

THE EURASIA PROCEEDINGS OF HEALTH, ENVIRONMENT AND LIFE SCIENCES



VOLUME 18 ICMEHELS CONFERENCE

ISSN: 2791-8033

ISBN: 978-625-6959-78-1

ICMEHELS 2025: 5th International Conference on Medical, Health and Life Sciences (ICMeHeLS)

July 10 - 13, 2025

Peja, Kosovo

Edited by: Mehmet Ozaslan (Chair), Gaziantep University, Türkiye

ICMEHELS 2025

5th International Conference on Medical, Health and Life Sciences (ICMeHeLS)

Proceedings Book

Editor

Mehmet Ozaslan
Gaziantep University, Türkiye

ISBN: 978-625-6959-78-1

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Published by the ISRES Publishing

Address: Askan Mah. Akinbey Sok. No: 5-A/Konya/Türkiye

Web: www.isres.org

Contact: isrespublishing@gmail.com

Dates: July 10 - 13, 2025

Location: Peja, Kosovo

<https://2025.icmehels.net/>



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Aims & Scope

Compared to other fields, developments and innovations in the fields of medical and health sciences are very fast. In this century, where the human population is rapidly increasing and technology is developing rapidly, health problems are constantly changing and new solutions are constantly being brought to these problems. With the Covid 19 epidemic, it has emerged that a health problem affects all humanity and all areas of life. For this reason, this conference focused on the changes and innovations in the field of Medical and Health Sciences.

The aim of the conference is to bring together researchers and administrators from different countries, and to discuss theoretical and practical issues of Medical and Health Sciences. At the same time, it is aimed to enable the conference participants to share the changes and developments in the field of Medical and Health Sciences with their colleagues.

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The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELs), 2025

Volume 18, Pages 1-4

ICMeHeLS2025: International Conference on Medical, Health and Life Sciences

Low Levels of Testosterone as a Risk Factor of Hip Fractures in Men Above the Age of Sixty-Five - A Case Series Study

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Abstract: Hip fractures are a major cause of morbidity and mortality in elderly men. Various factors contribute to hip fractures, including osteoporosis, falls, and metabolic imbalances. Recent research suggests that hormonal deficiencies, particularly low testosterone levels, may play a crucial role in bone health and fracture risk. The aim of this study is to evaluate the correlation between low testosterone levels and hip fractures in men above the age of sixty-five. This case series study was conducted at the University Clinic for Surgical Diseases ‘St. Naum Ohridski – Skopje’ in North Macedonia. The study included 10 male patients above 65 years of age who presented with hip fractures, while the control group comprised 10 randomly selected age- and race-matched men without fractures. Testosterone and Vitamin D levels were measured in both groups. The average testosterone levels in the fracture group were 181.97 ng/dl, whereas in the control group, they were 360.006 ng/dl. Average Vitamin D levels in the fracture group were 9.185 ng/ml, compared to 21.232 ng/ml in the control group. These findings suggest that low levels of testosterone and Vitamin D may be significant risk factors for hip fractures in men over 65 years old. Further research is required to establish definitive prevention protocols incorporating hormonal assessments for elderly males at risk of fractures.

Keywords: Testosterone, Hip fracture, Osteoporosis, Prevention protocols, Vitamin D

Introduction

Osteoporosis is becoming a world – wide concern in the elderly population. A significant cause of morbidity and mortality among elderly individuals are hip fractures, especially in men above 65 years of age (Cooper et al., 1992). Osteoporosis, falls and metabolic imbalances also contribute to hip fractures (Cummings & Melton, 2002). Hormonal deficiencies especially low levels of testosterone have an important role in bone density and the risk of hip fracture (Golds et al., 2017). Bone mineral density (BMD) and muscle strength, which are critical factors for fracture prevention, depend on testosterone levels (Shigehara et al. 2021). The aim of this study is to find out whether low levels of testosterone and vitamin D contribute to hip fractures in elderly men. In addition, we want to evaluate the necessity of forming prevention protocols for osteoporosis in men above 65 years old.

Method

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- Selection and peer-review under responsibility of the Organizing Committee of the Conference

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This case series study was conducted at the University Clinic for Surgical Diseases ‘St. Naum Ohridski – Skopje’ in North Macedonia during the period February 2022 – October 2022. The participants of this study are 20 male patients above the age of 65, of which 10 male participants are patients with hip fractures admitted to the hospital for further treatment and 10 male age- and race – matched participants without hip fracture who are randomly selected from the outpatient clinic. Patients with pathological fractures (metastatic disease), chronic corticosteroid therapy, chronic liver and kidney disease, active malign disease, acute hypogonadism (surgical or pharmacological castration), chronic alcoholism and patients who refuse consent to participate are excluded from this study.

Data Collection

Laboratory testing was done to all the participants in order to determine testosterone and vitamin D levels. The blood was taken between 07 – 10 am having in consideration the circadian rhythm. Testosterone levels were measured using chemiluminescent immunoassay (ng/dl) while Vitamin D Levels were measured using electrochemiluminescence immunoassay (ng/ml). The data from the laboratory results were analyzed. Comparative and descriptive methods were used to analyze the levels of testosterone and Vitamin D between the fracture and control groups.

Results and Discussion

The results show a significant difference between the fracture and control group. The average age in the fracture group is 80.8 years, 93 being the oldest and 71 being the youngest participant. The average age in the control group is 73.5 years, 93 being the oldest and 66 being the youngest participant. The average level of testosterone in the fracture group is 181.97 ng/dl, 395.29 ng/dl being the highest and 9.02 ng/dl being the lowest value. The average testosterone in the control group is 360.006 ng/dl, 548.38 ng/dl being the highest and 33.71 ng/dl being the lowest value. The average level of vitamin D in the fracture group is 9.185 ng/ml, 19.89 ng/ml being the highest and 3 ng/ml being the lowest value. The average level of vitamin D in the control group is 21.232 ng/ml, 35.33 ng/ml being the highest and 13.21 ng/ml being the lowest value (Table 1).

Table 1. Average values in fracture and control groups

Group	Average age (years)	Age range (years)	Average testosterone (ng/dl)	Testosterone range (ng/dl)	Average Vitamin D (ng/ml)	Vitamin D range (ng/ml)
Fracture group	80.8	71 – 93	181.97	9.02 – 395.29	9.185	3 – 19.89
Control group	73.5	66 – 93	360.006	33.71 – 548.38	21.232	13.21 – 35.33

According to these results, there is a significant difference in the levels of testosterone and Vitamin D between the fracture and the control group. The average testosterone levels from the control group are twice higher than the average testosterone levels from the fracture group (Figure 1). In addition, the average Vitamin D levels from the control group are 2.3 times higher than the average Vitamin D levels from the fracture group (Figure 2).

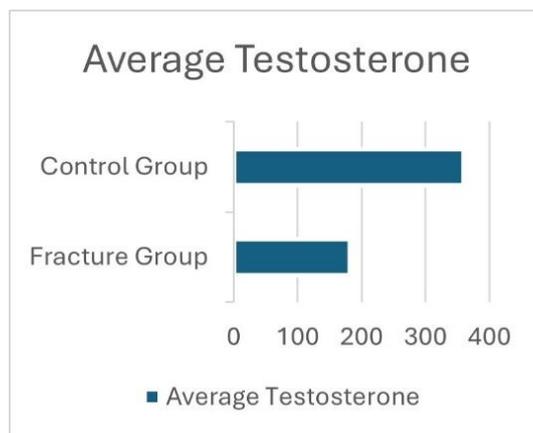


Figure 1. Average testosterone level

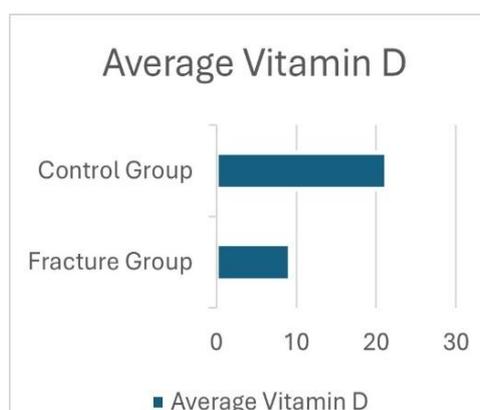


Figure 2. Average Vitamin D level

According to the results, the participants with hip fracture had significant lower testosterone and Vitamin D levels in comparison to the control group. This suggests that there may be a correlation between low levels of testosterone and Vitamin D with hip fractures in men above the age of 65. Testosterone levels enhance bone mineral density (BMD) and muscle strength which are critical factors for fracture prevention (Shigehara et al., 2021). Similarly, low levels of Vitamin D decrease calcium absorption and contribute to bone fragility (Dawson-Hughes et al., 1997). Low levels of testosterone correlate with increased hip fracture risk as a consequence of reduced bone strength in men above the age of 65. In addition, maintaining normal levels of Vitamin D helps in the prevention of hip fractures in elderly individuals (Han et al. 2020). According to the results, there is a need for well standardized screening in elderly men, who then might join a well-designed preventive protocol against hip fractures. We have to keep in mind that the sample size of this study is limited in the number of participants. On the other hand, these results suggest that further research with a larger number of participants is needed in order to have statistically relevant results.

