

Title : MUSCLE WATER AND ELECTROLYTES IN INJURY AND INFECTION

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Injury and infection are associated with water retention and increases in weight. The distribution of retained fluid in various body tissues is unknown at present. Although it has been assumed that the retained fluid is sequestered mainly at the site of the injury, our previous studies have suggested that abnormalities of muscle H<sub>2</sub>O and electrolyte composition occur in non-injured areas (1). This study examines changes in muscle water and electrolyte composition in major trauma and sepsis.

**Methods:** Eight patients were studied after major trauma (multiple fractures, gunshot injuries to chest and abdomen). Muscle biopsies were performed on the third morning following injury. Four patients developed sepsis during which time 2 repeat biopsies were performed.

Muscle samples were obtained using the percutaneous biopsy technique of Bergstrom (2) from the quadriceps femoris of a non-injured leg. Local anesthesia (Xylocaine 1%) was confined to skin infiltration only. Water content was determined by comparing weights before and after freeze drying at -90° C. Chloride was determined by potentiometric titration. Sodium, potassium and magnesium were determined by atomic absorption spectrophotometry. Extracellular versus intracellular distribution was calculated by the chloride space method using the Nernst equation assuming a normal membrane potential. The procedures have been described in detail (2). This study was approved by the Institutional Review Board; informed consent was obtained.

**Results:** See table:

	Normal (N=16)	Injury (N = 7)	Infection (N=8)
H <sub>2</sub> O <sub>T</sub>	325	362	367*
Na <sub>T</sub>	8.5	15.0*	21.3 <sup>†</sup>
Cl <sub>T</sub>	6.2	11.3*	14.6 <sup>†</sup>
K <sub>T</sub>	46	43.8 <sup>†</sup>	43.0 *
Mg <sub>T</sub>	8.4	8.6	8.0
H <sub>2</sub> O <sub>I</sub>	272	277	247
H <sub>2</sub> O <sub>E</sub>	48	88 <sup>†</sup>	120s

Units of electrolytes: meq/100 gms dry fat-free solids

Units of water: ml/100 gms dry fat-free solids

\*P<.05; <sup>†</sup>P<.01; sP<.001 compared to normal values

A significant increase in extracellular water during injury occurs, apparently further increased by infection (P<.05). Total muscle Na and Cl are increased while the major intracellular cations, potassium and magnesium, are decreased.

**Discussion:** Positive fluid balance occurs following injury. The finding of increased muscle water, sodium and chloride is of interest since it indicates fluid retention is occurring in non-injured portions of the body. Since muscle tissue is the largest component of lean body tissue, the changes reported are of quantitative significance for the whole body. A major limitation of water balance studies is the inability to detect internal fluid shifts. Studies of muscle composition in conjunction with water balance allows a determination of whether loading is in excess of what is being sequestered at the site of injury or infection.

Our results differ with those of Shires et al (3) who have suggested that fluid is transferred from the extracellular space to the intracellular space in injury, hence there is an extracellular deficit requiring large volumes of crystalloid administration. The increase in total muscle water is due to an expansion of the extracellular space with no significant changes in intracellular fluid. Our findings are in agreement with Elwyn et al (4). Changes in major injury and infection differ from that due to elective operation in that muscle potassium is decreased in major trauma and sepsis, but not in elective skeletal injury in the form of total hip replacement (1).

Muscle water and electrolytes seem to vary with the severity of the injury state and whether or not infection complicates the post-injury course. Accordingly, this technique may serve as a guide for fluid replacement therapy.

## REFERENCES

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