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Early Osteoarthritis of the Hip in Young Adults: Role of Orthobiologics, Ozone Infiltration, and Radiofrequency Ablation in Pain Relief and Joint Preservation

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Abstract
Background: Early hip osteoarthritis (OA) in young adults is increasingly recognized and demands joint-preserving strategies. This study evaluates a stepwise, multimodal protocol (PRP or HA with ozone ± diagnostic block; RFA for non-responders) for pain relief and functional recovery.
Methods: Prospective single-arm cohort of 24 patients (28 hips) with Tönnis Grade 0-2 hip OA. Day-0 injection (leukocyte-poor PRP 4 mL or high-MW HA 2 mL) + ozone (10 mL at 20 µg/mL) under C-arm guidance; RFA (femoral/obturator articular branches) at 2 weeks for <50% VAS responders. Outcomes: VAS, Harris Hip Score (HHS), WOMAC at 2, 6, 12 weeks, 6 months, and 1 year.
Results: Mean VAS improved from 7.4±0.8 to 2.3±1.0 at 1 year (p<0.001); HHS from 56.7±6.1 to 83.9±7.8 (p<0.001); WOMAC from 68.5±8.3 to 34.7±6.9 (p<0.001). Two-thirds improved after injections alone; one-third required RFA and achieved comparable 1-year outcomes. Radiographs (6-month, 1-year) showed maintained joint space without progression.
Conclusion: A multimodal protocol combining orthobiologics, ozone, and selective RFA yields clinically meaningful, durable benefits in early hip OA and is a safe, joint-preserving option in young adults.

Keywords: Hip osteoarthritis, platelet-rich plasma, hyaluronic acid, ozone therapy, radiofrequency ablation

Introduction

Hip pain in young adults frequently reflects early joint degeneration rather than isolated soft-tissue pathology. Early osteoarthritis (OA) of the hip is characterized by labral and focal chondral changes that precede visible radiographic joint-space loss [1]. Because the hip is central to load transfer and gait, small structural aberrations can translate into substantial pain and disability in active individuals [2]. Conventional care (activity modification, physiotherapy, NSAIDs, corticosteroids) often provides short-term relief without altering the degenerative cascade [3]. In parallel, regenerative and interventional pain techniques—orthobiologics (PRP, MSCs), ozone therapy, and radiofrequency ablation (RFA)—have emerged as minimally invasive options that target biological milieu and nociceptive pathways [4-6]. We implemented and prospectively evaluated an integrated, stepwise protocol intended to maximize pain relief, support function, and preserve the joint in early hip OA.

Review of Literature

Early hip OA arises from the interplay of mechanical conflict (e.g., femoroacetabular impingement, dysplasia), subclinical inflammation, and microstructural cartilage/labral injury. MRI studies have linked labral tears and focal cartilage defects to subsequent progression, even when radiographs remain normal [11]. In athletic and high-impact cohorts, early chondrolabral pathology is common and may be present in asymptomatic hips [12].

Orthobiologics: Platelet-rich plasma (PRP) delivers a milieu of growth factors (PDGF, TGF-β, VEGF) and cytokines capable of down-modulating inflammation while promoting chondrocyte anabolism and matrix synthesis. Clinical studies and meta-analyses—largely knee-dominant but increasingly including hip subsets—report PRP-associated improvements

in pain and function over HA and corticosteroids at short- to mid-term follow-up [2-4, 13, 14]. Heterogeneity in PRP preparation (leukocyte content, activation, platelet concentration) and dosing intervals remains a key methodological limitation.
Mesenchymal stem cell (MSC) therapies (bone marrow-derived or adipose-derived) have shown paracrine-mediated immunomodulation and trophic support for cartilage repair. Reviews and umbrella analyses suggest symptomatic benefit and potential structural effects in early OA, though high-quality hip-focused randomized evidence is still evolving [5, 1]. Combination biologics (e.g., PRP+MSC) may offer synergy in preclinical work, prompting cautious clinical exploration [15].

Ozone therapy: Intra-articular ozone (typically 10-20 μg/mL) provides controlled oxidative preconditioning, up-regulating endogenous antioxidant defenses, improving microcirculation, and modulating nociceptor sensitivity. Randomized trials and systematic reviews—particularly in knee OA—have shown clinically meaningful reductions in VAS and WOMAC versus placebo and in some studies versus corticosteroids [6, 7]. Safety profiles are favorable when strict dosing and aseptic technique are observed.
Radiofrequency ablation: Articular branch RFA of the femoral and obturator nerves reduces nociceptive transmission from the anterior hip capsule. Narrative reviews and case series report 50-70% pain reduction sustained for 6-12 months in refractory hip pain cohorts [8, 9]. Cooled and conventional RFA techniques are described, with technique selection guided by anatomy, equipment, and operator experience [10, 1]. Evidence gaps include randomized trials specific to hip OA and standardized outcome reporting.

