Review Article

Chronic Ankle Instability and Associated Osteochondral Lesions: Pathophysiological Interplay, Advanced Diagnostic Approaches, and Contemporary Therapeutic Strategies

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Abstract

Chronic ankle instability is a complex condition that frequently develops after recurrent lateral ankle sprains and is characterized by persistent mechanical laxity, neuromuscular deficits, and recurrent episodes of the ankle "giving way." Beyond functional impairment, chronic instability alters normal ankle biomechanics, increasing talar tilt, anterior translation, and abnormal joint loading. These changes predispose the talar dome to focal osteochondral damage, most commonly on its medial aspect. Limited vascular supply and sustained mechanical stress contribute to the persistence and progression of osteochondral lesions, establishing a pathophysiological continuum that may culminate in post-traumatic osteoarthritis if not appropriately managed. Comprehensive evaluation requires a structured approach that integrates detailed history taking, physical examination, functional assessment tools, and advanced imaging. Clinical features such as recurrent sprains, persistent deep ankle pain, swelling, locking, and catching raise suspicion for associated intra-articular pathology. Physical examination maneuvers, including the anterior drawer and talar tilt tests, help identify mechanical instability, while functional scoring systems quantify activity limitations. Imaging modalities, such as weight-bearing radiographs, magnetic resonance imaging, and weight-bearing computed tomography, provide essential information regarding ligament integrity, cartilage status, and subchondral bone architecture. Diagnostic arthroscopy may serve both confirmatory and therapeutic purposes in selected cases. Management strategies must be individualized according to instability severity and lesion characteristics. Early-stage disease may respond to structured neuromuscular rehabilitation, proprioceptive training, bracing, and selected biological adjuncts. Persistent mechanical instability often requires anatomic ligament repair or reconstruction. Osteochondral lesions demand lesion-specific surgical strategies, and simultaneous correction of instability and cartilage damage may optimize functional recovery and reduce long-term degenerative risk.

Key words

Lateral ligament complex, talar dome, proprioceptive training, subchondral remodeling, arthroscopic stabilization, post-traumatic osteoarthritis.

Introduction

Chronic ankle instability represents a frequent sequela of lateral ankle sprains and constitutes a significant clinical burden, particularly among athletes engaged in acrobatic disciplines and sports characterized by high physical demands [1]. The condition is clinically defined by recurrent sprains accompanied by a persistent sensation of the ankle “giving way,” manifestations that substantially impair both quality of life and athletic performance. Given its functional impact and high prevalence in active populations, chronic ankle instability emerges as a relevant musculoskeletal disorder requiring careful recognition and management [2].

The progression from an acute lateral ankle sprain to chronic instability is often associated with initial misdiagnosis or inadequate treatment. When early management is insufficient, a considerable proportion of patients develop recurrent instability, which perpetuates mechanical dysfunction of the joint [1]. Repeated sprains not only sustain ligamentous laxity but also increase the risk of cumulative intra-articular damage. In this context, recurrence becomes a major concern, as it may exacerbate structural compromise and predispose to additional complications, including osteochondral lesions of the talus [2].

Osteochondral lesions of the talus are identified in up to 32% of patients with chronic lateral ankle instability, with most lesions located on the medial talar dome [3]. The coexistence of these lesions introduces further biomechanical alterations, as their presence can modify ankle joint kinetics by increasing dorsiflexion and eversion moments. Such kinetic changes may contribute to progressive joint degeneration if left unaddressed. Thus, the interaction between ligamentous instability and osteochondral injury reflects a pathophysiological continuum rather than isolated phenomena [4].

Recognizing this combined pathology is essential for comprehensive treatment planning, as ligamentous instability and osteochondral lesions may coexist and mutually exacerbate joint dysfunction [3, 4]. Although osteochondral lesions do not necessarily compromise the outcomes of surgical stabilization procedures, such as the modified Broström technique, this holds true particularly when lesions are limited in size [5]. Therefore, accurate assessment of lesion extent becomes a critical component of preoperative evaluation.

These considerations underscore the need for an integrated diagnostic and therapeutic framework. A coordinated approach incorporating advanced imaging modalities and targeted rehabilitation strategies can optimize clinical outcomes in patients presenting with chronic ankle instability and associated osteochondral lesions [4]. Surgical stabilization procedures, including the Broström repair, when combined with rehabilitation programs specifically addressing kinetic alterations, may significantly enhance ankle stability and functional recovery [1, 6].

