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An Assessment of Ankle Function, Oxidative Damage, and Inflammatory Factor Levels in Minimally Invasive Ankle Joint Fusion Surgery for the Treatment of Traumatic Ankle Osteoarthritis

Evaluación de la Función del Tobillo, el Daño Oxidativo y los Niveles de Factores Inflamatorios en la Cirugía Mínimamente Invasiva de Fusión de la Articulación del Tobillo para el Tratamiento de la Osteoartritis Traumática del Tobillo

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SUMMARY: Traumatic ankle osteoarthritis is a degenerative condition resulting from traumatic injuries. The objective of this study was to evaluate the impact of minimally invasive ankle joint fusion surgery on ankle function, oxidative damage, and inflammatory factor levels in traumatic ankle osteoarthritis patients. A total of 112 traumatic ankle osteoarthritis patients treated in our hospital from January 2022 to January 2023 were enrolled. They were randomly rolled into a control group (Group C) and an experimental group (Group E), with the former undergoing conventional open ankle joint fusion surgery and the latter receiving minimally invasive ankle joint fusion surgery. A comparison was made between the two groups based on American Orthopedic Foot and Ankle Society (AOFAS), bony fusion rates, and visual analog scale (VAS) scores at pre-operation, and at 1, 2, and 3 months post-operation. Additionally, serum oxidative damage indicators and inflammatory factor levels were measured to evaluate the recovery effects in both groups. Relative to Group C, Group E showed drastically increased AOFAS scores and bony fusion rates (P<0.05), as well as greatly decreased VAS scores (P<0.05). Moreover, Group E exhibited more pronounced improvements in oxidative damage indicators and inflammatory factors versus Group C (P<0.05). Minimally invasive ankle joint fusion surgery drastically improves ankle function in traumatic ankle osteoarthritis patients and reduces levels of oxidative damage and inflammatory response. This provides an important clinical treatment option.

KEY WORDS: Minimally invasive ankle joint fusion surgery; Ankle function; Oxidative stress damage; Traumatic ankle osteoarthritis.

INTRODUCTION

The ankle joint, located between the lower leg and the foot, is composed of three bones: the tibia, fibula, and talus, along with associated ligaments and muscles. It serves as a vital weight-bearing joint in the human body, providing support, stability, balance maintenance, facilitating various movements, as well as cushioning impacts and preventing injuries (Bendall *et al*., 2022). Given the large population and high labor intensity in China, the likelihood of ankle and foot-related diseases is notably elevated. Traumatic ankle arthritis, in particular, is prominent, with research indicating that approximately 1-4.4 % of the global population suffers from ankle arthritis, often resulting from trauma. Statistics reveal that traumatic ankle arthritis accounts for 70 % of hip arthritis cases and 78 % of knee arthritis cases, whereas primary ankle arthritis causes only 7.2 % of hip arthritis cases and 9 % of knee arthritis cases (Kiely & Lloyd, 2021). Consequently, safeguarding and maintaining the health of the ankle joint are paramount for normal bodily functions and daily life activities.

Traumatic ankle arthritis refers to degenerative changes in the ankle joint caused by traumatic injuries, characterized by lesions such as articular cartilage damage, ligament laxity, and synovitis within the ankle joint (Han *et al*., 2017; Ingall *et al*., 2022). Common traumatic causes include sprains, fractures, and dislocations. If these injuries are not promptly and effectively treated, they may lead to chronic inflammation and pain in the ankle joint, subsequently affecting the patients' ankle function and quality of life (Lei *et al*., 2023). The incidence of traumatic ankle arthritis has

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been increasing over the years, primarily due to the growing emphasis on sports and fitness in modern society, which also increases the likelihood of traumatic injuries. Additionally, with the aging population, elderly individuals are more susceptible to injuries and traumatic osteoarthritis (Li *et al*., 2022b). Traumatic ankle arthritis drastically impacts patients' lives, leading to gait abnormalities, pain, joint stiffness, and in severe cases, limping or even inability to walk. Thus, the treatment of traumatic ankle arthritis is of utmost importance.