Integrated protocols: Combining biologic modulation (PRP/HA±ozone) with targeted neuromodulation (RFA) is conceptually compelling—orthobiologics improve the intra-articular environment while RFA rapidly suppresses pain, enabling adherence to rehabilitation. Our stepwise protocol (injection first; RFA for <50% responders) operationalizes this logic while minimizing unnecessary procedures. Contemporary literature supports each component individually, and early prospective data—including the present study—suggest additive clinical value over one year [2, 6, 8, 9, 1].

Materials and Methods

Design and setting: Prospective, single-arm interventional study conducted at the Department of Orthopedics and Pain Clinic, Amandeep Hospital, Amritsar (January 2023-March 2024). Approval was obtained from the Institutional Ethics Committee; all patients gave written informed consent. All procedures were performed under aseptic conditions using C-arm fluoroscopic guidance.

Participants: Twenty-four consecutive patients (28 hips) aged 25-55 years with symptomatic early hip OA were enrolled. Diagnosis incorporated clinical examination, MRI evidence of early chondrolabral change, and radiography graded by the **Tönnis classification** (Grades 0-2 included; Grade 3 excluded).

Inclusion criteria: (i) hip pain ≥3 months refractory to conservative care; (ii) Tönnis 0-2; (iii) no intra-articular injection or ablation in prior 6 months; (iv) ability to comply with follow-up. Exclusion criteria: (i) Tönnis 3 or AVN; (ii) prior arthroplasty/major deformity; (iii) inflammatory or septic arthritis; (iv) coagulopathy/uncontrolled systemic illness; (v) pregnancy/lactation.

Intervention protocol: **Day 0**—intra-articular injection of leukocyte-poor PRP (4 mL) *or* high-MW hyaluronic acid (2 mL) plus **ozone-oxygen mixture** (10 mL at 20 μg/mL). Diagnostic articular branch block with 0.25% bupivacaine (1 mL per branch) was added when pain generator localization was uncertain. **Week 2**—patients with <50% VAS reduction underwent **RFA** of femoral/obturator articular branches using a 22-G curved-tip cannula (80 °C×90 s per site) with post-lesion 0.25% bupivacaine (1 mL) + methylprednisolone (20 mg).

Rehabilitation: Standardized protocol emphasizing hip ROM, gluteal strengthening, and activity modification. NSAIDs permitted for ≤5 days post-procedure only.

Outcomes and follow-up: Assessments at baseline, **2, 6, 12 weeks**, **6 months**, and **1 year**. Primary: **VAS (0-10)** and **Harris Hip Score (HHS, 0-100)**. Secondary: **WOMAC (0-100)**, patient satisfaction (Likert 1-5), and adverse events. Clinically meaningful improvement was defined a priori as ≥50% VAS reduction and ≥10-point HHS gain.

Statistics: Continuous data are mean± SD; categorical as counts/percentages. Within-patient changes were analyzed by paired tests/repeated measures; subgroup comparisons (RFA vs non-RFA) by independent tests. Two-tailed $p<0.05$ denoted significance (IBM SPSS v26.0).

Results

Cohort characteristics: Mean age 42.1±7.2 years; 62.5% male. Tönnis grade distribution (hips): Grade 0 = 4 (14%), Grade 1 = 14 (50%), Grade 2 = 10 (36%). Mean symptom duration was 10.3±4.7 months. Baseline mean scores: VAS 7.4±0.8; HHS 56.7±6.1; WOMAC 68.5±8.3.

Table 1: Baseline characteristics and scores

Variable	Mean/Count	SD/%	Notes
Age (years)	42.1	7.2	—
Male sex	15	62.5%	n=24
VAS (0-10)	7.4	0.8	Higher = worse
HHS / WOMAC	56.7 / 68.5	6.1 / 8.3	HHS higher = better; WOMAC higher = worse

Intervention course: All patients received Day-0 injection (PRP or HA) plus ozone. At 2 weeks, 16/24 patients (67%) achieved ≥50% VAS reduction; 8/24 (33%) underwent RFA. No major complications occurred; transient post-injection soreness (21%) and transient numbness after RFA (8%) resolved spontaneously.