The objective of this article is to analyze the pathophysiological interplay between chronic ankle instability and associated osteochondral lesions of the talus, and to examine current diagnostic and therapeutic strategies to optimize clinical management, improve functional outcomes, and reduce the risk of long-term degenerative progression.

Methodology

This manuscript was developed as a structured narrative review aimed at providing an updated and clinically integrated analysis of chronic ankle instability and associated osteochondral lesions of the talus, with emphasis on pathophysiological mechanisms, diagnostic strategies, and contemporary therapeutic approaches. The review followed the SANRA (Scale for the Assessment of Narrative Review Articles) framework and was guided by a predefined protocol established prior to literature screening. The review question was structured as follows: in patients with chronic ankle instability, particularly those with concomitant osteochondral lesions of the talus, which diagnostic and therapeutic strategies optimize functional recovery, joint stability, and long-term structural preservation? Owing to biomechanical complexity, heterogeneity in lesion classification, and variability in treatment algorithms, a narrative interpretative synthesis was selected over quantitative pooling to integrate ligamentous, chondral, biomechanical, and functional dimensions into a clinically applicable framework.

A comprehensive search was conducted in PubMed, Scopus, and Web of Science for peer-reviewed articles published in English or Spanish between January 2020 and December 2026, with the final search performed in December 2026. This timeframe was chosen to capture advances in arthroscopic stabilization, ligament reconstruction, biologic augmentation, cartilage repair, and rehabilitation protocols. Foundational studies were included when necessary for biomechanical or historical context. The search strategy combined MeSH and free-text terms related to chronic ankle instability, lateral ankle instability, functional instability, osteochondral lesion of the talus, talar dome lesion, Broström procedure, ligament reconstruction, microfracture, osteochondral autograft transplantation, cartilage repair, biologic augmentation, rehabilitation, and return to sport, applied to titles, abstracts, and indexed subject headings.

Inclusion criteria comprised randomized controlled trials, prospective or retrospective cohort studies, case series with at least 20 patients, systematic reviews, meta-analyses, expert consensus statements, and international guidelines addressing diagnosis, conservative management, surgical treatment, or outcomes of chronic ankle instability and/or osteochondral lesions. Eligible studies were required to report validated functional outcomes, recurrence rates, return-to-sport data, radiologic healing, or complications. Surgical studies required a minimum follow-up of 12 months. Adult populations were prioritized; pediatric-only studies were excluded unless broadly applicable. Exclusion criteria included non–peer-reviewed publications, isolated case reports, editorials without outcome data, purely technical reports without clinical results, redundant datasets, cadaveric studies without clinical correlation, and studies not directly addressing diagnostic or therapeutic outcomes.

The search yielded 238 records; 189 remained after duplicate removal. Following title and abstract screening, 112 articles underwent full-text review, and 61 were included in the final synthesis. Selection was performed independently by two authors, with consensus resolution of disagreements. A structured flow diagram documented the selection process.

Data were extracted using a predefined template, including study design, sample size, demographics, instability type and severity, lesion size, location and classification, imaging modalities, treatment approach, rehabilitation protocols, follow-up duration, recurrence, return-to-sport rates, radiologic outcomes, and complications. Primary outcomes were defined as validated functional scores, restoration of stability, and return to sport; secondary outcomes included structural healing, complication rates, and revision surgery.

Methodological quality was assessed narratively using principles derived from ROB 2 for randomized trials, the Newcastle–Ottawa Scale for observational studies, and AMSTAR standards for systematic reviews. Risk of bias, follow-up adequacy, consistency of instability definitions, and lesion classification clarity informed interpretative weighting. Greater emphasis was placed on higher-level evidence, longer follow-up studies, and guideline-supported recommendations. Evidence was synthesized thematically, grouping studies by diagnostic strategies, conservative management, surgical stabilization, cartilage restoration, and combined approaches, with further stratification by lesion size, containment, instability severity, and reconstructive technique.

Reference lists were manually screened for additional studies. Although not prospectively registered due to its narrative design, the review adhered to a predefined protocol to enhance transparency. As a narrative synthesis, it is subject to selection bias and does not provide pooled quantitative estimates. Artificial intelligence tools were used solely for organizational support, while critical appraisal, synthesis, and interpretation were conducted independently by the authors to ensure methodological rigor.