Conclusion

This study emphasizes the eventual correlation between low levels of testosterone and Vitamin D with hip fractures in men older than 65 years of age. Even though this study has a small number of participants, the results suggest that there should be a well-established screening protocol for men above the age of 65 and hormonal supplementation therapies should also be incorporated in the prevention protocols to lower the risk of hip fractures in this population.

Recommendations

According to our results and analysis of this study we recommend testosterone and Vitamin D screening for all men above the age of 65 and hormonal supplementation protocols for those in need. We also recommend educational courses for healthcare providers to increase the awareness about this important topic.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPHELS journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest.

Funding

* This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements or Notes

* This article was presented as an oral presentation at the International Conference on Medical, Health and Life Sciences (www.icmehels.net) held in Peja/Kosovo on July 10-13, 2025.

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To cite this article:

Bekteshi, L., Nikolikj, K., Trpeski, S., & Nastov, N. (2024). Low levels of testosterone as a risk factor of hip fractures in men above the age of sixty-five - A case series study. *The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELS)*, 18, 1-4.

The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELs), 2025

Volume 18, Pages 5-9

ICMeHeLS 2025: International Conference on Medical, Health and Life Sciences

Isolation and Identification of Pathogenic Bacteria from Dead Fish in Rainbow Trout (*Oncorhynchus mykiss*) Farms in Türkiye

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Abstract: Aquaculture has emerged as an important component of global food security, and rainbow trout (*Oncorhynchus mykiss*) is among the most commercially valuable freshwater species. However, the intensification of trout farming has made fish populations increasingly vulnerable to bacterial infections, posing serious threats to both animal welfare and economic sustainability. This study was conducted to systematically isolate and identify the dominant bacterial pathogens involved in trout mortality cases observed in aquaculture farms in two geographically and climatically distinct regions of Türkiye (Gaziantep and Antalya). A total of 60 lethal fish samples were subjected to integrated microbiological diagnosis combining traditional culture-based methods (including Gram staining and a series of biochemical tests) with high-resolution proteomic identification methods via Matrix-Assisted Laser Desorption/Ionization–Time of Flight Mass Spectrometry (MALDI-TOF MS). Most of the isolates were taxonomically classified as *Aeromonas hydrophila*, *Yersinia ruckeri*, *Pseudomonas fluorescens*, and *Flavobacterium psychrophilum*, pathogens known to play a role in systemic and opportunistic infections in cold-water fish species. The spatial distribution of these bacterial agents revealed significant ecological variability, indicating a strong correlation between pathogen prevalence and environmental parameters such as water temperature, rearing conditions, and geographical location. In particular, MALDI-TOF MS provided high-accuracy species-level identification and showed over 90% agreement with traditional biochemical classification, thereby highlighting its utility as a rapid and reliable diagnostic tool for surveying aquatic diseases. In addition to its etiological importance, the study also provides region-specific epidemiological information on the spatial distribution of bacterial pathogens under changing environmental conditions. By offering this dual perspective, the research provides critical information for the development of targeted disease management frameworks and advocates for the integration of molecular diagnostics and sustainable biological control applications in the aquaculture industry.

Keywords: Aquaculture, Bacterial pathogens, Rainbow trout, MALDI-TOF MS, Fish health, Microbiology

Introduction

Rainbow trout (*Oncorhynchus mykiss*) is one of the most widely cultured freshwater fish species globally and in Türkiye, due to its rapid growth and high tolerance to environmental fluctuations. As of 2022, Türkiye ranks among the leading producers in Europe, with an annual production exceeding 160,000 tons (FAO, 2022). However, this intensive aquaculture activity puts considerable pressure on fish health, increasing the incidence and spread of bacterial diseases (Austin & Austin, 2016).

Stress factors such as temperature fluctuations, overstocking, poor water quality, changes in feed, and transportation suppress the immune system of fish, facilitating infection by pathogenic microorganisms (Roberts, 2012). Among these, bacterial infections are particularly significant, causing high mortality rates and substantial economic losses in aquaculture operations (Decostere et al., 2000).

Common pathogenic bacteria in rainbow trout include *Aeromonas hydrophila*, *Yersinia ruckeri*, *Flavobacterium psychrophilum*, *Pseudomonas fluorescens*, and *Lactococcus garvieae*. These microorganisms are capable of inducing both acute and chronic infections, complicating the diagnosis and treatment of diseases (Noga, 2010). Accurate isolation and identification of these pathogens are therefore essential for early detection and the development of effective treatment strategies (Cipriano, 2001).

This study aims to isolate and identify bacterial pathogens from dead fish collected from trout farms in different regions of Türkiye. By providing updated and region-specific data on bacterial prevalence and distribution, the study seeks to contribute to the development of sustainable disease management strategies in Turkish aquaculture.

Method

This study was conducted in three commercial rainbow trout (*Oncorhynchus mykiss*) farms located in the Southeastern Anatolia and Mediterranean regions of Türkiye. Sampling was performed during periods of increased fish mortality between September and March. A total of 60 dead fish were collected and transported to the laboratory in sterile bags within ice-cooled containers. Each specimen was examined macroscopically for external and internal pathological signs, including surface lesions, gill color, eye condition, bloating, and lesions in the mouth, pharynx, liver, and kidney (Noga, 2010).

Samples were taken from the kidney, liver, spleen, and gill tissues. These tissues were homogenized on slides sterilized with 70% ethanol using a sterile scalpel. The homogenates were inoculated onto Blood Agar (5% sheep blood) and Tryptic Soy Agar (TSA) and incubated at 25–37°C for 24–72 hours (Austin & Austin, 2016). Colonies exhibiting distinct morphological features were selected and subcultured for purification. Gram staining was performed to determine the bacterial cell wall structure, and characteristics such as cell morphology, pigment production, and hemolysis patterns were evaluated. Standard biochemical tests were used to characterize the isolates, including oxidase, catalase, indole, methyl red, H₂S production, urease activity, and hemolysis tests. These tests allowed for the identification of bacterial metabolic activities (Cipriano, 2001).

To confirm the identity of selected isolates and validate classical methods, MALDI-TOF MS (Matrix-Assisted Laser Desorption/Ionization–Time of Flight Mass Spectrometry) analysis was performed. This technique compares the bacterial protein profile against a reference library and provides highly accurate identification (Clark et al., 2013). The frequencies and distributions of the identified bacterial species were statistically evaluated. Variations between farms were compared and results were presented using Microsoft Excel and SPSS 26.0 through tables and graphs.

Results and Discussion

During the study, 60 dead rainbow trout were collected from two farms in Gaziantep and one farm in Antalya. Macroscopic examination revealed common signs of bacterial infection, including pale gills, hemorrhagic skin lesions, abdominal bloating, and swim bladder abnormalities. These signs were consistent with systemic bacterial infections typically observed in aquaculture settings (Noga, 2010).

A total of 72 bacterial isolates were obtained from various tissues, including the surface, gills, liver, and kidney. Colony growth was observed predominantly on TSA and blood agar media within 24–48 hours of incubation.

