ROLE OF PERIOSTEUM AND BONE MARROW IN LENGTHENING: A QUANTITATIVE STUDY IN RABBITS USING DEXA

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INTRODUCTION: This study evaluates quantitatively the bone formation due to periosteum and/or bone marrow endosteum in distraction osteogenesis.

MATERIALS AND METHODS: Surgical procedure. One femur of 18 NZW 2.4-3.0 kg rabbits was fitted with a custom-made external fixator (contralateral one-control). Periosteum (P) and bone marrow (BM) were treated, according to their preservation (+) or destruction (-): P+ P elevated; P- P stripped from the bone; BM+ corticotomy; BM- marrow cavity filled with PMMA. 4 surgical groups were individualized: 1) P+BM+ (5 animals); 2) P+BM- (5); 3) P-BM+ (5); 4) P-BM- (3). From POD 5, femora were lengthened 0.25 mm/day until POD 25. At sacrifice on POD 30, femora were harvested with a 0.5 to 1.0 mm muscle layer. Dual energy x-ray absorptiometry study (QDR1000, Hologic). The area, bone mineral density (BMD) and bone mineral content (BMC) were calculated. Femora were divided into 5 regions of interest (operated), or 4 (control), as shown below. Statistical study (JMP V2.0, SAS). Values (% obtained = [op. femur - control] / control) were transformed and compared data from regions 1-5 and 2-4. Differences between groups were analyzed (Tukey-Kramer test).

RESULTS: X-ray evaluation: BM forms bone around the distraction gap, nor in the muscle. Percent increase in area, BMC & BMD with respect to the contralateral bone: Table I. Statistical analysis on the transformed data: Table II. The comparison of surgical groups showed a significant difference for area (p<0.0008), BMC (p<0.0004) & BMD (p<0.004) in the whole specimens. Tukey-Kramer test: significant differences between surgical groups 1 and 4, 2 and 3, 2 and 4. For the 3 central regions, similar results, but greater significant difference (p<0.0001, area, BMC, BMD).

DISCUSSION: Quantitatively, the P contributes more than the BM to new bone formation. The interaction between BM and P is significant. The spatial distribution of the bone formed is different for P and BM: BM deposits new bone around itself, at the fracture or distraction site, and P forms bone along the elevated P and covers a larger area. When BM is destroyed, periosteal bone formation fills the distraction site, and P forms bone along the P and covers a larger area.

CONCLUSION: A synergistic effect (spatial and qualitative) may result from the combination of periosteum and bone marrow-endosteum in bone healing.

Table I. Measurements on the whole specimens (W) and in the 3 central regions (C) in the 4 groups: % increase in area, BMC and BMD, for the op. femur / non-op. femur (mean ± 1 SD).

Table II. Effects (+ or - , with probability p) of Periosteum (P), bone marrow (BM) and interaction P/BM (PB) on the area, BMC & BMD of the whole specimens (W) and of the 3 central regions of interest, around the distraction gap (C).