Myoglobinemia after Burn Injury: Relationship to Creatine Kinase Activity in Serum

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Myoglobin is released into the blood after burn injury. We measured it and other analytes in blood collected from 22 burn patients two to seven times during their recovery. There was a significant correlation between myoglobinemia and creatine kinase (CK) activity in serum (r = 0.784; p < .001). In a group of 14 thermal-burn subjects a correlation was found between burn depth (clinically expressed as Unit Burn Surface) and both myoglobinemia (r = 0.825; p < .01) and CK activity (r = 0.688; p < .01). In eight thermal-burn patients who were recovering satisfactorily, myoglobin and CK activity measured on days 2, 4, 7, 10, and 13 after injury were significantly increased (p < .05) on days 2, 4, and 7. Evidently myoglobinemia and CK activity are good biological markers of burn depth, and reflect muscle damage equally well.

Additional Keyphrases: extent of burns · muscle damage

Myoglobin, a heme protein involved in oxygen storage and transport in muscle, is found in abundance in cardiac muscle and in skeletal muscle fibers (1). After muscular injury, myoglobin is released into interstitial fluid and blood (1). Immunoassays (2–5) can detect increases in myoglobinemia in different disorders, including myocardial infarction, muscular dystrophy, myopathies, and polymyositis (6–13). Myoglobin is also released from muscle after lightning stroke (14) and other electric shock (15). Walsh et al. (16) described an increase in myoglobinemia after burn trauma, and showed a relationship between the depth and severity of burns and the degree of myoglobinemia. Patients with marked myoglobinemia had an increased risk of early death.

We report here the measurement of myoglobin in serum of burn patients and compare it with creatine kinase (CK, EC 2.7.3.2) activity, which is known to be increased in serum of burn patients (17). Special attention was given to the relationship between myoglobinemia or CK activity and burn depth, which is often difficult to evaluate clinically. Finally, we studied the kinetics of the appearance and disappearance of myoglobin and CK activity in thermal-burn patients who had good recovery.

Materials and Methods

Patients. We measured myoglobinemia and CK activity in serum from 22 burn patients two to seven times during recovery. The causes of burns were flame (14), fire and explosion (five), and electrical (three); 17 patients survived and five died.

The percentage total burn surface area (TBSA) (18) was recorded during the 24 h after admission. Burn depth was expressed as Unit Burn Surface; UBS = TBSA + (3 x the percentage of third-degree burn area).

In eight of the 14 thermal-burn patients (TBSA = 23 ± 4%; mean ± SD) who recovered well, we sampled blood on days 2, 4, 7, 10, and 13 after injury for kinetic studies. Fifteen presumably healthy subjects served as controls, for determination of the myoglobin reference interval.

Methods. Serum myoglobin was measured by radioimmunoassay with reagents and assay protocol of a competitive-type technique (MYOK*; Cia-Sorin, Gif sur Yvette, France). Total CK activity was routinely measured at 30 °C by the "CK-NAC optimized method" (J. T. Baker Chemicals BV, Deventer, The Netherlands) in a OLI 1 C + D* discrete analyzer (Kone, Evry, France). The normal reference interval for CK in our laboratory is < 150 U/L. Samples from each subject were analyzed in the same batch. Interassay variation (CV) was < 9% for myoglobin, < 6.5% for CK activity.

Statistics. We used the Mann and Whitney U test, Spearman rank correlation (19), and linear regression analysis (after log transformation for nonlinear distribution) for statistical assessment of results.

Results

Myoglobinemia vs CK activity. Table 1 gives the ranges of myoglobinemia and CK activity in the different groups of burn patients on day 2 or 3 after injury, when the measured concentrations were highest. The range of TBSA and UBS values are given for each group. In the controls, the concentration of myoglobin was less than 35 µg/L.