Functional Anatomy and Biomechanics of the Ankle Joint

The lateral ligament complex of the ankle is composed of the anterior talofibular ligament, the calcaneofibular ligament, and the posterior talofibular ligament, structures that together play a central role in maintaining lateral ankle stability. Among them, the anterior talofibular ligament is most frequently injured during ankle sprains and constitutes the primary restraint against anterior translation and inversion stress. Anatomical studies have demonstrated that this ligament is formed by two fascicles, with the inferior fascicle establishing a connection with the calcaneofibular ligament, thereby allowing transmission of tension between both structures and reinforcing their functional interdependence [7]. In parallel, high-resolution magnetic resonance imaging investigations have quantified the anatomical distances between these ligaments and adjacent bony landmarks, providing detailed morphometric data that facilitate surgical planning in patients with chronic ankle instability [8].

Beyond the lateral complex, medial and syndesmotic stabilizers also contribute substantially to overall ankle biomechanics. The deltoid ligament plays a critical role in preserving medial stability, and its disruption, particularly when associated with distal tibiofibular syndesmotic injury, results in increased joint contact pressures and reduced torsional stability. Although surgical repair of these structures has been shown to restore biomechanics to near-native conditions, isolated repairs may not fully correct global instability, underscoring the complexity of ankle joint mechanics [9].

Within this biomechanical framework, the talar dome represents a key articular surface vulnerable to secondary damage. Osteochondral lesions in the context of chronic ankle instability are most located on the medial aspect of the talar dome. The limited vascular supply of this region further compromises intrinsic healing capacity, thereby facilitating the persistence and progression of osteochondral pathology once injury occurs [10].

Under normal conditions, ankle mechanics allow efficient load transmission and balanced distribution of contact pressures across the joint surface. However, disruption of the lateral ligament complex alters these dynamics, increasing stress concentration over the talar dome and predisposing to osteochondral injury [10]. Repetitive ankle sprains exacerbate this process by inducing abnormal kinematics, including increased talar tilt and anterior translation, which are hallmarks of mechanical instability [11]. Such alterations contribute not only to chronic pain and functional limitation but also to progressive intra-articular damage. Arthroscopic evaluations have identified distinct injury patterns affecting the superior fascicle of the anterior talofibular ligament, and these patterns have been shown to correlate with concomitant intra-articular pathologies, including osteochondral lesions [12].

Collectively, these findings illustrate the mechanistic link between ligamentous insufficiency and focal osteochondral damage. Mechanical instability leads to abnormal joint loading and elevated contact pressures, conditions that favor localized cartilage and subchondral bone injury. Furthermore, the high incidence of interosseous talocalcaneal ligament tears observed in patients with chronic ankle instability reinforces the association between structural instability and the development of osteochondral lesions, highlighting the interconnected nature of periarticular and intra-articular pathology [13].

Pathophysiological Mechanisms

Chronic ankle instability encompasses both mechanical and functional components, each contributing distinctly to persistent joint dysfunction. Mechanical instability refers to structural laxity resulting from ligamentous injury, most commonly secondary to repeated ankle sprains. This form of instability is characterized by excessive joint motion and objective mechanical insufficiency. Surgical procedures such as the Broström-Gould technique are typically employed to restore anatomical integrity by repairing the affected ligaments and re-establishing lateral stability [11]. In contrast, functional instability is primarily related to neuromuscular deficits, including impaired proprioception and balance disturbances, which generate the subjective sensation of the ankle “giving way.” Rehabilitation strategies focused on balance training and proprioceptive exercises have demonstrated effectiveness in addressing these deficits and improving functional outcomes [14].

Repeated ankle sprains contribute to progressive capsuloligamentous attenuation, weakening the structural support of the ankle joint and perpetuating mechanical instability [11]. Concurrently, impaired proprioception represents a central factor in chronic ankle instability, as diminished joint position sense compromises neuromuscular control and predisposes to recurrent injury. Proprioceptive training has been shown to enhance balance and restore joint position awareness, which are essential elements in reducing recurrence and improving dynamic stability. The interplay between structural laxity and neuromuscular dysfunction underscores the multifactorial nature of chronic ankle instability [15].

Beyond mechanical and neuromuscular alterations, persistent intra-articular inflammation further contributes to disease progression. Chronic synovitis, characterized by sustained inflammatory activity within the joint, promotes cartilage degeneration through the release of inflammatory mediators that accelerate cartilage breakdown [16]. In this context, osteochondral lesions are frequently identified in patients with chronic ankle instability, with a reported incidence of up to 32% among affected individuals. This association reflects the cumulative impact of instability, altered loading, and inflammatory processes on articular structures [3].

