

Healing Efficiency and Complication Risk Following Low-Energy Oscillating-Saw Osteotomy in Distraction Osteogenesis: Role of Intermediate Stage Callus Patterns

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INTRODUCTION:

Distraction osteogenesis (DO) is a widely utilized technique for limb lengthening and bone defect management, but its outcomes remain variable. Traditional indices such as healing index (HI) and distraction consolidation time (DCT) provide delayed insights. This study evaluates radiographic callus progression patterns as early prognostic markers for bone healing and investigates the influence of patient age and distraction length on DO outcomes.

METHODS:

We retrospectively reviewed 129 patients (155 bone segments) who underwent lower limb DO between 2003 and 2023. The patients came from all ages and had a mean age of 37.3 years (5.6 to 77). The mean distraction length was 53.2mm (11 to 174). Radiographs were graded monthly using a modified Ru-Li classification, defining two callus consolidation routes: Route 1 (had not gone through type 5/8) and Route 2 (gone through type 5/8). Patients were stratified by age (younger: <25 years; middle: 25–49 years; older: ≥50 years) and distraction length (short: <5 cm; long: ≥5 cm). Standard outcome measures included DCT, HI, distraction index (DI), and external fixator index (EI), compared with analysis of variance. Progression of radiographic grading were drawn by Loess regression. Complications were recorded per Paley's classification. Statistical comparisons were performed using Mann-Whitney U tests with effect size estimation.

RESULTS:

Route 1 demonstrated more favorable healing with significantly lower DCT (300.4 vs 381.6 days; $p = 0.002$) and HI (70.1 vs 89.1 days/cm; $p = 0.021$) with medium effect sizes. Among age groups, younger age patients showed negligible differences between callus routes. However, middle and older age groups showed delayed maturation in Route 2, particularly from the high-intermediate callus density grades onward ($p < 0.05$). Long distraction gaps further amplified route-based divergence. Overall, 103 (66.5%) segments experienced complications, though only 3 major complications (1.9%) were recorded. Outcomes using modified oscillating saw osteotomy were non-inferior to traditional techniques.

DISCUSSION AND CONCLUSION:

Radiographic callus progression patterns strongly correlated with consolidation outcomes in DO. Negative patterns (types 5/8) are associated with delayed healing, particularly in older patients and those with longer distractions. These findings supported the use of early radiographic classification for risk stratification and suggested heightened surveillance for adverse callus features to optimize outcomes. Future prospective studies may explore interventions targeting these high-risk patterns.

