

ULTRASOUND-GUIDED TREATMENT OF CHRONIC KNEE PAIN DUE TO OSTEOARTHRITIS: DIAGNOSTIC AND THERAPEUTIC APPROACH BASED ON THE TYPE OF PAIN

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Abstract: Knee osteoarthritis (OA) is a prevalent cause of chronic pain and disability. Pain phenotyping (inflammatory, mechanical, and neuropathic) guides more effective interventions. Ultrasound (USG) allows diagnostic stratification (synovitis, effusion, periarticular changes) and accurately guides intra-articular injections (corticosteroid, local anesthetic, hyaluronic acid), genicular nerve blocks, and Valeix injections. This review summarizes the diagnostic basis, technique, and pharmacological choices guided by USG, discussing evidence and practical applications.

Keywords: osteoarthritis; knee; ultrasonography; genicular block; joint injection; chronic pain.

Introduction

Osteoarthritis (OA) of the knee is the most common joint disease and one of the leading causes of disability after age 50. (Hunter DJ et al, 2019)

Pain in OA results from the interaction of inflammatory, mechanical, and neuropathic mechanisms; Identifying the predominant mechanism improves therapeutic selection. (Bannuru RR et al, 2019)

Ultrasonography (USG) has been consolidated in interventional practice because it combines dynamic evaluation and real-time guidance of the needle, with greater accuracy and safety of the procedures. (Finlayson RJ et al, 2012)

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Diagnosis and differentiation of pain types

Chemical/inflammatory pain: mediated by cytokines (IL-1, TNF- α) and prostaglandins; clinically it progresses with morning stiffness and pain at rest; USG shows synovial thickening, effusion, and Doppler hyperemia. (Hunter DJ et al, 2019)

Physical/mechanical pain: related to structural overload due to chondral degeneration, osteophytes, and subchondral bone alterations; it manifests with pain on exertion and relief at rest; US may show effusions, chondral irregularity, and osteophytes. (Bannuru RR et al, 2019)

Neurological/neuropathic pain: involves peripheral and central sensitization; it is characterized by burning, shocks, allodynia and hyperalgesia; DN4 and PainDETECT instruments aid clinical screening. (Freynhagen R et al, 2006)

USG-guided therapeutic strategies

Inflammatory (chemical) pain

USG-guided intra-articular infiltration with corticosteroids (triamcinolone or methylprednisolone), with or without local anesthetic, rapidly reduces synovial inflammation with short-term benefits. (Bannuru RR et al, 2019)

Viscosupplementation with hyaluronic acid (HA) can be added when there is persistence of inflammatory pain or coexistence of mechanical pain; formulations with higher molecular weight have greater persistence of effect. (Jevsevar DS et al, 2013)

Physical/mechanical pain

In predominantly mechanical pain, HA reduces joint friction and improves function in the medium term. (Jevsevar DS, 2013)



Platelet-rich plasma (PRP) shows expanding evidence for improvement in pain and function in knee OA, with results superior to HA in some studies. (Filardo G et al, 2015)

Neurological/neuropathic pain

USG-guided genicular nerve block (GNB), directed at the superomedial, superolateral, and inferomedial branches, is indicated when there is peripheral hypersensitization or refractoriness to intra-articular infiltration. (El-Hakeim EH et al, 2018)

Local anesthetics, corticosteroids, or 5–10% glucose solution may be used for perineural neuromodulation, depending on the clinical phenotype and previous response. El-Hakeim EH et al, 2018)

Valeix suture infiltrations (PIT) focus on periarticular sensory branches that are painful to palpation and may employ local anesthetic or hyperosmolar glucose. (Jevsevar DS, 2013)

Role of Ultrasonography (USG): Accuracy, Safety, and Personalization

USG enables real-time guidance (in-plane and out-of-plane planes), needle tip visualization and solution spreading, and the use of hydrodissection to open tissue planes, increasing the hit rate and reducing failures. (Finlayson RJ et al, 2012)

Color Doppler maps genicular and periarticular vessels prior to puncture, mitigating intravascular injection and hematomas—especially useful in genicular blocks and periarticular infiltrations. (Finlayson RJ et al, 2012)

Compared to fluoroscopy, ultrasound eliminates radiation, is portable, enables outpatient procedures, allows dynamic evaluation and longitudinal documentation (e.g., post-infiltration stroke reduction) without patient displacement. (Valeix B et al, 1948)

Good practices include transducer and puncture plane selection, fine echogenic needles (22–



