1.21) | 0.003 |
| Postoperative 6 month | 1.66 (0.77) | 1.08 (0.28) | 0.23 (0.08 – 1.08) | 0.024 |

*Significance values were obtained with the Independent T-test

**Table 6.** ACL-RSI Score value of patients with or without using a knee brace

| ACL-RSI Score | Brace Group N = 12 | Non-Brace Group N= 12 | Mean Difference | P Value |
|---|---|---|---|---|
| Preoperative | 24.75 (18.4-30.4) | 27 (24.2-45.3) | -3.08 (-7.1 - 0.9) | 0.141 |
| Postoperative 1 month | 51.2 (43.5-54.2) | 52.85 (43.5-55.4) | -0.94 ( -4.1 - 2.2) | 0.311 |
| Postoperative 3 month | 73.1 (64.9-77.3) | 65.9 (63.2-74.2) | 5.42 (2.3 – 8.5) | 0.004 |
| Postoperative 6 month | 67.3 (38.3-82.5) | 63.2 (50.8-88.3) | 2.39 (-7.0 – 11.8) | 0.355 |

*Significance values obtained with the *Mann Whitney test*

Similar findings were also found in the 3-month postoperative rolimeter assessment with significant differences. Previous research has described anterior translation exceeding 3 mm in subjects undergoing ACL reconstruction. The results here indicate that the residual translation observed may not be clinically significant, especially when the mean translation remains within normal limits. In contrast, a study by Jacobi et al. in 2016 reported significantly better rolimeter results in patients receiving post-ACL reconstruction bracing. This difference may be attributed to the varying durations of follow-up, as their study had a 2-year follow-up period.[12,13]

While significant differences were noted between the brace and non-brace groups, there were no observable variations in functional outcomes. This implies that

despite differing knee stability as measured by anterior translation, functional outcomes were not impacted. Interestingly, functional outcomes were superior in the brace group, despite poorer clinical outcomes, highlighting the beneficial effect of brace use in providing ACL support and improving knee stability. Assessment via various scores like IKDC, KOOS, Tegner Lysholm, and ACL-RSI showed differing outcomes. The IKDC score, evaluating subjective and objective aspects of the knee, displayed comparable baseline function preoperatively. Post-ACL reconstruction, a decrease in IKDC scores was noted, consistent with previous findings of improving postoperative IKDC scores reported in the literature. This study corroborates a similar trend with decreased IKDC scores at the 1-month evaluation post-surgery, potentially related to common post-ACL reconstruction knee pain.[14-17]

Observations in this study show that, at the 1-month postoperative evaluation, the non-brace group had lower IKDC scores compared to the brace group, although this difference was not statistically significant. This suggests that brace use may still offer clinical benefits in terms of functional outcomes one month after surgery. However, previous research supports the statistical outcomes indicating no significant correlation between post-ACL operation brace use and IKDC scores. This study aligns with a meta-analysis of randomized controlled trials by Yang et al. in 2019, asserting that brace utilization does not enhance IKDC functional outcomes in patients following ACL arthroscopic reconstruction. The study emphasized that bracing's effects were only relative during wear, lacking significant long-term benefits. Earlier research by Moller et al. also highlighted that patients using braces face higher risks of tissue swelling due to soft tissue compression, associated with lower limb muscle atrophy and reduced knee joint flexion range of motion.[18-20]

This study compared the functional outcomes between brace and non-brace groups following ACL reconstruction, utilizing the KOOS scoring system to assess differences at preoperative, 1-month, and 3-month postoperative stages. The KOOS system, which evaluates symptoms, pain, daily activities, sports, and knee-related quality of life, showed no significant differences between the groups. Although prior research suggested that brace use post-reconstruction could lead to functional improvement, this study did not find a significant correlation between brace usage and KOOS scores, including in areas such as pain and sports activities, where the non-brace group showed better recovery at 1-month post-operation. This aligns with previous findings emphasizing the benefits of brace use in enhancing functional outcomes, particularly in the sports domain, at longer follow-up periods.[21-23]

This study evaluated post-operative outcomes using the Tegner Lysholm Knee Scoring and ALC-RSI scores, finding that the use of bracing did not significantly impact outcomes except for psychological factors measured by the ALC-RSI three months post-ACL reconstruction. The ALC-RSI assesses the psychological readiness of patients with ACL injuries to return to sports, including emotions, confidence levels, and risk assessment, where brace users showed significantly better psychological readiness at three months. This indicates a potential positive psychological impact of bracing on returning to sports activities. Despite this, previous research has shown no long-term functional difference in patients post-ACL reconstruction with or without brace use, suggesting that while bracing might improve psychological confidence in the short-term, it doesn't necessarily translate into long-term functional improvements.[24-28]

Research suggests that the utility of knee braces following ACL reconstruction surgery is dependent on the duration and manner of use to achieve optimal outcomes. According to a study by Masini et al., braces should be worn constantly for 4-8 weeks post-surgery, except during bathing or physical therapy sessions, with the knee held in maximum extension for better functional outcomes compared to a 0-90 degree flexion position. This study found no incidents of re-rupture post-ACL reconstruction, contrasting with previous studies like Balendra et al., which reported a 5.2% graft rupture rate within the first year, often before returning to competitive sports, highlighting the highest risk of graft failure within the first 12 months post-reconstruction. The causes of graft failure are multifactorial, with factors including the injury's initial contact mechanism and the return to sports impacting the risk of recurrent ACL rupture. Patients with initial contact mechanism injuries face a threefold risk of graft re-rupture, potentially due to differences in tendon properties, such as the quadriceps tendon's higher elasticity and thickness compared to other tendons and the normal ACL.[29-32]

This research is a randomized controlled trial that specifically investigates the subjective and objective functional outcomes of patients using a brace versus those not using a brace after undergoing arthroscopic ACL reconstruction with an autograft from the quadriceps tendon. It's noteworthy that clinical studies detailing the specific impact of brace use on patients following arthroscopic ACL reconstruction with quadriceps tendon autografts have not been previously reported, making this study a primary data source for future research. However, the study faces limitations, including a short follow-up duration of three months and inconsistent post-operative rehabilitation protocols across patients. For more conclusive findings, further research is recommended with a longer follow-up period and more homogenous subject groups, such as athletes or younger individuals.

## Conclusion

There were no significant differences in functional outcomes, as assessed by the IKDC, Lysholm, and KOOS scores, between patients who used a knee brace and those

who did not after arthroscopic ACL reconstruction using a quadriceps tendon autograft. Significant between-group differences were observed in ACL-RSI scores at 3 months and in Rolimeter measurements at 1, 3, and 6 months post-operatively. Overall, routine knee bracing did not provide a significant functional benefit following ACL reconstruction with a quadriceps tendon autograft.

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# Instruction for Authors

**Jurnal Orthopaedi dan Traumatologi Indonesia**
**(The Journal of Indonesian Orthopedic & Traumatology)**

## Conditions for Submission

• Articles are accepted for exclusive publication in The Journal of Indonesian Orthopedic &Traumatology. Previous presentation at a scientific meeting, and/or publication of the abstract in conjunction with the meeting, does not preclude publication of the article; however, this information must be disclosed in a cover letter at the time of submission. Previously published articles, including those published in non-English-language journals, are not accepted.
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• If requested by the Editor-in-Chief, authors must make the tabulated raw data that forms the basis of their work available for examination in a timely fashion.

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All manuscripts must conform to the following formatting instructions:

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