Gram staining results showed that 62% of the isolates were Gram-negative rods, 28% were Gram-positive cocci, and 10% were Gram-positive rods. The biochemical characterization revealed that *Aeromonas spp.* was the most frequently isolated genus (46%), followed by *Enterococcus spp.* (26.6%), *Pseudomonas spp.* (18.3%), and *Lactococcus garvieae* (13.3%). Less frequent isolates included *Acinetobacter spp.*, *Flavobacterium spp.*, *Bacillus spp.*, and *Micrococcus spp.* (Table 1)

Table 1. Prevalence of bacterial isolates identified from trout farms

Bacterial Species	Number of Isolates	Percentage (%)
<i>Aeromonas spp.</i>	28	46.0
<i>Enterococcus spp.</i>	16	26.6
<i>Pseudomonas spp.</i>	11	18.3
<i>Lactococcus garvieae</i>	8	13.3
<i>Acinetobacter spp.</i>	7	11.6
<i>Flavobacterium spp.</i>	6	10.0
Others (e.g., <i>Bacillus</i>)	9	15.0

The identification results were further confirmed by MALDI-TOF MS for 50 selected isolates. The protein profiles obtained from MALDI-TOF analysis matched classical methods with approximately 90% consistency. Particularly accurate identifications were achieved for *Aeromonas* and *Pseudomonas* species, supporting previous findings on the efficacy of this method (Clark et al., 2013).

Comparison of farms revealed notable differences in bacterial prevalence. In Gaziantep farms, *Aeromonas hydrophila* and *Pseudomonas fluorescens* were dominant, while in the Antalya farm, *Lactococcus garvieae* and *Aeromonas veronii* were more prevalent. These variations may be attributed to environmental factors such as water temperature, hygiene practices, stocking density, and feeding regimes.

Organ-specific distributions also showed clear trends. *Aeromonas spp.* were more prevalent in internal organs like the liver and kidney, indicating systemic infection potential. In contrast, *Enterococcus spp.* were more commonly isolated from the mouth, pharynx, and cloacal regions, suggesting a gastrointestinal origin. *Pseudomonas spp.* and *Acinetobacter spp.* were mostly found on the surface and gills, pointing to environmental opportunism. These findings are in line with previous studies reporting similar bacterial profiles in Turkish trout farms (Altınok & Kurt, 2003; Kara et al., 2021). Furthermore, the higher detection of *Flavobacterium psychrophilum* in the cooler waters of Antalya supports the known psychrophilic nature of this pathogen.

Conclusion

This study successfully identified the dominant pathogenic bacteria present in dead rainbow trout (*Oncorhynchus mykiss*) from aquaculture farms in Turkey, with a particular focus on regional and environmental variations. The most frequently isolated pathogens were *Aeromonas hydrophila*, *Enterococcus spp.*, *Pseudomonas fluorescens*, and *Lactococcus garvieae*. These bacteria are known to cause significant health problems and economic losses in the aquaculture industry. The use of MALDI-TOF MS significantly improved the accuracy and speed of bacterial identification and showed strong agreement with classical biochemical methods. The observed regional differences in pathogen prevalence underscore the importance of localized monitoring and farm-specific disease management strategies.

Overall, the findings contribute valuable data for developing more effective and sustainable health management protocols in trout farming. Early diagnosis, environmental monitoring, and the integration of advanced diagnostic tools such as MALDI-TOF MS are essential for improving fish health and reducing the impact of bacterial diseases in aquaculture systems.

Recommendations

Based on the results of this study, the following recommendations are proposed to enhance fish health and disease management in trout farming:

- **Routine Microbiological Surveillance:** Regular monitoring of bacterial pathogens should be implemented in aquaculture facilities to detect infections at an early stage and to prevent widespread outbreaks.

- *Molecular and Antibiotic Resistance Profiling*: Future studies should incorporate molecular techniques such as 16S rRNA sequencing and antibiotic susceptibility tests to better understand the genetic characteristics and resistance profiles of isolated bacteria.
- *Alternative Control Strategies*: Sustainable approaches such as bacteriophage therapy, probiotics, and vaccination should be explored as alternatives to traditional antibiotic use, which may lead to antimicrobial resistance.
- *Farm-Specific Disease Management*: Environmental parameters like water temperature, oxygen levels, and stocking density should be optimized based on regional pathogen profiles to minimize disease risk.
- *Capacity Building and Training*: Aquaculture workers should be trained in disease identification, biosecurity practices, and hygienic management to strengthen farm resilience against bacterial outbreaks.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPHELS journal belongs to the authors.

* This study was conducted in accordance with ethical and legal standards applicable to research involving animal specimens. Prior to the initiation of the study, ethical approval was obtained from the Gaziantep University Local Ethics Committee for Animal Experiments (HADYEK). In addition, official permission for the collection of fish samples from commercial aquaculture farms was granted by the Gaziantep Provincial Directorate of Agriculture and Forestry, Ministry of Agriculture and Forestry of the Republic of Türkiye.

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Funding

* This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements or Notes

* This article was presented as an oral presentation at the International Conference on Medical, Health and Life Sciences (www.icmehels.net) held in Peja, Kosovo, on July 10–13, 2025.

* This study was carried out as part of the author's MSc thesis at Gaziantep University, Institute of Natural and Applied Sciences, Department of Biology.

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To cite this article:

Boyraz, E. F., Kilic, I. H., Vural, U., Celik, Z., Cilkiz, M., & Polat, A. (2025). Isolation and identification of pathogenic bacteria from dead fish in rainbow trout (*Oncorhynchus mykiss*) farms in Türkiye. *The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELS)*, 18, 5-9.

The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELs), 2025

Volume 18, Pages 10-17

ICMeHeLS 2025: International Conference on Medical, Health and Life Sciences

Arthroscopy in Acute Ankle Fractures: A Weber Classification-Based Analysis

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Abstract: Ankle fractures are common orthopedic injuries, often treated with open reduction and internal fixation (ORIF). However, 21% to 45% of patients report unsatisfactory outcomes, possibly due to intraarticular pathology. This study aimed to assess these injuries arthroscopically and statistically analyse their prevalence and relation to the Weber classification. A prospective cohort study was conducted on 48 patients with acute ankle fractures at the University Clinic for Surgical Diseases “St. Naum Ohridski” from January 2020 to January 2023. Patients underwent standard preoperative radiographic examinations and were classified according to the Weber classification, followed by arthroscopic intraarticular examination and ORIF. The arthroscopic examination evaluated syndesmotic injury, chondral lesions, loose bodies, and deltoid ligament injuries. Forty-eight patients were studied, with intraarticular pathology found in 33 cases (68.75%). For Weber fractures: type A had 58.33%, type B had 72.73%, and type C had 84.21% of intraarticular pathology. Syndesmotic injury appeared in 33.33% of type A, 50% of type B, and 41.67% of type C fractures. Chondral lesions occurred in 41.67% of type A, 54.55% of type B, and 66.67% of type C fractures. Loose bodies were detected in 8.33% of type A, 18.18% of type B, and 25% of type C fractures. Deltoid ligament injuries were observed in 16.67% of type A, 27.27% of type B, and 41.67% of type C fractures. The study concludes that arthroscopy during ORIF in ankle fractures is valuable for diagnosing intraarticular pathology. It highlights the Weber classification's importance, noting that type C fractures have a higher chance of such involvement. Understanding arthroscopy's diagnostic value in these cases helps surgeons decide on concurrent interventions during ORIF, potentially improving patient outcomes. Further research may investigate how arthroscopy-guided interventions affect clinical outcomes.

Keywords: Ankle fracture, Ankle arthroscopy, Weber classification, Intra-articular injury

Introduction

Fractures of the ankle joint represent one of the most common injuries encountered in everyday trauma practice. These injuries are estimated to account for 10% of all bone injuries (Heckman et al.,2014). The highest incidence occurs in women aged 60–69, and in most cases, it involves an isolated injury sustained from a fall from standing height (Thur et al.,2012).