In the early stages of traumatic ankle arthritis, various treatment options such as supportive braces, medications, and corrective exercises can be employed. Common therapeutic approaches in clinical practice include ankle arthroscopy and debridement, allograft osteochondral transplantation, ankle joint fusion, joint distraction, and total ankle arthroplasty (Hollawell *et al*., 2023). Nevertheless, traditional open surgical methodologies for treating ankle arthritis are associated with drawbacks such as significant trauma, slow postoperative recovery, and inconsistent outcomes. Additionally, ankle and hindfoot misalignment are common symptoms among patients with post-traumatic ankle osteoarthritis (Deleu *et al*., 2021). Minimally invasive ankle joint fusion, performed arthroscopically, offers advantages over traditional open ankle fusion procedures, including smaller incisions, reduced trauma, and faster postoperative recovery. It effectively enhances patients' ankle function, alleviates pain, and improves quality of life (Buchhorn *et al*., 2022). After appropriate application, ankle joint fusion achieves successful outcomes in approximately 80 % to 85 % of treated patients (Brumat *et al*., 2022). Minimally invasive ankle joint fusion surgery is becoming increasingly popular among patients due to its advantages of minimal tissue damage and shorter hospital stay. Arthroscopic ankle joint fusion is primarily suitable for patients with minimal deformities of the ankle joint. Patients in the acute infection stage or with inadequate soft tissue support for internal fixation are often treated using external fixation methodologies, which can reduce the occurrence of soft tissue complications and inflammation reactions, although there is a potential risk of pin tract infection (Shibuya *et al*., 2023). In comparison to external fixation, internal fixation for ankle joint fusion demonstrates significantly higher success rates and greater convenience (Rüschenschmidt *et al*., 2020). Ankle joint fusion surgery markedly alleviates pain, improves ankle joint function, and contributes to enhancing the condition of surrounding soft tissues. This holds significant importance for the treatment of traumatic ankle osteoarthritis.

With the widespread application of arthroscopic techniques, arthroscopic ankle joint fusion surgery, as a minimally invasive treatment approach, holds significant clinical value. Through further research and expanded application, it holds promise in offering improved therapeutic options for patients with traumatic ankle osteoarthritis, thereby enhancing their ankle function and quality of life. Concurrently, it provides clinicians in related fields with an effective treatment modality and promotes the advancement of trauma-related technologies. The objective of this study was to assess the impact of minimally invasive ankle joint fusion surgery on ankle function, levels of inflammatory factors, and oxidative damage in patients with traumatic ankle osteoarthritis, thus providing a basis for clinical treatment.

MATERIAL AND METHOD

Research object. From January 2022 to January 2023, a total of 112 patients with traumatic ankle arthritis who underwent treatment at our institution were enrolled as study subjects. These patients were randomly assigned into a control group (Group C) and an experimental group (Group E), with 56 patients in each group.

Inclusion criteria: patients diagnosed with traumatic ankle arthritis at our institution; a history of ankle trauma; patients experiencing severe ankle pain; X-ray imaging of the foot showing narrow or absent joint space; presence of osteophytes.

Exclusion criteria: patients with systemic infectious diseases; patients with pyogenic or tuberculous arthritis of the ankle joint; patients with ankle joint tumors; patients with observable dysfunction of vital organs.

Therapeutic methodologies. Group C was treated as follows. Patients underwent open ankle arthrodesis. Patients were placed in a supine position under general anesthesia on the operating table. A lateral arc incision was made to access the lateral aspect of the ankle joint, and the subperiosteal tissue of the fibula was dissected. The fibula was obliquely cut downward above the ankle joint to expose the joint. The tibia, medial malleolus, and talus articular surfaces were debrided, removing necrotic tissue and dead bone. Bone end alignment was corrected to ensure close contact between the talus and tibia. The tibial sliding technique was employed to harvest a 4.0 cm × 2.5 cm full-thickness tibial cortical graft from the anterior lower tibia. This graft was placed at the ankle joint and fixed. A hole was drilled in the talar body and neck, corresponding to the graft, which was then flipped to bridge the hole. A curved intramedullary nail was inserted into the heel base to fix the tibiocalcaneal joint, maintaining the ankle dorsiflexion angle below 10°. Tibia and fibula were also stabilized using screws. Autograft and allograft bone were packed into the ankle

fusion site and compacted with pressure. Postoperatively, X-ray imaging was performed on the patients' ankle and foot to observe whether the midfoot was upright. The incision was then sutured and dressed.

Group E was treated as follows. Patients underwent minimally invasive ankle arthrodesis. Patients were placed in a supine position on the operating table, and bony markers were placed on the blood vessels and nerves at the ankle joint site. Either epidural or general anesthesia was administered. The affected limb was suspended and maintained in dorsiflexion. A longitudinal incision was made on the lateral side of the Achilles tendon, and bony landmarks were established for the ankle joint. Arthroscopy was then used to explore the ankle joint cavity. Chondral fragments, synovial edema, and necrotic tissue within the ankle joint were meticulously removed. Subchondral bone resection was performed to eliminate approximately 1 to 2 mm of bone tissue, ensuring close contact of the joint surfaces and maintaining the ankle mortise in an upright position. Autograft or allograft bone was then introduced into the ankle joint fusion site and compacted with pressure. Intraoperative X-ray examination was conducted to assess the corrected ankle joint position. Two hollow screws were inserted using Kirschner wires and tightened with pressure to ensure fixation. Finally, the incision was closed, sutured, and dressed.