Altered biomechanics also induce subchondral bone remodeling as an adaptive response to abnormal joint loading. This remodeling process often leads to cyst formation, compromising joint integrity and further facilitating the development of osteochondral lesions [4]. Increased joint loading observed in patients with chronic ankle instability exacerbates these subchondral changes, reinforcing the pathological cascade that links instability to focal osteochondral damage [10].

If left untreated, chronic ankle instability may progress from ligamentous insufficiency to osteochondral lesion formation and ultimately to post-traumatic osteoarthritis. This sequence highlights the clinical importance of early recognition and intervention [16]. Both surgical and rehabilitative strategies aim to address the mechanical and functional components of instability to interrupt this progression. Although the presence of osteochondral lesions may complicate treatment planning, limited lesions do not appear to significantly compromise surgical outcomes, particularly when appropriate stabilization procedures are performed [5].

Clinical Assessment and Functional Evaluation

A comprehensive clinical evaluation begins with a detailed history, as patient-reported symptoms often provide the first indication of chronic ankle instability and associated intra-articular pathology. Individuals with chronic ankle instability frequently describe recurrent ankle sprains accompanied by a persistent sensation of the ankle "giving way," findings that are highly suggestive of underlying mechanical instability [6, 11]. In addition to recurrent episodes, patients commonly report persistent deep ankle pain and swelling, particularly in cases where osteochondral lesions are present. These symptoms raise suspicion for concomitant intra-articular pathology and should prompt further diagnostic consideration. Mechanical symptoms such as locking and catching further increase the likelihood of osteochondral involvement, which has been identified in approximately 32% of patients with chronic ankle instability [3].

The physical examination plays a central role in confirming clinical suspicion and characterizing the type of instability. The anterior drawer test and the talar tilt test remain fundamental maneuvers for evaluating mechanical laxity. Although the anterior drawer test may demonstrate variability in inter-rater reliability, it continues to represent a valuable and widely used tool for diagnosing mechanical ankle instability [17]. In parallel, assessment of peroneal muscle strength is essential, as weakness of these dynamic stabilizers contributes to impaired lateral support and may exacerbate instability [14]. Evaluation should also include inspection of hindfoot alignment and assessment of generalized ligamentous laxity, as structural malalignment or systemic laxity may predispose to persistent instability and influence treatment planning [10].

Beyond clinical examination, functional scoring systems provide objective quantification of symptom severity and activity limitation. The American Orthopaedic Foot and Ankle Society score and the Foot and Ankle Ability Measure are commonly employed instruments for assessing functional status in patients with chronic ankle instability. These tools facilitate evaluation of the impact of instability on daily activities and sports participation, while also serving as benchmarks for monitoring therapeutic outcomes and guiding clinical decision-making [6, 14].

Certain clinical features should be recognized as red flags for osteochondral lesions. Persistent deep ankle pain is particularly concerning, as osteochondral lesionsmost frequently located on the taluscan alter ankle joint kinetics and contribute to ongoing dysfunction [3, 4]. Likewise, mechanical symptoms such as locking and catching strongly suggest intra-articular pathology and warrant further evaluation through advanced imaging or diagnostic arthroscopy. Collectively, these historical, clinical, and functional elements form the basis of a structured and integrated assessment of patients with chronic ankle instability and suspected osteochondral involvement [3, 5].

Imaging and Diagnostic Strategies

Weight-bearing radiographs constitute an essential first step in the imaging evaluation of chronic ankle instability and associated osteochondral lesions, as they provide valuable information regarding structural alignment and degenerative changes. These radiographs allow assessment of joint space narrowing and subchondral alterations, which may reflect chronic overload or evolving degenerative processes. In addition, stress views enhance diagnostic sensitivity by demonstrating the dynamic response of the ankle under load, thereby facilitating identification of mechanical instability [18]. This modality is particularly useful in detecting subtle syndesmotic instability, a condition that may progress to posttraumatic arthritis if left unrecognized [19].