Anatomy

Anatomically, the ankle joint consists of three parts: the talocrural, talocalcaneonavicular, and subtalar segments (Brockett & Chapman., 2016). In everyday communication, when referring to the ankle joint, we usually mean

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the talocrural part. To avoid confusion, in this text the term “ankle joint” will be used as a synonym for the talocrural joint, even though this is not anatomically precise. The talocrural joint is formed by the tibia, fibula, and talus, along with the ligaments connecting them (Knupp et al., 2006).

Anteriorly, the Anterior Inferior Tibiofibular Ligament (AITFL) extends from the Chaput tubercle of the tibia, slightly distally to the anterior aspect of the lateral malleolus. This attachment is often referred to as the Wagstaffe tubercle. Other key elements are the Posterior Inferior Tibiofibular Ligament (PITFL) and the Inferior Transverse Ligament (ITL). The PITFL attaches to the posterior malleolus and runs obliquely distally to the back of the lateral malleolus. The ITL lies distal and parallel to it. A short distance above the ankle joint, at the midpoint between the two bones, the tibiofibular interosseous membrane forms a thickening known as the Interosseous Ligament (IOL). These four components together form the distal tibiofibular syndesmosis. Rupture of these elements leads to loss of structural integrity of the ankle joint, causing the joint mortise to open and the talus to displace laterally, resulting in loss of normal alignment between the talus and the load-bearing surface of the tibia.

The deltoid ligament is made of a superficial and deep bundle. Its superficial portion attaches on the anterior aspect of the medial malleolus, runs distally to the talus, calcaneus, and navicular bone. The primary medial stabilizer of the ankle joint is the deep portion of the deltoid ligament, which attaches to the posterior-lateral part of the medial malleolus. The articular surfaces of the tibia and talus are covered with cartilage, which is particularly susceptible to damage during ankle fractures (Chen et al., 2015).

Biomechanics

In 1976, Inman defined the “empirical axis” of the ankle joint (Inman, 1976), which is a line running just behind the tips of the lateral and medial malleoli. Normal movement of the talocrural joint involves rotation around this axis, which is obliquely oriented relative to the articular surface between the tibia and talus. The articular surface forms an angle with the midline of the tibia, averaging 93 degrees, but this is in the opposite direction from the slope of the empirical axis. In practice, this means an average valgus angulation of the foot of 3 degrees. The angle between the empirical axis and the plane of the tibial plafond is called the talocrural angle and is 83 ± 4 degrees (Sarafian, 1983). This angle is one of the radiographic indicators for evaluating the normal anatomical alignment of the bony components of the talocrural joint.

The fundamental principle for treating any malleolar fracture is restoration of the normal anatomical relationship between the three bones that form the joint, achieving congruence of the articular surfaces to ensure appropriate distribution of loading forces across the entire surface of the talus.

Classification

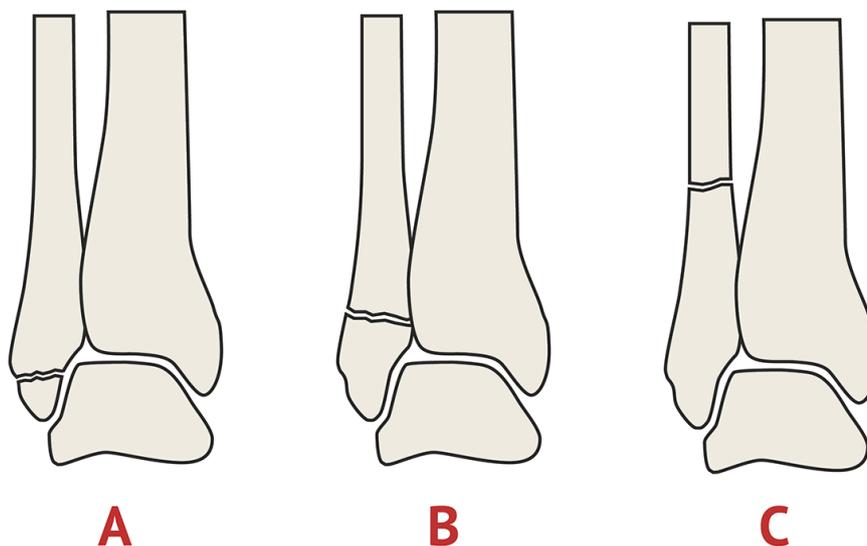


Figure 1. Weber classification

The Weber classification system (Figure 1) is one of the most widely used schemes for categorizing ankle fractures and is based on the level of the fibular fracture in relation to the syndesmosis. It differentiates between type A (fracture below the syndesmosis), type B (at the level of the syndesmosis), and type C (above the syndesmosis) fractures (Weber, 1972). This classification is frequently used in clinical practice due to its simplicity, reproducibility, and its relevance in predicting fracture stability and associated ligamentous injuries (Michelson, 1995; Ovaska et al., 2013).

Furthermore, studies have shown that higher-grade Weber fractures are more likely to be associated with post-traumatic degenerative changes, highlighting the classification's prognostic value (van Dijk et al., 2005). For these reasons, the Weber classification was adopted in this study to allow for meaningful analysis of intra-articular pathology across different fracture patterns. Other classification systems exist—such as the Lauge-Hansen or AO/OTA classifications—but were not applied in this study due to their complexity or limited relevance to the study objectives (Lauge-Hansen, 1950; Ovaska et al., 2013).

Diagnostic Protocol

The usual diagnostic protocol in surgical institutions in our country includes radiographs in two views (Musgrave et al., 1998), additional projections upon request from the attending traumatologist or orthopedist, and possibly a CT scan for cases with complex fracture morphology where more detail is needed for surgical planning (Magid et al., 1990). The value of these diagnostic methods is well established; they are essential for assessing bony structures, fracture lines, displacement, and comminution of fragments and their relationships. However, they are not sufficient for detecting intra-articular non-bony injuries. MRI can identify some of these injuries, especially osteochondral injuries of the talus (Mintz et al., 2003). Its sensitivity in detecting such injuries varies in the literature from 62% to 83% (Bae et al., 2012; Laumann et al., 2011; Verhagen et al., 2005). On the other hand, detecting ligamentous injuries with MRI in the acute phase is nearly impossible. Additional factors include the availability of MRI in the facility and scan waiting time. All these factors make its practical value debatable in the acute phase of injury.

Treatment

In some of these injuries, the anatomical relationship is not disrupted—they are stable and amenable to conservative treatment. Larsen showed in his study that for certain groups of patients with displaced fractures who achieved initial closed reduction and immobilization, outcomes could be expected to be similar to those in surgically treated patients (Larsen et al., 2019). Fractures for which reduction cannot be achieved or maintained using conservative methods (such as casting or orthotic devices) are considered unstable (Browner et al., 2019). Unstable ankle fractures, according to evidence-based recommendations, are treated with open reduction and internal fixation. The goal of such treatment is to restore anatomical alignment of the joint surfaces through open manipulation of the fragments and achieve absolutely stable fixation using one of the available osteosynthesis materials (Ruedi, 2007)

The standard surgical treatment is based on the principles established by the AO group (Ruedi, 2007) and consists of open reduction and fixation of the lateral malleolus through a lateral approach. This is followed, if necessary, by fixation of the medial and/or posterior malleolus, depending on the fracture morphology and instability. In the presence of a syndesmotic injury, fixation of the distal tibiofibular syndesmosis is performed, most commonly with one or more cortical screws or, more recently, with dynamic fixation using suture-button systems. The choice of fixation method is usually left to the surgeon's discretion, depending on experience, availability of materials, and assessment of the mechanical stability required.

Postoperative treatment includes short-term immobilization and early initiation of passive range-of-motion exercises. Weight-bearing is typically delayed until radiographic confirmation of fracture healing. Studies suggest that early mobilization leads to better functional outcomes, provided the fixation is stable (Rammelt et al., 2008; Day et al., 2001).

Although surgical treatment of ankle fractures has advanced significantly, complications still occur. The most common complications include infection, malunion or nonunion, posttraumatic osteoarthritis, and hardware-related issues. Among these, posttraumatic arthritis is one of the most significant, as it often leads to chronic pain and functional limitations. Its incidence is directly related to the degree of initial articular surface damage and the quality of reduction. Hence, achieving and maintaining an anatomical reduction is paramount.