Postoperative treatment. Postoperatively, all patients were required to have their ankle joint on the affected leg immobilized using a plaster cast to prevent displacement during movement. After one and a half months post-surgery, patients were instructed to use crutches for ambulation, with the affected limb avoiding weight-bearing. Limited weight-bearing activities could commence after two months post-surgery. At three months post-surgery, patients could independently practice walking and engage in weight-bearing exercises, and the plaster cast could be removed.

Observation of bone fusion rate after treatment in patients. X-ray imaging was utilized to observe patients' osseous fusion status. Patients were followed up at 3, 6, and 12 months postoperatively to assess osseous fusion rates.

Observation of ankle function of patients before and after treatment. The ankle-hindfoot score, as assessed by the American Orthopedic Foot and Ankle Society (AOFAS) (Fahmy *et al*., 2023), was employed to evaluate patients' foot and ankle functionality, with assessments conducted preoperatively, as well as at 1, 2, and 3 months postoperatively. A score of 100 represented the highest level of functionality recovery, with higher scores indicating better restoration of foot and ankle function.

Observation of limb pain before and after treatment in patients. The visual analog scale (VAS) (Salehi *et al*., 2023) was employed to assess patients' limb pain, with evaluations conducted preoperatively, as well as at 1, 2, and 3 months postoperatively. A score of 10 represented the highest level of pain intensity, with higher scores indicating more severe pain perception.

Observation of ankle joint activity before and after treatment in patients. At one year postoperatively, patients were followed up, and their ankle dorsiflexion function, plantarflexion function, inversion function, and eversion function were assessed using the AOFAS scale.

Detection of oxidative damage indicators and inflammatory factors in the serum of patients before and after treatment. Prior to surgery and at 1 month postoperatively, fasting venous blood samples of 3 mL were collected and centrifuged to obtain supernatants, which were stored at -80 ºC. Enzyme-linked immunosorbent assay (ELISA) was employed to detect serum oxidative damage markers: myoglobin (Myo), malondialdehyde (MDA), total antioxidant capacity (TAC), superoxide dismutase (SOD) levels, and ischemia-modified albumin (IMA). Thermo Scientific MGC 240 biochemical analyzer was utilized to measure serum levels of interleukin-6 (IL-6), high-sensitivity C-reactive protein (hs-CRP), and tumor necrosis factor-alpha (TNF-α) in patients' serum samples.

Data statistics. The data in this study were analyzed using SPSS 26.0. Mean ± standard deviation (M ± SD) was how measurement data were indicated, and between-group comparisons were conducted using the t-test. Quantity data were denoted as percentages (%) and between-group comparisons were performed using the chi-squared test. The significance level was set at $P<0.05$.

RESULTS

Comparison of general information. Group C consisted of 29 male and 27 female patients, with an average age of (61.98±4.79) years and a disease duration of(103.27±21.34) months. The affected site distribution was as follows: 32 cases on the left foot and 24 cases on the right foot. Clinical symptoms included ankle instability in 13 cases, calcaneal fractures in 21 cases, and ankle fractures in 22 cases. Group E comprised 31 male and 25 female patients, with an average age of (62.08±4.62) years and a disease duration of (103.58±20.74) months. The distribution of affected foot sites was 34 cases on the left and 22 cases on the right. Clinical symptoms included ankle instability in 14 cases, calcaneal fractures in 20 cases, and ankle fractures in 22 cases. The age, gender, affected foot site, and clinical symptoms differed

inconsiderably between the two groups (P>0.05), indicating statistical insignificance (Figs. 1 and 2).

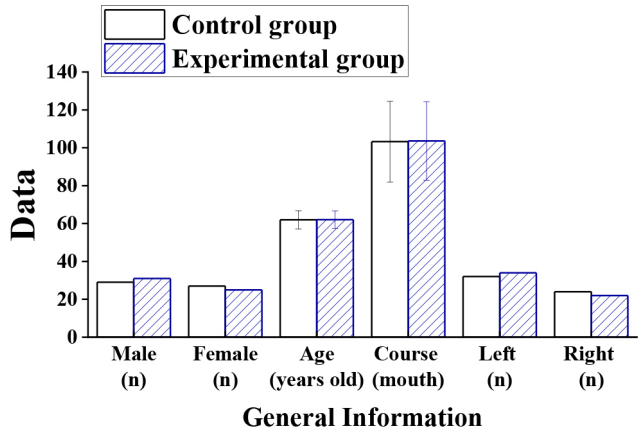


Fig. 1. Comparison of general information between two groups of patients.

