Short Platelet-Rich Plasma Exposure Induces a Priming Effect on the Biophysiological Potency of Bone Marrow Mesenchymal Stem Cells in Humans

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Purpose: Platelet-rich plasma (PRP) and bone marrow mesenchymal stem cells (BM-MSCs) find application in the surgical treatment of nonunions and bone defects. Due to their different mechanisms of action, combination therapy has been popularized. However, there remains a lack of high-quality in vitro evidence supporting their use in combination. We therefore undertook a donor-matched laboratory study examining the biological effects of PRP on BM-MSC in humans. We therefore aim to investigate the effect of short autologous PRP exposure of 30 minutes on BM-MSC growth at the single-cell level.

Methods: 17 patients (median age 30 years [interquartile range (IQR): 27-42; range: 19-73]; male: female ratio = 1.8) undergoing surgery for nonunion (n = 6), osteonecrosis (n = 7), and second-stage Masquelet procedure (n = 4) were recruited. Bone marrow aspirate (BMA) was harvested from the patient's iliac crest, and PRP was generated following centrifugation of the same patient's peripheral blood. Donor-matched comparative groups were: (1) BMA and (2) BMA + PRP mixed at a 1:1 ratio to reflect clinical practice. Samples underwent 30-minute laboratory incubation at room temperature to mimic average surgical time (time from harvest to implantation), prior to processing for colony forming units–fibroblast (CFU-F) assay. Samples were assessed for BM-MSC characteristics by measuring MSC colony number/mL of BMA, colony area, and colony integrated density (ID) at day 14 of culture.

Results: A total of 1310 and 1324 colonies were analysed for the BMA and BMA + PRP group, respectively. In comparison to BMA alone, incubation of BMA with PRP resulted in a statistically significant increase in average colony ID (1.5-fold; $P<0.0001$) and colony area (1.5-fold; $P<0.0001$). Paired analysis (n = 17) demonstrated a statistically significant increase in both the median colony area (1.6-fold; $P<0.0001$) and median colony ID (n = 1.6-fold; $P<0.0001$), with a trend toward increased median colony number/mL.

Conclusion: This study demonstrates that short exposure to autologous PRP as seen in clinical practice induces a beneficial and long-lasting priming effect on the proliferative capacity of BM-MSC at the single-cell level. Further studies are needed to uncover molecular mechanisms behind this physiological phenomenon towards further optimization of bone regeneration strategies.