Magnetic resonance imaging represents the gold standard for evaluating osteochondral lesions due to its capacity to assess cartilage integrity, bone marrow edema, and ligamentous status in a single examination [20]. Its multiplanar capability enables comprehensive characterization of both soft tissue and subchondral bone involvement. Advanced magnetic resonance techniques, including three-dimensional magnetic resonance imaging, provide high-resolution visualization of small and curved anatomical structures, thereby offering detailed assessment of ligament and tendon abnormalities that may accompany chronic instability [21]. Furthermore, postoperative magnetic resonance evaluation using tools such as the Magnetic Resonance Observation of Cartilage Repair Tissue score and biochemical magnetic resonance imaging techniques permits assessment of repair tissue quality and overall cartilage health, thereby supporting longitudinal monitoring of surgical outcomes [20].

Computed tomography also plays a critical role in diagnostic evaluation, particularly in the characterization of osseous structures. It is valuable for determining lesion size, containment, and subchondral architecture. Weight-bearing computed tomography provides a three-dimensional representation of the ankle in a standing position, thereby enhancing measurement precision and allowing more physiologic assessment of joint alignment [22]. When combined with distance mapping techniques, weight-bearing computed tomography enables quantification of osteochondral lesion surface area, volume, and depth, information that is fundamental for surgical planning and informed decision-making [23].

In more complex cases, advanced imaging modalities further refine diagnostic accuracy. Computed tomography arthrography and three-dimensional imaging techniques facilitate detailed visualization of internal joint structures and improve preoperative planning by delineating lesion morphology and spatial relationships [18]. These approaches are particularly advantageous when conventional imaging does not provide sufficient detail to guide accurate diagnosis or therapeutic strategy [23].

Diagnostic ankle arthroscopy complements imaging modalities by offering direct visualization of intra-articular structures. It is considered the gold standard for diagnosing syndesmotic instability and provides the opportunity to address identified lesions during the same procedure [19]. Through direct inspection and immediate intervention, arthroscopy serves both confirmatory and therapeutic purposes, establishing itself as a pivotal tool in the comprehensive management of chronic ankle instability and its associated pathologies [3].

Nonoperative Management

Conservative treatment is generally indicated in early-stage chronic ankle instability and in patients presenting with small osteochondral lesions of the talus, particularly when symptoms are mild and imaging does not demonstrate significant lesion progression. In the context of osteochondral lesions, nonoperative management tends to be more successful when lesions are limited in size and clinical manifestations are minimal. Reported clinical success rates range from 45% to 59%, underscoring that conservative strategies may be appropriate in carefully selected patients [24, 25].

Within this framework, structured neuromuscular rehabilitation plays a central role. Proprioceptive Neuromuscular Facilitation techniques have been shown to significantly improve balance, muscle strength, and pain in patients with chronic ankle instability. These benefits are reflected in measurable improvements in functional balance assessments, including the Y Balance Test and the Star Excursion Balance Test [26]. More broadly, balance and proprioceptive exercises contribute to enhanced dynamic stability and improved subjective outcomes. Evidence supports the integration of balance training with strength conditioning to optimize recovery and reduce recurrence risk [14].

Strengthening of the peroneal musculature and implementation of dynamic stabilization protocols are also fundamental components of conservative management. Targeted peroneal strengthening enhances lateral ankle support, while dynamic stabilization exercises improve neuromuscular control during functional activities. These elements are routinely incorporated into rehabilitation programs to promote functional performance and minimize the likelihood of recurrent sprains [14, 27].

Adjunctive measures such as bracing and orthotic interventions further support conservative treatment. The use of semirigid, lace-up, or soft-shell braces is common in patients with chronic ankle instability. Importantly, these devices do not impair functional performance and may even enhance dynamic activities such as jumping, hopping, and balance tasks. Bracing has demonstrated particular benefit in preventing secondary sprains and facilitating the rehabilitation process [28].

In selected cases, biological adjuncts may complement standard conservative strategies. Intra-articular injections of platelet-rich plasma and hyaluronic acid have been shown to improve pain and functional scores for more than six months in patients with osteochondral lesions of the talus. These interventions are typically considered when structured rehabilitation and bracing alone do not provide adequate symptom relief, offering a non-surgical option to address persistent pain [24].

Despite these measures, certain factors predict failure of conservative management. Greater lesion depth on magnetic resonance imaging, the presence of subchondral cyst formation, and extensive bone marrow edema is associated with poorer outcomes. When symptoms fail to improve after three months of structured conservative therapy, surgical intervention may be recommended to prevent further structural deterioration and functional limitation [24].