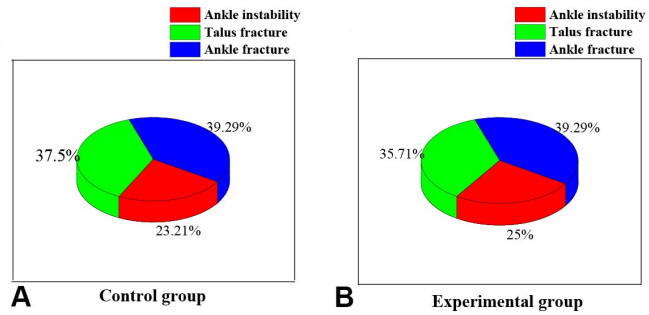


Fig. 2. Comparison of clinical symptoms between two groups of patients. (A represents the proportion of clinical symptoms in Group C, and B represents the proportion of clinical symptoms in Group E).

Comparison of bone fusion rates after treatment. At 3, 6, and 12 months (1 year) following surgical intervention, patients in both groups exhibited progressively increasing osseous fusion rates. Furthermore, patients in Group E displayed markedly higher osseous fusion rates versus those in Group C (P<0.05), indicating statistically considerable differences. At the one-year postoperative mark, both groups of patients achieved a 100 % osseous fusion rate, underscoring that minimally invasive ankle arthrodesis promotes accelerated limb bone fusion. Figure 3 shows the comprehensive visual representation.

Comparison of AOFAS scale scores before and after treatment. Before surgery, the AOFAS scores differed slightly between the two patient groups (P>0.05), indicating statistical insignificance. Nevertheless, at 1, 2, and 3 months postoperatively, AOFAS scores in both groups increased with the passage of time. Moreover, at the same time points, patients in Group E exhibited markedly higher AOFAS scores relative to patients in Group C (P<0.05) (Fig. 4).

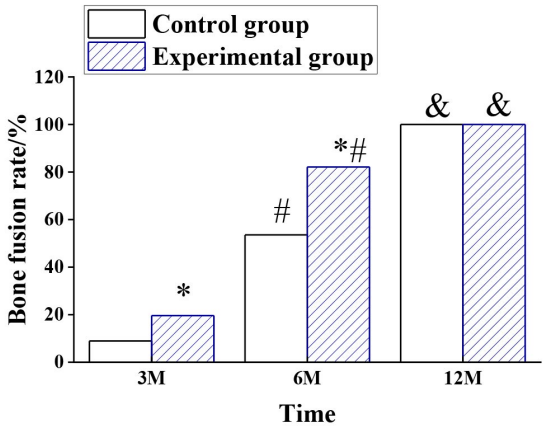


Fig. 3. Comparison of bone fusion rates between two groups of patients after treatment. Note: *P<0.05 vs. Group C; #P<0.05 vs. 3M; &P<0.05 vs. 6M.

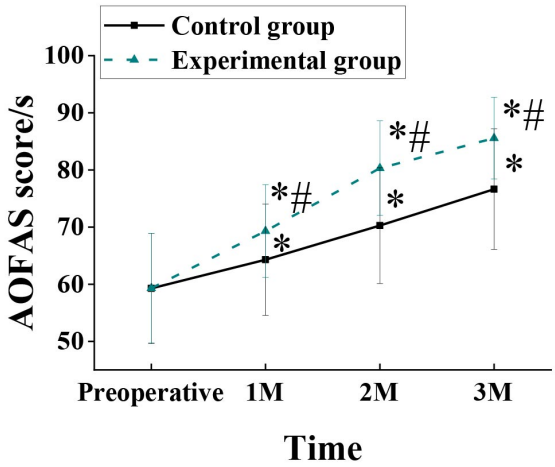


Fig. 4. Comparison of AOFAS scale scores between two groups of patients before and after treatment. Note: #P<0.05 vs. Group C; *P<0.05 vs. preoperative.

Comparison of VAS scale scores before and after treatment. Before surgery, no substantial differences were indicated in VAS scores between the two patient groups (P>0.05), indicating statistical insignificance. Nevertheless, at 1, 2, and 3 months postoperatively, VAS scores in both groups progressively decreased with the passage of time. Moreover, at the same time points, patients in Group E exhibited greatly lower VAS scores compared to patients in Group C (P<0.05) (Fig. 5).