In all, we studied 97 samples, but only 67 showed a myoglobin concentration greater than the detection limit of the method (25 µg/L). For these samples myoglobinemia ranged from 25 to 9100 µg/L and CK activity from 11 to 43 575 U/L. The highest values were found on day 15 after injury, in a subject whose case was reported elsewhere (20), who developed a rhabdomyolysis with acute renal failure. The correlation (Figure 1) between the concentrations of myoglobin and CK was significant (r = 0.764, p < .001, Spearman correlation; and r = 0.804, p < .001, linear correlation after log transformation).

Among the surviving patients, none showed myoglobinemia.

Table 1. Range of Myoglobinemia and CK Activity on Day 2 or 3 after Burn, as a Function of Burn Origin

<table>
<thead>
<tr>
<th></th>
<th>Thermal burns</th>
<th>Thermal burns + explosion</th>
<th>Electrical burns</th>
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<tbody>
<tr>
<td>n</td>
<td>14</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>TBSA, %</td>
<td>7–81</td>
<td>22.5–30</td>
<td>7–9</td>
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<tr>
<td>UBS</td>
<td>16–320</td>
<td>22.5–120</td>
<td>8–28</td>
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<tr>
<td>Myoglobin, µg/L</td>
<td>25–4850</td>
<td>58–688</td>
<td>340–8900</td>
</tr>
<tr>
<td>CK, U/L</td>
<td>14–2841</td>
<td>79–290</td>
<td>580–2619</td>
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</tbody>
</table>

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2 Nonstandard abbreviations: CK, creatine kinase; TBSA, total burn surface area; UBS, Unit Burn Surface.

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emia and CK activities greater than 550 μg/L and 866 U/L, respectively. In four of the five patients who died, the respective peaks were >1225 μg/L and 1545 U/L; in the fifth they were 315 μg/L and 290 U/L.

Myoglobinemia and CK activity vs UBS. As shown in Figure 2, both myoglobinemia and CK values correlated with UBS \( r = 0.825 \) and 0.686, respectively; \( p < 0.01 \) in the thermal-burn patients, the group in which UBS is best defined clinically.

Kinetic aspects. Myoglobinemia and CK activity measured on days 2, 4, 7, 10, and 13 after injury for a group of eight thermal burn patients who had a good recovery were significantly increased \( p < 0.05 \) on days 2, 4, and 7 (Figure 3).

Discussion

The present study, involving repeated blood samples, confirms the increased concentrations of myoglobin and CK activity found in serum after burn injury (16, 17). As previously observed, electrical burns result in higher concentrations of these analytes than do thermal burns of equivalent surface area. The good correlation between myoglobin and CK suggests that they are equally good markers of muscular damage. We confirmed the previous observations of Walsh et al. (16), that increased myoglobin concentrations are associated with an increased risk of death. Unlike Walsh et al., who did not systematically associate CK measurement and myoglobin determination, we also found that this risk is also correlated with CK activity. In the group of thermal-burn subjects we found a good correlation between myoglobinemia or CK activity and burn depth, expressed in UBS. These results also complete those from Walsh et al. (16), who reported only an indirect relation between burn depth and myoglobinemia (cf. their Figure 1, right panel). We excluded electrically and thermally burned patients thought to have other muscular trauma because UBS is inadequate for measuring muscular damage in such patients. Our results show that myoglobinemia and CK activity are good biological markers of burn depth in thermal-burn patients.
Concentrations of myoglobinemia and CK activity return to normal by day 10 after injury, in the absence of complications. Although in myocardial infarction myoglobin concentration returns to normal faster than does CK (7), this difference does not seem to be of importance in thermal-burn myolysis.

In conclusion, the strong correlation between CK and myoglobin, two markers of myolysis, is of practical interest: although myoglobinemia provides valuable prognostic data (16), its determination is time-consuming and expensive. In contrast, CK activity is rapidly measurable at a lower cost and seems to provide the same assessment of muscle damage as myoglobinemia. We therefore recommend measuring CK activity daily after burn for assessment of both myolysis and the risk of renal failure.

References