Measurement of Changes in Muscle Oxygen Saturation Using Near Infrared Spectroscopy Produced by a Specialized Fracture Brace and the Effect of Muscle Contraction

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INTRODUCTION: Numerous studies have demonstrated that cyclically increasing tissue hypoxia results in the release of growth factors necessary for angiogenesis and healing[1,2]. Cyclic hypoxia is the periodic exposure to cycles of hypoxia and re-oxygenation[2]. The aim of this in vivo study in intact human is to determine if localized external compression of muscle causes de-oxygenation and is the de-oxygenation amplified with physiologic muscle contraction. Historically, the successful outcomes observed with the Sarmiento brace are credited to the "motion between fragments."[3] However, we hypothesize that a cyclic hypoxic environment created by our modified functional brace, augmented with muscle contraction potentially being responsible for the robust healing observed.

METHODS: Using near infrared spectroscopy (infrared technology) changes of oxygenated hemoglobin in muscle were measured in 9 healthy volunteers. Five defined events (timepoints) were used to measure tissue oxygenation with and without localized external pressure, with and without controlled physiologic muscle contraction.

RESULTS: Applying 40 mmHg of localized external pressure using a specialized fracture brace with simultaneous muscle contraction produced a statistically significant increase in the muscle de-oxygenation compared to contraction alone. The de-oxygenation was three times greater with pressure and muscle contraction.

DISCUSSION AND CONCLUSION: Our study suggests that this specialized fracture brace with its unique internal contour causes soft tissue de-oxygenation augmented with muscle contraction. This physiologic hypoxia creates an environment that may promote fracture healing. Future studies should investigate the biochemical composition of the growth factors released and the impact they have on bone healing.