Table 2: Outcomes over time (mean± SD)

Timepoint	VAS	HHS	WOMAC
Baseline	7.4±0.8	56.7±6.1	68.5±8.3
2 weeks	4.3±1.1	64.2±7.3	53.4±7.5
6 weeks	3.2±1.0	74.8±8.1	44.8±7.1
12 weeks	2.8±0.9	80.3±7.9	39.1±6.8
6 months	2.5±0.8	83.1±8.0	36.2±7.2
1 year	2.3±1.0	83.9±7.8	34.7±6.9

All primary and secondary endpoints improved significantly at each follow-up compared with baseline ($p<0.001$). At 1 year, 75% maintained ≥50% VAS reduction; HHS increased by +27.2 points on average; WOMAC improved by ~49%. Patients requiring RFA showed faster early pain relief at 6 weeks, with similar 1-year outcomes to injection-only responders.

Fig 1: AP pelvic radiograph at 6-month follow-up showing preserved joint space and decreased subchondral sclerosis.

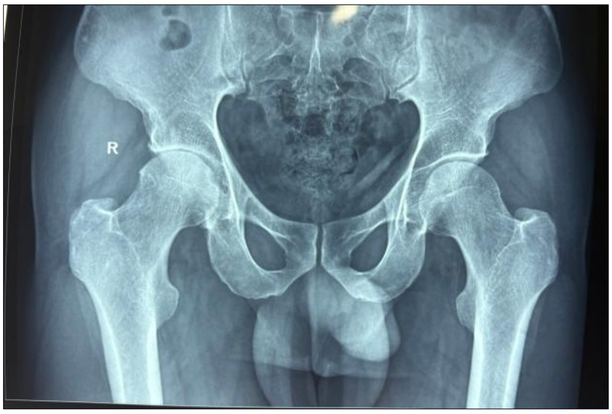

Fig 2: AP pelvic radiograph at 1-year follow-up demonstrating maintained articular congruity and no progressive osteoarthritic change.

Discussion

In this prospective cohort of young adults with early hip OA, a stepwise multimodal protocol—PRP or HA plus ozone at baseline with selective RFA at 2 weeks for non-responders—produced rapid and durable improvements across pain and functional outcomes over one year. Two-thirds achieved clinically meaningful pain relief after injection therapy alone, while the remaining third benefited from RFA without added safety concerns. The overall trajectory aligns with contemporary evidence supporting biologic modulation of the articular milieu and targeted neuromodulation of nociceptive pathways [2-7, 8-10].

Mechanistic rationale: PRP delivers growth factors that may suppress NF-κB signaling and promote chondrocyte anabolism, potentially stabilizing early matrix damage. HA provides viscoelastic supplementation and boundary lubrication; combining biologic (PRP) or hyaluronan with ozone—an oxidative preconditioning stimulus—may further reduce nociceptor sensitization, downregulate pro-inflammatory cytokines, and improve microvascular oxygen delivery [5-7]. Where these mechanisms do not sufficiently blunt nociception, RFA of femoral/obturator articular branches interrupts afferent input from the anterior capsule, delivering an analgesic window in which rehabilitation can reinforce functional gains [8, 9].

Comparative context: Meta-analyses suggest PRP outperforms HA and corticosteroids in OA pain and function at 6-12 months [13-14], while narrative and cohort evidence supports hip articular branch RFA with 50-70% pain reduction sustained up to a year [8, 9, 16]. Our findings mirror these magnitudes: VAS dropped ~69% and HHS rose ~27 points at one year. Although ozone evidence is strongest in knee OA, the direction and size of effect in our hip cohort were consistent with published RCTs and reviews [6, 7].

Clinical implications: A sequential protocol minimizes overtreatment by reserving RFA for persistent pain after biologic/ozone injection, reducing procedural burden while maximizing outcomes. The safety profile was favorable: no infections or neurovascular injuries; transient post-injection soreness and numbness resolved promptly. Pragmatically, this approach is deliverable in a day-care setting under fluoroscopy, aligning with resource realities in high-volume centers.

Limitations: Single-arm design without randomization or a comparator, modest sample size, and reliance on patient-reported outcomes introduce susceptibility to bias. Imaging beyond plain radiography was not standardized at follow-up, limiting structural inference. Generalizability beyond early OA (Tönnis 0-2) requires caution. Future trials should randomize PRP vs HA (with/without ozone), define standardized PRP preparations, and compare early RFA vs deferred RFA strategies. Incorporating quantitative MRI (T2 mapping, dGEMRIC) could clarify structure-modifying effects.

Despite these constraints, this study contributes prospective evidence for a pragmatic, joint-preserving pathway in early hip OA that is safe, reproducible, and associated with durable patient-centered benefits.

Conclusion

A stepwise multimodal regimen—PRP or HA with ozone under fluoroscopic guidance, reserving RFA for early non-responders—achieved substantial and sustained improvements in pain and function over one year in young adults with early hip OA. This protocol is a viable, joint-preserving option that merits evaluation in larger randomized studies with longer follow-up.

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