Objectives

For our study we defined the following objectives:

1. To arthroscopically and minimally invasively identify intraarticular injuries associated with ankle fractures.
2. To establish a correlation between the type of fracture and the intraarticular injuries identified.

Method

The research represents an interventional, prospective, clinical study of a series of patients, conducted with the approval of the professional board of the University Clinic for Surgical Diseases “St. Naum Ohridski” – Skopje. The study included 48 patients (22 women and 26 men) who were surgically treated at the University Clinic for Surgical Diseases “St. Naum Ohridski” by the first author during the period from January 2020 to January 2023. Prior to inclusion in the study, each patient signed an informed consent form. Inclusion criteria for the study were patients over 18 years of age with isolated, unstable, closed ankle fractures where open reduction and internal fixation was indicated according to current recommendations for surgical treatment of this type of fracture, with the injury sustained no more than 14 days prior.

Patients were excluded from the study if they had old, healed fractures or prior surgical interventions on the ankle joint, congenital deformities of the affected limb, open ankle fractures, multiple injuries, acute infections, mental illness, or high anesthetic risk. The surgical interventions were performed under general endotracheal or spinal anesthesia, depending on the anesthesiologist’s recommendation and the patient’s preference. The patient was positioned supine on the operating table, with the foot placed at the edge to allow for unimpeded plantar and dorsal flexion, without the use of traction. A tourniquet was used to create a bloodless field. The topographic anatomy was marked with a marker before the beginning of the intervention.

Two standard arthroscopic portals were established – anteromedial and anterolateral. The portals were created by making a skin incision with a No. 11 scalpel, followed by blunt dissection with a clamp to the joint capsule to avoid injury to anatomical structures surrounding the portals. After perforating the joint capsule with the clamp, an arthroscopic camera with a diameter of 4.0 mm and a 30-degree angle was inserted. Through the other portal, synovectomy and removal of fracture hematomas and debris were performed using a shaver to improve visualization of the ankle joint structures.

A systematic inspection of the ankle joint was performed following the Ferkel protocol (Ferkel & Fasulo, 1994), with detailed documentation of intra-articular injuries, including syndesmotic ligament injuries, deltoid ligament injuries, chondral or osteochondral lesions, as well as loose bodies within the joint. From the lateral side, the syndesmosis was visualized and its status documented—whether ruptured or intact. Any unstable remnants of the syndesmotic ligaments were removed with the shaver or stabilized using arthroscopic electro-cautery.

From the medial side, after synovectomy with the shaver, inspection of the deep bundle of the deltoid ligament was carried out, with documentation of its condition, as well as the character, direction, and comminution of the fracture lines of the medial malleolus, in cases where such a fracture was present. Small bony and chondral fragments were removed and documented. Chondral injuries were thoroughly documented, measured, and classified according to the Outerbridge classification (Outerbridge, 1961). Chondroplasty was performed using a shaver and electro-cautery. In patients with high-grade chondral lesions, micro fracturing was performed using a chondro-pick.

Upon completion of the arthroscopy, standard open reduction and internal fixation were performed in accordance with AO principles (Ruedi, 2007). The lateral malleolus was fixed with one or more cortical screws (when allowed by the fracture configuration) and a 3.5 mm one-third tubular steel plate. If the arthroscopic findings indicated syndesmotic rupture, fibulo-tibial transfixation was performed using a single screw. Fractures of the medial malleolus were fixed with two screws, a combination of a screw and a Kirschner wire, or a tension-band (Zuggurtung) technique, depending on the size and configuration of the fractured fragment. After completing osteosynthesis, a repeat arthroscopic inspection of the ankle joint was conducted to assess the quality of the reduction and the stability of the tibiofibular syndesmosis under direct visual control. The surgical wounds were closed in layers and dressed in sterile bandages.

Results and Discussion

This study included a total of 48 patients, of whom 22 were women and 26 were men, each with an unstable ankle fracture treated surgically. According to the Weber classification, 12 patients (25%) had Weber type A fractures, 22 patients (45.8%) had Weber type B fractures, and 14 patients (29.2%) had Weber type C fractures. Table 1 shows the distribution of fracture types.

Table 1. Distribution of fracture types by weber classification

Fracture Type	Number of Fractures	Percentage
Weber A	12	25.0%
Weber B	22	45.8%
Weber C	14	29.2%

Intraarticular pathology was identified in 33 of the 48 patients (68.75%). The most common injuries were syndesmotic ruptures, found in 21 patients (43.75%), followed by chondral lesions in 26 patients (54.17%). Deltoid ligament injuries were observed in 13 patients (27.08%), and loose bodies were present in 9 patients (18.75%). Table 2 presents the distribution of intraarticular injuries across the three Weber groups.

Table 2. Intra-articular Injuries by fracture type

Injury Type	Weber A (%)	Weber B (%)	Weber C (%)
Intraarticular pathology	58.33%	72.73%	84.21%
Syndesmotic injury	33.33%	50.00%	41.67%
Chondral lesions	41.67%	54.55%	66.67%
Loose bodies	8.33%	18.18%	25.00%
Deltoid ligament injuries	16.67%	27.27%	41.67%

Deltoid ligament injuries were more commonly seen in Weber C fractures, present in 41.67% of such cases, followed by 27.27% in Weber B, and 16.67% in Weber A fractures. Syndesmotic injuries were most frequently observed in Weber B fractures (50%), followed by 41.67% in Weber C and 33.33% in Weber A fractures. Chondral lesions followed a pattern of increasing frequency with fracture severity, found in 41.67% of type A, 54.55% of type B, and 66.67% of type C fractures. Loose bodies were least frequent in Weber A fractures (8.33%) and more common in Weber B (18.18%) and C (25%) fractures.

These findings suggest that the presence and severity of intraarticular pathology correlate with the Weber classification, with Weber C fractures being most frequently associated with complex intraarticular involvement. The frequency of intraarticular injuries in 68.75% fractures in this study supports the existing literature, which has demonstrated high prevalence of chondral and ligamentous injuries associated with ankle fractures. In their study of arthroscopically evaluated ankle fractures, Chen et al. (2015) reported chondral lesions in 63.3% of patients. Another study (Leontaritis et al., 2009) demonstrated that the severity and number of chondral lesions increase with fracture complexity.

Among the subjects in this study, chondral lesions were found in 54.17% of fractures, and their rate increased proportionally with the extent of osseous damage — i.e., with the severity of the fracture. In Weber C fractures, chondral lesions were present in 66.67% of patients. A level II evidence study (Stufkens et al., 2010) showed that the degree of cartilage damage may predict the clinical outcome of treatment, which could be of significant value in properly setting patient expectations.

There are several methods for assessing syndesmotic integrity in ankle fractures. Standard radiographs and stress radiographs are the most used, but Nielson has suggested that there is no correlation between the tibiofibular clear space on AP X-rays and the presence of ligamentous injury on MRI (Nielson et al. 2005). Intraoperative assessment of syndesmotic stability—and thereby the integrity of the ligamentous complex—is usually performed using the Cotton test. Many techniques for this test have been described, but there is no consensus on cutoff values that define a positive result. A recent level I study reported a very low sensitivity rate and questioned the utility of this test (van den Bekerom, 2011). Takao et al. (2011) compared standard radiographs to direct arthroscopic visualization for evaluating syndesmotic injuries. Their results showed identification of 42% of syndesmotic injuries using AP views and 55% using oblique radiographs. In contrast, all syndesmotic injuries were identified with direct arthroscopic visualization.

This study further confirms the value of arthroscopy in diagnosing such ligamentous injuries. We arrived at the same observation in our patient cohort, where visualization of the syndesmosis was a direct factor in deciding whether tibiofibular fixation was necessary. As for the incidence of syndesmotic injury in the context of ankle

fractures, the rate reported in the literature ranges from 77% to 78% (Chen et al., 2015; Takao et al., 200). Our study found syndesmotic disruption in 43.75% of patients, which is approximately 10–15% lower than in other series. This discrepancy may be due to differences in the distribution of high-energy versus low-energy trauma patients among the studies.