Comparison of ankle joint activity before and after treatment between two groups of patients. In Figure 6, the results demonstrate that a year post-surgery, patients in Group E exhibited notably higher scores in inversion function, eversion function, dorsiflexion function, and plantarflexion function evaluations relative to patients in Group C (P<0.05), signifying notable differences.

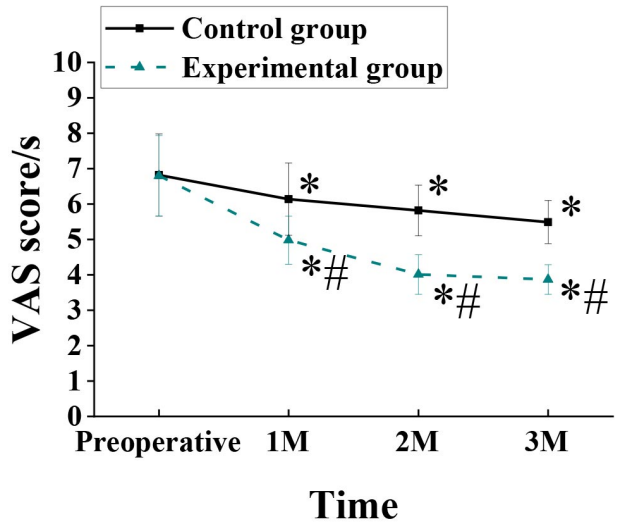


Fig. 5. Comparison of VAS scale scores between two groups of patients before and after treatment. Note: #*P*<0.05 vs. Group C; **P*<0.05 vs. preoperative.

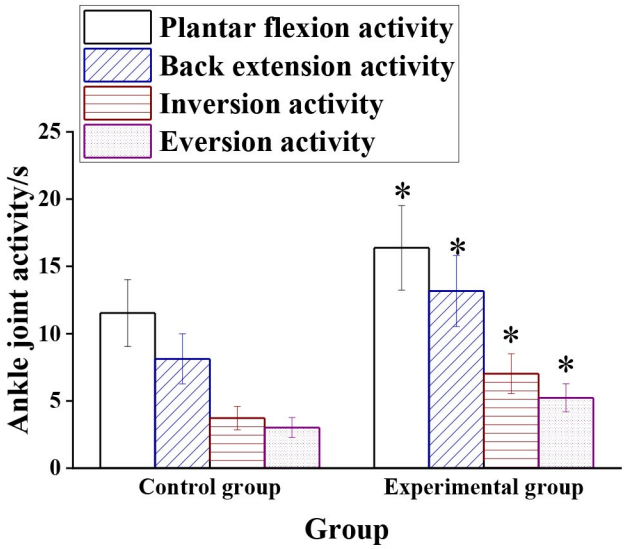
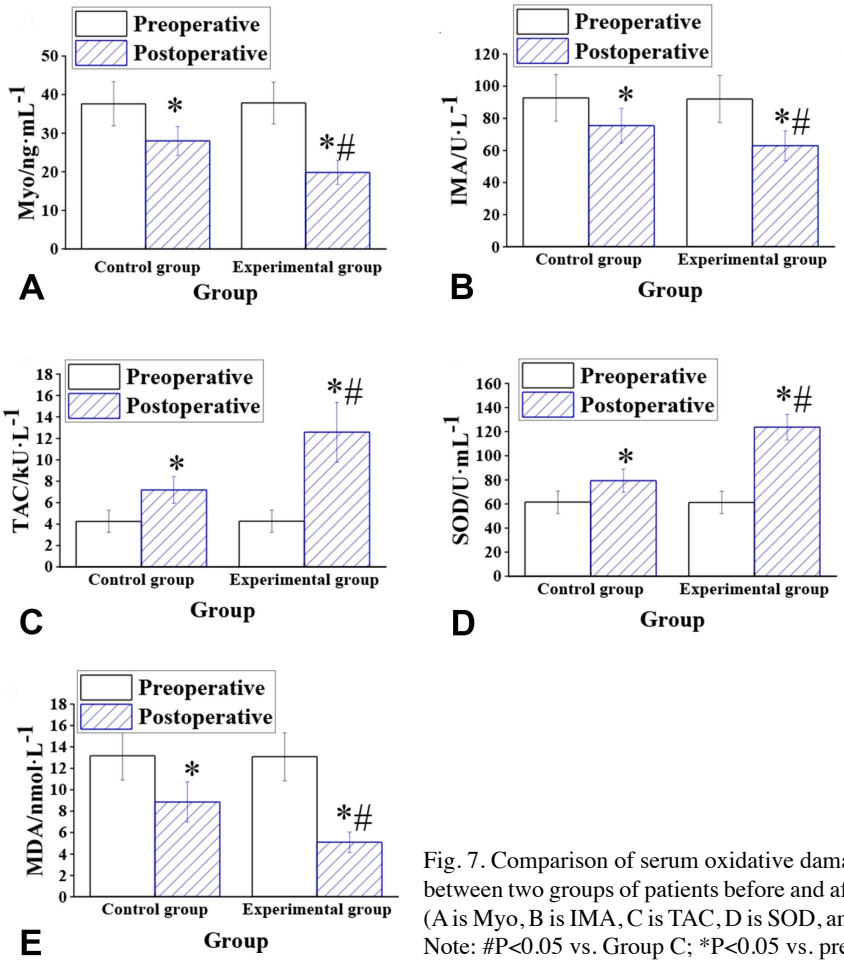


