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Therapeutic Role of Platelet-Derived Extracellular Vesicles: Isolation, Morpho-Functional Characterization, Anti-Inflammatory Effects and Clinical Outcome

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INTRODUCTION:

Cartilage damage in older adults can lead to osteoarthritis (OA) due to poor self-repair capacity. The scarcity of adult chondrocytes and lack of vascularization hinder regeneration. Biological therapies, particularly platelet-derived extracellular vesicles (PEVs), offer the potential for cartilage repair by delivering bioactive molecules directly. This study aimed to (i) isolate and characterize human PEVs; (ii) investigate their anti-inflammatory effects on IL-1β-induced OA-like chondrocytes; and (iii) evaluate the clinical outcome of PEVs in treating knee OA.

METHODS:

PEVs were isolated from peripheral blood using differential centrifugation and characterized using electron microscopy, nanoparticle tracking, and western blotting. Their functionality was assessed through chondrocyte proliferation and phenotype maintenance. An in vitro IL-1β-induced OA-like chondrocyte model was developed and used to analyse the impact of PEVs on cell proliferation, extracellular matrix, and inflammatory markers. Microarray screening was conducted to examine miRNA expression. Sixty-two OA patients with Kellgren-Lawrence grades I-III completed pre- and post-treatment questionnaires to assess the effectiveness of PEV injection. Kruskal-Wallis, Wilcoxon tests, and Monte Carlo simulation were applied to analyse group and within-group differences.

RESULTS:

PEVs were successfully isolated via high-speed centrifugation, yielding vesicles with an average size of <150 nm (Fig. 1a). Platelet activation was confirmed through morphological changes and CD63, TSG101, and HSP70 expression. A 10% PEV concentration maximized chondrocyte proliferation and preserved differentiation. IL-1β-induced OA-like changes, including increased MMP-13, were mitigated by PEV treatment, enhancing proliferation and collagen type II production (Fig. 1b). Microarray analysis identified 334 differentially expressed miRNAs, with downregulation of miRNA-29, miRNA-146, and miRNA-155, indicating anti-inflammatory properties (Fig. 1c). Clinically, PEV improved symptoms and quality of life in mild-to-moderate knee OA, demonstrating the greatest improvement compared to controls, despite variable statistical significance across subscales.

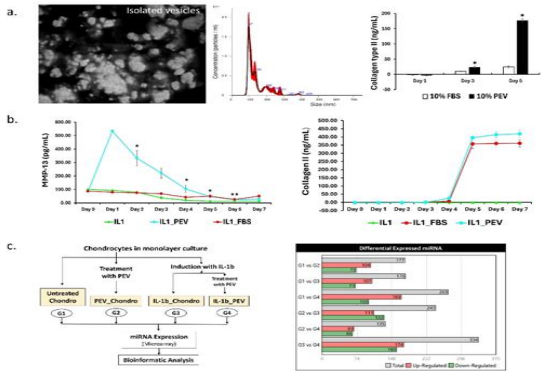

Figure 1: (a) characteristics of isolated PEVs; (b) impact of PEVs on MMP13 and collagen type II; and (c) differentially expressed miRNAs across experimental groups.

DISCUSSION:

Platelet-derived EVs mediate physiological processes and aid tissue regeneration. Their bioactive molecules, particularly miRNAs [1], support chondroprotection and anti-inflammatory regulation.

CONCLUSION:

PEVs can be isolated efficiently, promoting chondrocyte proliferation while preserving phenotype. They mitigate IL-1β-induced inflammation by reducing inflammatory markers and modulating anti-inflammatory miRNAs, supporting cartilage regeneration. Our PEV injection targets early-stage OA, aiming to relieve symptoms and improve patients' quality of life.

REFERENCES:

[1] Bracht et al. J Extracell Vesicles 2023