Deltoid ligament injuries are difficult to diagnose, especially in the presence of a fracture. There is currently no consensus, but values of 4 to 6 mm of tibiofibular widening on radiographs have been proposed as thresholds for a positive finding (Lafferty et al., 2009). At the time of this writing, no published values for arthroscopically diagnosed deltoid ligament lesions in the context of ankle fractures had been found in the literature. The results obtained in this study suggest that arthroscopy is a reliable method for diagnosing this injury, and it revealed a higher prevalence of deltoid ligament ruptures in isolated Weber A fractures.

The presence of free chondral or osteochondral fragments in the joint during fracture has been reported by Tordardson (Tordardson et al., 2001) in 55% of cases, and by Yassin (Yassin et al., 2017) in 36%. We found loose bodies in 18.75% of cases, with distribution by fracture type suggesting a direct correlation with injury severity.

Beyond its diagnostic value in identifying intraarticular injuries accompanying ankle fractures, arthroscopy also enables lavage and debridement of the joint, thereby reducing inflammatory burden. This may theoretically improve therapeutic outcomes by increasing range of motion, reducing pain, and lowering the risk of post-traumatic arthritis (Adams et al., 2017). Our study not only provides a statistical overview of the distribution of intraarticular injuries across different fracture types but also supports previous literature showing that arthroscopy during the surgical treatment of ankle fractures offers significantly better insight into these injuries and enables their concurrent management when indicated.

Conclusion

This study confirms that intraarticular injuries are commonly associated with ankle fractures and that their prevalence increases with fracture severity, as classified by the Weber system. Arthroscopic assessment during ORIF offers a valuable diagnostic advantage, allowing for direct visualization and treatment of chondral lesions, syndesmotic instability, deltoid ligament injuries, and loose bodies. These findings support the integration of arthroscopy as a complementary tool in selected cases of ankle fractures, particularly those with suspected intraarticular involvement, to improve diagnostic accuracy and potentially optimize clinical outcomes.

Recommendations

Based on the findings of this study, we propose the following recommendations:

- Consider routine arthroscopic evaluation during ORIF of ankle fractures, particularly in Weber B and C types, where intraarticular pathology is more prevalent.
- Use arthroscopy as a diagnostic adjunct in cases where preoperative imaging does not provide sufficient detail regarding chondral or ligamentous injuries.
- Standardize documentation of intraarticular findings during surgery to enhance post-treatment planning, rehabilitation, and patient counseling.
- Further prospective, randomized studies with larger cohorts are encouraged to evaluate the long-term clinical outcomes and cost-effectiveness of arthroscopy-assisted fracture fixation.
- Improve training in ankle arthroscopy for orthopedic surgeons to ensure safe and effective execution of the technique, particularly in trauma settings.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPHELS journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

Funding

* This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements or Notes

* This article was presented as an oral presentation at the International Conference on Medical, Health and Life Sciences (www.icmehels.net) held in in Peja, Kosovo on 10-13 July 2025.

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To cite this article:

Todorov, R. & Kuzmanovska, B. (2025). Arthroscopy in acute ankle fractures: A weber classification-based analysis. *The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELS)*, 18, 10-17.

The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELs), 2025

Volume 18, Pages 18-21

ICMeHeLS 2025: International Conference on Medical, Health and Life Sciences

Effect of IGF-1 on Bladder Cancer

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Abstract: Insulin-like Growth Factor 1 (IGF-1) is a protein involved in cell growth, development, and regeneration, and it is produced in the liver in response to growth hormone. Recent studies have shown that IGF-1 may play a role in the development and spread of certain types of cancer. While IGF-1 promotes cell proliferation, it can also inhibit apoptosis a feature that may lead to uncontrolled growth of cancer cells and aggressive tumor progression. Numerous studies have investigated IGF-1 levels in relation to breast, prostate, colorectal, and lung cancers. Researchers have found strong evidence that IGF-1 not only contributes to cell proliferation in cancer patients but may also facilitate metastasis. Therefore, research targeting IGF-1 levels and its receptors is considered a promising strategy in cancer treatment and management. In our study, we examined IGF-1 levels in 100 bladder cancer tissue samples 50 from patients with low-grade cancer and 50 from those with high-grade cancer. Tissue samples were properly processed and converted into supernatant form, after which they were analyzed using the chemiluminescent immunoassay method on an autoanalyzer. According to our results, the IGF-1 levels in patient samples were found to be below the reference range of the IGF-1 kit used. However, statistical analysis revealed that IGF-1 levels were significantly higher in patients with high-grade bladder cancer compared to those with low-grade cancer. This suggests that IGF-1 expression pathways may be disrupted in cancer and could have a negative impact in high-grade cases. We believe that our study may shed light on cancer by determining the level of IGF-1 hormone in tissue samples of patients with bladder cancer.

Keywords: IGF-I, CPS, Apoptoz, Chemilimmunoassay, Supernatant

Introduction

Insulin-like Growth Factor 1 (IGF-1) is a protein that plays a crucial role in cell growth, development, and regeneration in the body. IGF-1 is produced in the liver in response to growth hormone (GH) stimulation and regulates various biological processes. However, in recent years, increased research into the effects of IGF-1 on cancer cells and its relationship to cancer development suggests that IGF-1 could be a new target in cancer therapy (Pollak, 2000; Giovannucci et al., 2003). While IGF-1 stimulates cell proliferation and growth, this process can accelerate and become uncontrolled in cancer cells. IGF-1 promotes cell division and can speed up the growth of cancer cells (Le et al., 1998).

Normally, cells are expected to undergo a controlled cell death mechanism known as apoptosis in response to genetic damage or abnormal conditions. However, IGF-1 can inhibit apoptosis, preventing cell death. This feature may allow cancer cells to survive and proliferate, leading to more aggressive tumor growth (Baserga, 2003). Numerous studies have revealed that elevated levels of IGF-1 are more common in certain types of cancer. The effects of IGF-1 vary depending on the type of cancer. For example, high levels of IGF-1 have been associated with an increased risk of common cancers such as breast cancer, prostate cancer, colorectal cancer,

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and lung cancer. IGF-1 particularly stimulates the growth of estrogen receptor-positive breast cancer cells (Yu & Rohan, 2000).

Furthermore, studies on prostate cancer show that high IGF-1 levels can increase the risk of prostate cancer and contribute to more aggressive tumor growth (Giovannucci et al., 2003). IGF-1 is also reported to play a role in the development of colorectal cancer, with high IGF-1 levels accelerating tumor growth and spread in colorectal cancer patients. While IGF-1 promotes the growth of lung cancer cells, its role in lung cancer can vary depending on the tumor stage and type. IGF-1 can also facilitate the metastasis of cancer cells. It promotes cell migration, which can accelerate cancer spread. Studies showing that metastatic cancer cells are influenced by IGF-1 levels suggest that IGF-1 should be targeted in cancer treatment. The effects of IGF-1 on cancer are crucial in developing treatment strategies. Treatment methods that target IGF-1 receptors aim to inhibit cancer cell growth and stop tumor spread. Drugs that inhibit IGF-1 receptors can slow down or stop tumor growth in certain cancer types, offering a new opportunity for cancer therapy (Baserga et al., 2003).

Additionally, controlling IGF-1 levels may help reduce cancer risk. Lifestyle factors such as obesity, age, diet, and exercise play an important role in regulating IGF-1 levels. Conditions like obesity can increase IGF-1 levels and raise cancer risk (Giovannucci, E 2003). In conclusion, while IGF-1 is a critical factor for cell growth and development, it is also an important molecule associated with cancer development. IGF-1's ability to promote cancer cell growth, inhibit apoptosis, and facilitate metastasis demonstrates the need to target IGF-1 in cancer treatment. However, the effect of IGF-1 on cancer is complex and can vary across different cancer types. Controlling IGF-1 levels may help reduce cancer risk, and future research will allow us to better understand IGF-1's role in cancer and improve cancer treatment by targeting IGF-1.