Surgical Management of Chronic Ankle Instability

Operative intervention is indicated when structured conservative management fails to resolve mechanical instability in patients with chronic ankle instability [11]. Individuals who continue to experience recurrent ankle sprains, persistent objective instability, and functional limitations despite rehabilitation are considered appropriate surgical candidates [2]. The presence of associated intra-articular pathology, including osteochondral lesions, may further support the indication for surgery; however, limited lesions do not appear to significantly compromise postoperative outcomes when appropriately addressed [5].

Among surgical options, anatomic repair techniques remain the foundation of treatment. The modified Broström procedure is widely regarded as the gold standard for repair of the lateral ligament complex, particularly the anterior talofibular ligament [11]. Both open and arthroscopic approaches to this procedure have demonstrated significant improvements in functional outcomes. Arthroscopic techniques, in particular, have been associated with faster recovery in terms of pain reduction and restoration of stability when compared with traditional open surgery [2, 29].

In cases of severe, generalized, or long-standing instability in which native ligament tissue is insufficient, ligament reconstruction using autografts or allografts may be required [11]. Autologous gracilis tendon grafts are commonly utilized in these scenarios. Arthroscopic all-inside anatomic reconstruction with autologous gracilis tendon has demonstrated advantages in earlier return to full weightbearing and sports participation compared with open reconstructive procedures [30].

The choice between arthroscopic and open approaches continues to evolve. Arthroscopic techniques are increasingly favored due to comparable clinical outcomes and advantages in early postoperative recovery and reduced pain. Although long-term functional scores and complication rates are similar between open and arthroscopic procedures, arthroscopy offers the benefit of earlier return to daily activities and sports participation [30, 31].

Postoperative outcomes following anatomic lateral ankle stabilization are generally favorable. The return-to-sport rate is high, with approximately 83% of patients resuming their pre-injury level of athletic activity. The mean time to return to sport has been reported at approximately 12.45 weeks, with professional athletes demonstrating higher return rates than recreational athletes [22]. Complication rates remain low for both open and arthroscopic techniques, and no significant differences have been observed in surgical duration or overall complication profiles between approaches [30, 31].

Surgical Management of Osteochondral Lesions of the Talus

Appropriate management of osteochondral lesions of the talus requires careful lesion stratification, as size, depth, and containment are decisive factors in selecting the optimal surgical strategy. Lesions exceeding 90 to 100 mm² in surface area and deeper than 7.5 mm frequently necessitate more aggressive interventions than bone marrow stimulation alone, including bone grafting or autologous osteochondral transplantation [32]. Cystic lesions with a diameter greater than 8 mm represent a distinct subgroup that may benefit from autologous osteoperiosteal transplantation or autologous osteochondral transplantation, both of which have demonstrated comparable clinical efficacy [33].

Among available treatment modalities, bone marrow stimulation techniques remain widely used, particularly for smaller defects. Microfracture, as a commonly applied bone marrow stimulation method, has shown effectiveness in smaller lesions, with reported success rates of approximately 61% in this subgroup. Its minimally invasive nature and cost-effectiveness support its role as a primary treatment option [34]. However, outcomes tend to decline with increasing lesion size. The adjunctive use of scaffolds has been proposed to enhance results in lesions larger than 1.0 cm², although current evidence regarding the superiority of specific scaffold types remains limited [24].

For larger osteochondral defects, autologous osteochondral transplantation and mosaicplasty have demonstrated consistent clinical effectiveness. These techniques have been associated with significant improvements in functional scores and high survival rates during long-term follow-up [20, 35]. Autologous osteochondral transplantation appears particularly advantageous in lateral osteochondral lesions, where favorable intermediate-term outcomes and high rates of return to pre-injury activity levels have been reported [36].

Autologous chondrocyte implantation represents another advanced cartilage restoration strategy with demonstrated long-term efficacy. Clinical studies have reported sustained improvements in functional scores extending over two decades [6]. Nevertheless, this technique is more complex and costly than other options and often requires a two-stage procedure, factors that may limit its routine use [34]. Scaffold-based techniques, particularly when combined with autologous bone grafting, have also shown stable and favorable outcomes, including in adolescent populations, with median follow-up periods of six years [37].

The management of cystic lesions further highlights the importance of addressing subchondral pathology. Subchondral bone grafting provides structural support and enhances integration of grafts or implants, thereby improving the biological and mechanical environment for repair. Techniques utilizing autologous bone graft harvested from the tibial plafond have been developed for deep lesions, offering a minimally invasive alternative associated with reduced complication rates [38].