Fig. 6. Comparison of ankle joint activity before and after treatment between two groups of patients. Note: #*P*<0.05 vs. Group C.



Comparison of serum oxidative damage indicators before and after treatment. In Figure 7, before surgery, the serum oxidative damage markers, including Myo, IMA, TAC, SOD, and MDA levels, differed slightly between the two patient groups (*P*>0.05), indicating statistical insignificance. One month after surgical intervention, levels of serum oxidative damage markers Myo, IMA, and MDA were markedly reduced in both groups versus baseline. Moreover, Group E exhibited a more pronounced reduction in Myo, IMA, and MDA levels versus Group C (*P*<0.05), signifying marked differences. Serum oxidative damage markers TAC and SOD levels were notably increased in both groups after treatment, with Group E showing a more substantial elevation in TAC and SOD levels versus Group C (*P*<0.05).

Fig. 7. Comparison of serum oxidative damage indicators between two groups of patients before and after treatment. (A is Myo, B is IMA, C is TAC, D is SOD, and E is MDA), Note: #P<0.05 vs. Group C; *P<0.05 vs. preoperative.

Comparison of serum inflammatory factor levels before and after treatment. In Figure 8, the inflammatory cytokine levels differed inconsiderably between the two patient groups before surgery (P>0.05), indicating statistical insignificance. One month after surgery, levels of inflammatory cytokines IL-6, TNF-α, and hs-CRP in both groups were markedly decreased versus baseline, with a more pronounced reduction observed in Group E when relative to Group C (P<0.05).

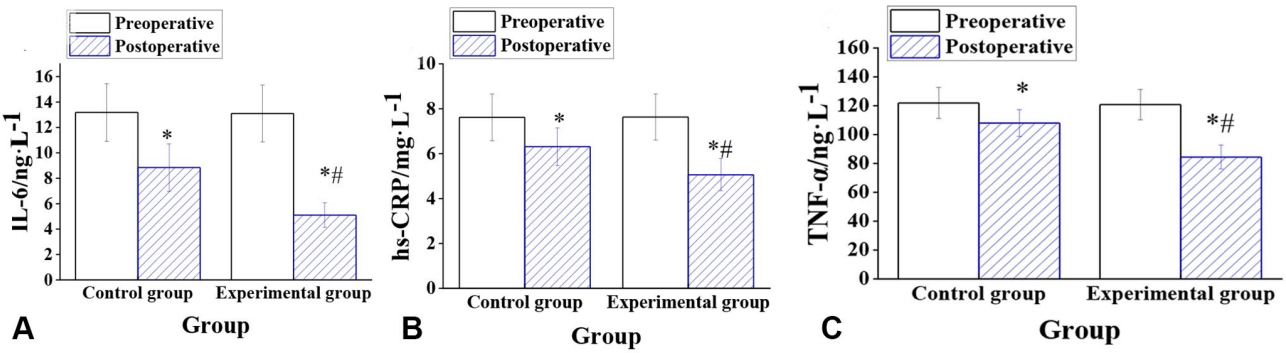


Fig. 8. Comparison of serum inflammatory factor levels between two groups of patients before and after treatment. (A is IL-6, B is hs-CRP, and C is TNF-α) Note: #P<0.05 vs. Group C; *P<0.05 vs. preoperative.