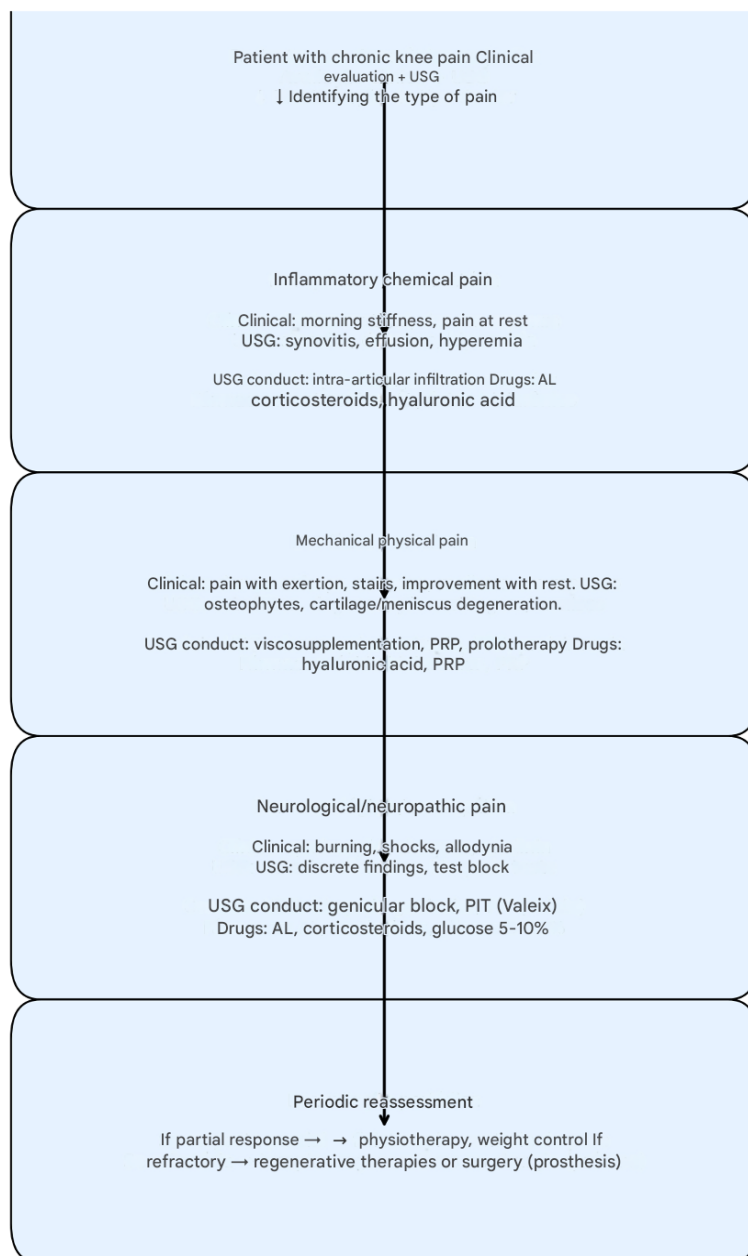
25G), conservative volumes with intermittent aspiration, and imaging/video recording. Proficiency requires structured training and a supervised learning curve. (Valeix B et al, 1948)

Chart 1 – USG-guided management of chronic knee pain due to osteoarthritis

Type of pain	Clinical features	USG findings	USG-guided interventions	Usual drugs	Evidence
Chemical / Inflammatory	Pain at rest, morning stiffness, improvement with NSAIDs	Synovitis, effusion, Doppler hyperaemia	Intra-articular infiltration	Corticosteroids ± local anesthetics; OH	Forté (OARSI/ACR)
Physics / Mechanics	Pain on exertion, worsening on stairs, relief on rest	Osteophytes, chondral irregularity, meniscopathy	Viscosupplementation; PRP/Prolotherapy	OH; PRP	Moderate – strong (HA/PRP)
Neurological / Neuropathic	Burning, shock, allodynia, hyperalgesia	low-specific USG; Lock Test	GNB; PIT (Valeix)	LA, corticosteroid, glucose 5–10%	Moderate (GNB RCT; PIT series)



Figure 1 – USG-guided diagnostic-therapeutic algorithm for knee OA



Discussion

Stratifying pain by mechanism guides choices: intra-articular infiltration (corticosteroid/HA) for inflammatory and mechanical pain; GNB and ITP for refractory neuropathic component.



(El-Hakeim EH et al, 2018)

Therapeutic combinations (e.g., HA for mechanics associated with GNB for neuropathic pain) and non-pharmacological measures (exercise, weight loss, physiotherapy) enhance clinical outcomes. (Bannuru RR et al, 2019)

Limitations include methodological heterogeneity, technical variations, and lack of standardization of volumes/drugs and outcomes—requiring better quality comparative studies. (El-Hakeim EH et al, 2018)

Conclusion

The management of chronic pain in knee OA should be individualized according to the predominant mechanism of pain.

USG is a central tool because it integrates diagnostic evaluation, precise needle guidance, and response monitoring, increasing safety and efficacy. (Finlayson RJ et al, 2012)

Under USG, infiltrations with corticosteroids and HA, PRP, prolotherapy, GNB, and ITP make up a versatile arsenal; Selection should be guided by pain phenotyping and functional goals. (Filardo G et al, 2015)

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