Method

In the pathology laboratory, paraffin tissue samples from 50 low-grade and 50 high-grade bladder cancer patients (total of 100 patients) diagnosed with bladder cancer were obtained from the laboratory archive. After the tissue underwent the paraffinization process, supernatant was obtained using Atl tissue homogenizer solution. The IgF supernatants were analyzed using the chemiluminescent immunoassay method on an Immulite 2000 device

Results and Discussion

The study was conducted. In the control group, the measurement at low levels was 773,692 CPS, while the measurement at high levels was 2,519,914 CPS. In tissue samples obtained from patients with low-grade bladder cancer, the average CPS value was 431,200, whereas in patients with high-grade bladder cancer, this value was measured as 447,000 CPS. These measurement values were found to be below the device's reading range of 15 ng/ml. When the CPS values of the samples were statistically analyzed, as shown in Table 1, IGF levels were found to be higher in patients with high-grade bladder cancer compared to those with low-grade tumors. According to the Independent Sample t-test we conducted, this difference was found to be statistically significant ($p < 0.05$) (Table 2). As illustrated in Figure 1, which presents a box plot comparing IGF values between patients with low- and high-grade bladder cancer, IGF levels were observed to be significantly higher in patients with high-grade tumors.

Table 1. IGF-1 levels in bladder tumor grades?

Group statistics				
	Tumor	N	Mean	Std. Deviation
Igf	Low grade Tumor	50	43,6741	7,75930
	High grade Tumor	50	61,3509	11,52540

Table 2 Independent samples test

F	Sig.	t	Sig. (2tailed)	95% Confidence Interval of the Difference	
9,287	,003	-9,015	,000	Lower -21,61272	Upper -13,81416

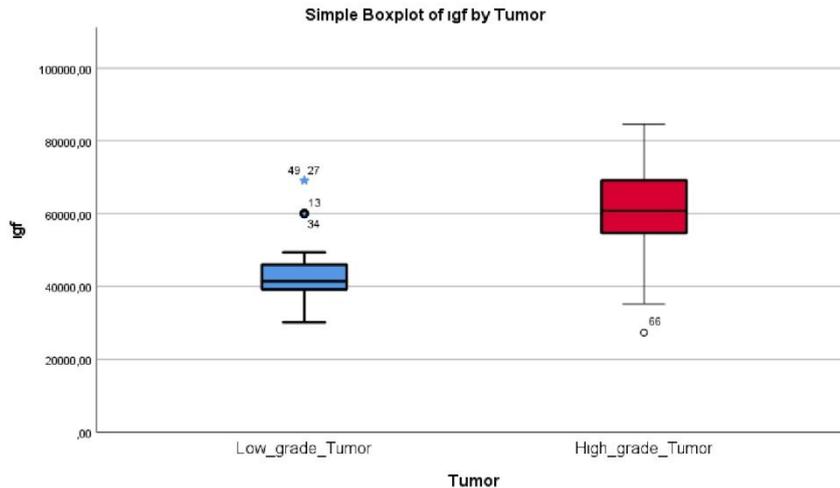


Figure 1. Low -grade and high-grade tumor box plot

Conclusion

In conclusion, this study examined IGF-1 levels in tissue samples from bladder cancer patients and found significantly higher levels in those with high-grade tumors. This finding suggests that IGF-1 may be associated with the progression and aggressiveness of bladder cancer. The proliferative and anti-apoptotic effects of IGF-1 may contribute to uncontrolled tumor growth and increased metastatic potential. However, IGF-1 levels alone do not solely determine tumor behavior; interactions with other biological factors also influence the course of the disease. Therefore, a more detailed investigation of the molecular effects of IGF-1 in bladder cancer cells is essential, and large-scale clinical studies are needed to evaluate IGF-1 as a potential prognostic biomarker.

Recommendations

Our findings indicate that IGF-1 levels are significantly elevated in high-grade bladder cancer, suggesting its potential as a biomarker of tumor aggressiveness. The ability of IGF-1 to enhance proliferation and inhibit apoptosis, particularly through PI3K/AKT and MAPK pathways, may explain the aggressive behavior of high-grade tumors. However, the study is limited by the exclusive use of tissue samples and a relatively small cohort. Future studies should include both serum and tissue analyses and investigate the IGF-1/IGF-1R axis in relation to treatment response and metastasis.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPHELS journal belongs to the authors.

*The study was approved by the Gaziantep University Clinical Research Ethics Committee (Decision No: 2024/181).

Conflict of Interest

* The authors declare that they have no conflicts of interest

Funding

* This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements or Notes

*This article was presented as an oral presentation at the International Conference on Medical, Health and Life Sciences (www.icmehels.net) held in Peja, Kosovo, on July 10–13, 2025.

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To cite this article:

Dagdeviren, M.A., & Ozaslan, M. (2025). Effect of IGF-1 on bladder cancer. *The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELS)*, 18, 18-21.

The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELs), 2025

Volume 18, Pages 22-26

ICMeHeLS 2025: International Conference on Medical, Health and Life Sciences

Functional and Clinical Outcomes After Modified Fulkerson Osteotomy for Patellar Maltracking

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Abstract: Patellar maltracking syndrome (PMS) is characterized by abnormal patellar motion, leading to anterior knee pain, instability, and patellofemoral joint degeneration. Often associated factors are patella alta, trochlear dysplasia, increased quadriceps angle, and vastus medialis oblique weakness. When conservative management, including physical therapy and McConnell taping fails, surgical intervention is required. This retrospective study, performed at the University Clinic for Surgical Diseases ‘St. Naum Ohridski’ – Skopje, North Macedonia, evaluates the clinical efficacy of modified Fulkerson tibial tubercle osteotomy in 30 patients with PMS. Diagnosis was based on clinical assessment and radiographic imaging. The preoperative Kujala Score ranged from 46 to 63 (mean 54.5, average 56), while the preoperative KOOS score ranged from 24 to 57 (mean 40.5, average 41.55), indicating moderate functional impairment. Depending on cartilage wear, either medialization or anteromedialization was performed through tibial tubercle osteotomy. Postoperatively, the patients were put on a partial weight – bearing for six weeks. Afterwards, strict rehabilitation program was followed to restore muscle strength, flexibility and patellar tracking. The postoperative outcomes showed a significant clinical improvement. Kujala scores range from 74 to 91 (mean 82.5, average 84) and KOOS score range from 50 to 85 (mean 67.7, average 62.62). Statistical analysis showed significant clinical improvement regarding pain and function ($p < 0.001$). Four patients experienced mild lateral knee pain which was successfully treated conservatively. There were not reported any cases of deep vein thrombosis, infection or fractures. The downside of this technique is the hardware removal which was required by eight patients after an average time of 2 years from the surgical intervention. This study claims that the modified Fulkerson osteotomy is successful in the treatment of PMS, when the conservative treatment fails. Significant clinical improvements in pain, function, and stability are achieved through this technique while maintaining a low complication rate.

Keywords: Patellar maltracking, Fulkerson osteotomy, Tibial tubercle transfer, Kujala Score, KOOS

Introduction

Anterior knee pain is commonly associated with patellar maltracking syndrome, resulting from abnormal alignment and movement of the patella in the trochlear groove. Anterior knee pain significantly compromises

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functional mobility in daily activities and has negative impact on athletic performance. Additionally the performance of routine motor tasks essential for independent living, such as walking, stair climbing, and transitioning from sitting to standing is compromised.

Patellar maltracking occurs as a result of an imbalance in the dynamic relationship between the patella and trochlea. This is often secondary to an underlying structural abnormality. Malalignment may be attributed to trochlear dysplasia, quadriceps insufficiency, patella alta, or excessive tibial tuberosity trochlear groove (TT-TG) distance (Jibri et al., 2019). Anterior knee pain (AKP) is one of the most common conditions to bring active young patients to a sports injury clinic. It is a heterogeneous condition related to multiple causative factors. Compared to the general population, there appears to be a higher risk of development of patellofemoral osteoarthritis in patients with AKP (D'Ambrosi et al., 2022). While the first line of treatment is conservative management, including physiotherapeutic intervention aimed at addressing quadriceps muscle imbalances, quadriceps retraining is associated with good clinical outcomes in patients found to have VMO impairments and taping for quadriceps muscle activation in subjects with PMS (McConnell taping), surgical intervention is justified when symptoms persist.