DISCUSSION

Traumatic ankle arthritis is primarily manifested by ankle joint pain and impaired functional mobility in patients (Xu *et al*., 2022). The normal articular surface of the ankle joint is covered by a layer of dense, white connective tissue known as cartilage, which serves to distribute the load-bearing forces across a larger area, thereby reducing contact stress. Additionally, this cartilaginous layer facilitates relative motion of the joint surfaces with minimal friction and wear. Nevertheless, the regenerative capacity of articular cartilage is relatively limited, rendering it susceptible to damage under excessive loads (Feng *et al*., 2022; Weinraub & Vijayakumar, 2023). In cases where ligamentous injuries or ankle fractures occur, and appropriate alignment therapy is not promptly administered, uneven restoration of the joint surface ensues. This disrupts the equilibrium of load dispersion within the joint, leading to prolonged exposure to such conditions, resulting in surface erosion and eventual cartilage necrosis. Consequently, the stability of the ankle joint diminishes substantially, culminating in persistent pain, muscular spasms, and constrained mobility in advanced stages (Li *et al*., 2022a).

Regarding the clinical management of traumatic ankle arthritis, non-surgical interventions encompass pharmacotherapy, orthodontic correction, and physical therapy. Nevertheless, these approaches serve solely as adjunctive measures and do not comprehensively eradicate the pathology of traumatic ankle arthritis (Danilkowicz *et al*., 2022). Surgical interventions primarily comprise joint replacement, joint reshaping, and ankle arthrodesis. Ankle arthrodesis proves effective in mitigating patient pain, arresting degenerative cartilaginous changes within the ankle joint, and exhibits broad applicability in cases of traumatic ankle arthritis, while being cost-efficient. This study predominantly employs minimally invasive ankle arthrodesis for the treatment of traumatic ankle arthritis, which fosters fusion between the ankle joint and surrounding tissues. Unlike the conventional approach of using intramedullary nails for single-point fusion between the talus and tibia, minimally invasive ankle arthrodesis allows for multi-point fusion, thus expanding the fusion interface and potentially enhancing bone fusion rates (Lee *et al*., 2023). Furthermore, open surgical procedures entail larger incisions, which may compromise local vasculature during periosteal dissection of the tibia, consequently impacting limb recovery. Conversely, minimally invasive ankle arthrodesis inflicts less damage on the local ankle joint tissues and the surrounding soft tissues, thereby augmenting the efficiency of bone fusion (Abuhantash *et al*., 2022). In this study, the results revealed a markedly higher osseous fusion rate in Group E patients compared to those in Group C, particularly evident at 6 months post-surgery. In Group E, the osseous fusion rate had reached 82.14 %, whereas Group C exhibited only 53.57 % fusion rate. These findings indicate that minimally invasive ankle arthrodesis can promote osseous fusion and expedite the rehabilitation process. In China, open ankle arthrodesis has been utilized for a longer duration, and research suggests that patients with severely distorted ankle joints may require open ankle arthrodesis, necessitating layer-by-layer tibial exposure to achieve visualization. Nevertheless, this approach prolongs surgical duration and inflicts significant soft tissue damage (Vier & Irwin, 2022).

In contrast, minimally invasive ankle arthrodesis entails smaller incisions and offers enhanced recovery efficiency (Lorente *et al*., 2023). The results indicate that patients in Group E exhibited significantly elevated scores on the AOFAS scale and VAS scale after surgery compared to Group C. Furthermore, postoperative scores for dorsiflexion, plantarflexion, inversion, and eversion activities were notably higher in Group E when compared to Group C. These findings underscore the pronounced advantages of minimally invasive ankle arthrodesis in terms of restoring ankle joint mobility. This implies that minimally invasive ankle arthrodesis is more effective in improving ankle joint function and alleviating patient pain levels. In comparison to open ankle arthrodesis, arthroscopic ankle arthrodesis requires only small incisions on the medial and lateral sides of the ankle, thus reducing both the initial incision and suture length. Additionally, the use of reamers during joint surface preparation enhances the preservation of bone contours, thereby facilitating fusion between the bone ends and joint surfaces. The combination of minimal incisions and high fusion rates accelerates the recovery of foot and ankle functionality in patients and reduces the duration of pain experienced by the patients (Martinelli *et al*., 2022).

