

Collagen Deposition and Biomechanical Behavior During the Healing Process of Gastrocnemius Muscle Injury Treated by Ultrasound in Rats

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BACKGROUND: Considering that ultrasound (US) treatment stimulates collagen deposition, and that the collagen maturation process can contribute to greater mechanical strength a quantitative study was undertaken in which histological findings of collagen were correlated with biomechanical data from lacerated rat muscle, treated by pulsed US.

METHODS: After lesioning, rats were randomly divided into 2 groups: The US group was treated daily with 1 MHz pulsed ultrasound 50% at 0.57 W/cm. for 5 min, and the Control group that received no treatment. Each group was further divided into subgroups (n=5) for histological and biomechanical evaluation at postoperative (p.o.) days 4, 7, 14 and 24. The absolute volume of lesions was estimated using the Cavalieri principle in serial tissue sections stained by hematoxylin-eosin, while stereology tools based on vertical sections were used in evaluation of picrosirius stained sections, in order to evaluate the impact of US in absolute volume of collagen fibers within the lesion. A biomechanical analysis was performed to estimate stress in kilopascals (KPa) and rigidity in Newtons per millimeter (N/mm).

RESULTS: Although the histological pattern was similar in both treated and control groups, the absolute volume of lesion (mean \pm SD, in mm³.) was lower in all US subgroups when compared with the corresponding controls for each time p.o. (**4** - 21.05 \pm 4.37 vs 44.47 \pm 6.09, p=0.02; **7** - 9.87 \pm 4.49 vs 18.27 \pm 3.27, p=0.017; **14** - 6.01 \pm 1.82 vs 13.49 \pm 4.95, p=0.016; **24** - 5.41 \pm 1.57 vs 9.69 \pm 3.23, p=0.047).

Stereological data showed that absolute volume (mean \pm SD, in mm³) occupied by collagen was higher in treated lesions at **4** (7.58 \pm 2.68 vs 2.32 \pm 1.01, p=0.006) and **7** (5.65 \pm 1.26 vs 1.91 \pm 0.69, p=0.011) days p.o. The stress and the rigidity were greater in both groups (US and Control) as the healing process progressed, but the US treatment promoted an earlier improvement of these variables: Stress and Rigidity at **4** days p.o., respectively (442.71 \pm 105.17 vs 287.90 \pm 71.66, p=0.049) and (2.47 \pm 0.37 vs 1.46 \pm 0.41, p=0.036). At **24** days p.o. these variables were even better in the US group (Stress: 701.40 \pm 83.96 vs 597.08 \pm 29.72, p=0.039) and (Rigidity: 3.99 \pm 0.38 vs 3.38 \pm 0.30, p=0.027).

CONCLUSIONS: Based on our results, this study suggests that pulsed US induces a better functional recuperation, which in practice means that the US group is able to perform heavier work sooner.