Method

This is retrospective study which included 30 patients diagnosed with PMS, all treated with Modified Fulkerson TTO at the University Clinic for Surgical Diseases 'St. Naum Ohridski' in Skopje. Inclusion criteria were: patients between 16 and 45 years of age with clinically and radiologically confirmed PMS, who underwent at least six months of conservative treatment, and showed no clinical improvement. All surgeries were carried out by the last author, Dr. Nebojsa Nastov, to ensure consistency in surgical technique. Structured diagnostic protocol was used, combining patient history, clinical examination and radiological evaluation to identify both structural and functional contributors to instability. Besides standard X-ray imaging, dynamic MRI allowed assessment of MPFL integrity, cartilage lesions, trochlear dysplasia, and associated soft tissue structures. According to Walter et al. (2022), when combined with detailed clinical assessment, real-time MRI confirmation of joint kinematics can significantly validate the choice between surgical intervention and targeted physical therapy.

The Caton-Deschamps index was measured on MRI using a cross-sectional imaging method. The assessment of CDI on MRI using a cross-sectional imaging method has a better correlation with traditional X-Ray assessment of CDI than single-slice assessment (Palmowski et al., 2024). CT imaging was used to quantify TT-TG distance, providing precise quantification of patellar lateralization relevant to surgical indication.

To achieve a more anatomical contour of the proximal tibia, we used a modification of the technique originally described by Tom Minas (*Minas, 2011*), which allows for consistent reduction of the anteromedial prominence of the tuberosity. Compared to conventional techniques, this approach involves a more extensive medial dissection. Full-thickness elevation of the medial periosteal sleeve was done, carried to the posteromedial cortex of the tibia. This approach enabled easier reapproximation of the subperiosteal flap during closure and minimized the likelihood of leaving a residual bony prominence. This modification improved aesthetic outcomes and patient satisfaction.

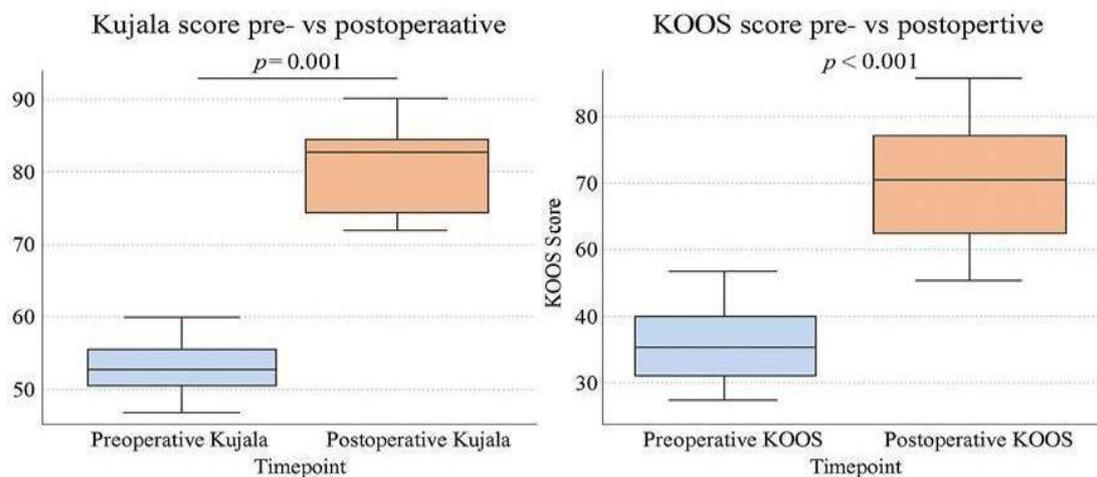


Figure 1. Patient-reported outcome measures after tibial tubercle osteotomy

With this approach precise correction of the lateralization of the tibial tubercle, patellar height and stress unloading of the patellofemoral joint was enabled. The amount of anterior and medial displacement can be adjusted based on the steepness of the osteotomy (Ridley et al., n.d.). The parameters shown in Table 1 were considered as surgical indications for tibial tubercle osteotomy.

Table 1. Osteotomy indications

Indication	Treatment
TT–TG \geq 20 mm	Medialize tibial tubercle
Patella alta (CD ratio $>$ 1.2)	Distalize tibial tubercle
Focal chondral lesion	Anteriorize tibial tubercle

Note: Treatments may be combined for those with multiple indications. CD, Caton–Deschamps; TT–TG, tibial tuberosity–trochlear groove

Postoperative care involved six weeks of partial weight-bearing, followed by a progressive rehabilitation protocol to restore knee function and optimize patellar tracking. Outcome measures included the Kujala Score for pain, KOOS for functional assessment, and clinical tests for stability (Patellar Apprehension and Tilt Tests).

Results and Discussion

Patient records from January 2021 to December 2022 were reviewed, allowing for a minimum follow-up of 1 year for clinical outcome evaluation and up to 3 years for postoperative events such as hardware removal. Preoperative Kujala Scores ranged from 46 to 63 (mean 54.5, average 56), and KOOS ranged from 24 to 57 (mean 40.5, average 41.55). Postoperative Kujala Scores ranged from 74 to 91 (mean 82.5, average 84), and KOOS from 50 to 85 (mean 67.5, average 62.62), showing a statistically significant improvement in pain and function ($p < 0.001$) (Figure 1.). The clinical outcomes, including Kujala and KOOS scores, were evaluated at one year postoperatively. In correlation with clinical improvement, both the patellar tilt test and patellar apprehension test showed clinically evident improvement, suggesting restored patellar stability. Four patients reported mild lateral knee pain which resolved with conservative treatment. No major complications such as deep vein thrombosis, infections, or fractures occurred.

We performed precise osteotomy ensuring the osteotomy fragment was of appropriate thickness, and did not overcompress it during fixation. We believe that this was crucial for not having fractures in our cohort. Similar results and recommendations were advocated by Payne et al. (2015). Orthopaedic patients are considered to be at particularly high risk for deep vein thrombosis (DVT) and venous thrombembolism (VTE). With routine VTE prophylaxis, fatal pulmonary embolism is uncommon in orthopaedic patients and the rates of symptomatic VTE within three months are in the range of 1.3% to 10%. LMWH seems to be more efficient overall compared with the other available agents (Flevas et al., 2018). We administered Enoxaparin (Clexane) for 28 days postoperatively.

Hardware removal was necessary in eight cases due to anterior knee pain (screw prominence), performed at an average of 2.5 years post-surgery. In comparison to the findings reported by Davis et al (2025) where the hardware removal rate was 21.1%, our cohort demonstrated a slightly higher incidence of hardware removal at 26.67%. In both studies, the predominant indication for hardware removal was persistent anterior knee pain.

Conclusion

The modified Fulkerson tibial tubercle osteotomy demonstrates excellent clinical efficacy in treating patellar maltracking syndrome, resulting in significant improvements in pain relief, knee function, and patellar stability (Buuck & Fulkerson, 2000). The procedure's success hinges on careful patient selection, thorough preoperative planning, and meticulous surgical execution. When appropriately indicated and performed, TTO can lead to significant improvements in patient outcomes (Sherman et al., 2014). With a low complication rate and favorable long-term outcomes, this surgical technique is a reliable option for patients who do not respond well to conservative treatment

Recommendations

Further prospective studies with larger cohorts and long-term follow-up are recommended to validate these findings and to explore the biomechanical impacts of tibial tubercle repositioning strategies in PMS management.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPHELS journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

Funding

* This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements or Notes

* This article was presented as an oral presentation at the International Conference on Medical, Health and Life Sciences (www.icmehels.net) held in Peja, Kosovo on July 10-13, 2025.

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To cite this article:

Nikolic, K., Bekteshi, L., Nikolic, F., Trpeski, S., & Nastov, N. (2025). Functional and clinical outcomes after modified fulkerson osteotomy for patellar maltracking. *The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELS)*, 18, 22-26.