Research has indicated that traumatic ankle arthritis can lead to significant pain, and both surgical anesthesia and postoperative pain exacerbate the perception of pain. Surgical trauma triggers imbalances in various factors within the patient's body. Trauma and pain induce oxidative stress and inflammatory responses in the body (Ochocki *et al*., 2022). Postoperative patients in orthopedics experience localized pain and restricted mobility, which can contribute to complications such as pneumonia, venous thrombosis, and pressure ulcers. During oxidative stress reactions, levels of Myo, IMA, and MDA in the patient's serum decrease, while levels of TAC and SOD increase. The results revealed that postoperative serum levels of oxidative damage markers, including Myo, IMA, MDA, TAC, and SOD, were imbalanced in both groups of patients. Nevertheless, the changes in serum levels of these oxidative damage markers were less pronounced in Group E, indicating a less pronounced imbalance compared to Group C. This suggests that minimally invasive ankle arthrodesis can mitigate the extent of oxidative damage and enhance antioxidant capacity. IL-6, TNF-a, and hs-CRP are significant inflammatory factors within the body, with their levels rising during inflammatory responses. The results demonstrate that in Group E of patients, serum levels of inflammatory factors IL-6, TNF-a, and hs-CRP were significantly reduced one month after surgical treatment, and these differences were notable compared to Group C. This indicates that minimally invasive ankle arthrodesis can effectively decrease the intensity of inflammatory reactions. The smaller incisions associated with minimally invasive ankle arthrodesis may lead to less severe inflammatory responses in the patients' bodies compared to open ankle arthrodesis, thereby enhancing the efficiency of recovery from the inflammatory reaction.

In summary, minimally invasive ankle arthrodesis offers advantages such as reduced surgical trauma, faster recovery, and favorable outcomes. The results demonstrated that minimally invasive ankle arthrodesis can enhance osseous fusion rate, ankle joint functionality, pain levels, and ankle joint range of motion. Moreover, postoperative elevation in serum levels of TAC and SOD, coupled with reduction in Myo, IMA, MDA, IL-6, hs-CRP, and TNF-a levels, indicates that minimally invasive ankle arthrodesis may alleviate oxidative damage and inflammatory reactions. This could be attributed to the surgery's potential to reduce the secretion of arthritic cytokines and improve local blood supply. Consequently, this technique presents a viable and effective option for the treatment of ankle joint disorders.

CONCLUSION

Minimally invasive ankle arthrodesis proves effective in enhancing foot and ankle functionality among traumatic ankle arthritis patients while reducing levels of oxidative damage and inflammatory responses. This presents a significant option for clinical treatment. Nevertheless, it's important to note that this study has a relatively small sample size. Further research with a larger sample size and long-term follow-up is necessary to validate its long-term efficacy and safety.

CHEN, B.; TAN, F. & LI, X. Evaluación de la función del tobillo, el daño oxidativo y los niveles de factores inflamatorios en la cirugía mínimamente invasiva de fusión de la articulación del tobillo para el tratamiento de la osteoartritis traumática del tobillo. *Int. J. Morphol., 42(2)*:462-469, 2024.

RESUMEN: La osteoartritis traumática del tobillo es una afección degenerativa resultante de lesiones traumáticas. El objetivo de este estudio fue evaluar el impacto de la cirugía mínimamente invasiva de fusión de la articulación talocrural sobre la función del tobillo, el daño oxidativo y los niveles de factor inflamatorio en pacientes con osteoartritis traumática del tobillo. Se inscribieron un total de 112 pacientes con artrosis traumática de tobillo tratados en nuestro hospital desde enero de 2022 hasta enero de 2023. Fueron divididos aleatoriamente en un grupo de control (Grupo C) y un grupo experimental (Grupo E), donde el primero se sometió a una cirugía de fusión de la articulación talocrural abierta convencional y el segundo recibió una cirugía de fusión de la articulación talocrural mínimamente invasiva. Se realizó una comparación entre los dos grupos según la Sociedad Estadounidense de Ortopedia de Pie y Tobillo (AOFAS), las tasas de fusión ósea y las puntuaciones de la escala visual analógica (EVA) antes de la operación y 1, 2 y 3

meses después de la operación. Además, se midieron los indicadores de daño oxidativo sérico y los niveles de factor inflamatorio para evaluar los efectos de la recuperación en ambos grupos. En relación con el grupo C, el grupo E mostró puntuaciones AOFAS y tasas de fusión ósea drásticamente aumentadas (P <0,05), así como puntuaciones VAS muy disminuidas (P <0,05). Además, el grupo E exhibió mejoras más pronunciadas en los indicadores de daño oxidativo y factores inflamatorios en comparación con el grupo C (P <0,05). La cirugía de fusión de la articulación talocrural mínimamente invasiva mejora drásticamente la función del tobillo en pacientes con osteoartritis traumática del tobillo y reduce los niveles de daño oxidativo y la respuesta inflamatoria. Esto proporciona una importante opción de tratamiento clínico.

PALABRAS CLAVE: Cirugía de fusión de la articulación talocrural mínimamente invasiva; Función del tobillo; Daño por estrés oxidativo; Artrosis traumática del tobillo.

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