Comparative analyses have demonstrated that autologous osteochondral transplantation and mosaicplasty provide durable long-term results, with sustained improvements in clinical outcomes and low morbidity [20, 35]. While autologous chondrocyte implantation offers long-lasting benefits, its complexity and cost often reserve its use for selected cases in which other treatments have failed [6]. Autologous osteoperiosteal transplantation has shown noninferior outcomes compared with autologous osteochondral transplantation and is associated with lower donor site morbidity, positioning it as a viable alternative for large cystic lesions [33].

Combined Treatment Strategies, Rehabilitation, and Prognosis

The rationale for simultaneous correction of chronic ankle instability and osteochondral lesions lies in the need to address both mechanical instability and cartilage damage within the same therapeutic framework. Treating these pathologies concurrently may reduce the risk of progressive joint degeneration and improve functional outcomes by restoring stability while simultaneously managing intra-articular structural compromise. Comparative evidence supports this integrated approach. A study evaluating single-stage versus staged surgical management demonstrated that single-stage intervention achieved superior short-term clinical outcomes, including higher Karlsson-Peterson and American Orthopaedic Foot and Ankle Society scores at 12 months, without showing inferiority at midterm follow-up. Moreover, addressing both conditions during the same procedure may decrease overall rehabilitation time and facilitate a faster return to normal activities [39].

When surgical strategies are compared, single-stage interventions consistently demonstrate favorable short-term recovery profiles, with improved functional scores relative to staged procedures [39]. Arthroscopic techniques, including the modified Broström procedure, have been shown to enhance functional outcomes, while anatomic reconstructions may provide greater mechanical stability in selected cases [40]. Both open and arthroscopic reconstructions using autologous grafts yield comparable long-term results; however, arthroscopic approaches may allow earlier return to daily activities and sports participation [30].

Postoperative rehabilitation protocols vary considerably across clinical settings, particularly regarding weight-bearing progression, immobilization strategies, and physical therapy recommendations. Although early weight-bearing and early initiation of rehabilitation have been suggested to accelerate recovery, many protocols remain time-based rather than criteria-based [25]. Structured approaches incorporating synovectomy and capsular shrinkage within a four-step strategy have demonstrated sustained improvements in stability and function over long-term follow-up [6].

Long-term outcomes following combined or isolated surgical treatment are generally favorable when appropriate stabilization and rehabilitation strategies are implemented. Nevertheless, recurrence of instability and degenerative progression remain potential concerns. Risk factors associated with recurrence and joint degeneration include greater lesion size and incomplete mechanical stabilization of the ankle [20]. Although most patients experience satisfactory outcomes, symptom recurrence and degenerative changes may still occur over time [2]. Preventive strategies aimed at correcting both medial and lateral instability have been proposed to reduce the long-term risk of osteoarthritis [41].

In parallel, emerging surgical techniques continue to evolve. Minimally invasive approaches, such as all-arthroscopic stabilization and synthetic augmentation, are gaining attention due to their potential to shorten recovery time and optimize functional results [41]. Regenerative procedures, including autologous osteochondral transplantation, have demonstrated promising long-term outcomes in the management of large osteochondral lesions, reinforcing their role in comprehensive joint preservation strategies [20].

Conclusion

Chronic ankle instability is a multifactorial disorder in which ligamentous insufficiency, neuromuscular deficits, and persistent intra-articular inflammation interact to disrupt normal ankle biomechanics. These alterations increase joint loading and stress over the talar dome, promoting the development of osteochondral lesions and creating a continuum that may progress toward post-traumatic osteoarthritis if left untreated.

Accurate diagnosis requires an integrated clinical and imaging approach. A detailed history, targeted physical examination, and functional scoring systems must be complemented by appropriate imaging modalities to identify both mechanical instability and associated osteochondral pathology. Advanced imaging and, when necessary, diagnostic arthroscopy allow precise characterization of structural damage and facilitate appropriate treatment planning.

Management should be individualized according to instability severity and lesion characteristics. Early-stage cases may respond to structured rehabilitation and bracing, whereas persistent mechanical instability requires anatomic repair or reconstruction. Osteochondral lesions demand lesion-specific strategies, and simultaneous correction of instability and cartilage damage may optimize functional recovery and reduce the risk of long-term degenerative progression.

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