INTRA-ABDOMINAL PRESSURE IN JUDO EXPERTS EXPOSED TO HEAVY SUDDEN TRUNK LOADING

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INTRODUCTION

Low back injuries are frequent among employees in the health care sector (Pheasant and Stubbs 1992, Trinkoff et al. 2002); nurses and nurses’ orderlies have among the highest injury rates in the US. The high risk has been associated with the exposure to sudden unexpected trunk loading in connection with patient handling e.g. patients falling, stumping, losing strength or making unforeseen movements. Given the situation of handling patients compared to solid objects sudden loadings are more likely to occur, since the patient might act unexpectedly. Injury may thus be seen as a break down of normal motor control mechanisms capable of securing sufficient spinal stability to avoid damage in case of external perturbations. The intra-abdominal pressure (IAP) may be an important spinal stabilizer (Cholewicki et al. 1999), but the timing of the pressure development with respect to the external load becomes crucial.

The aim of the present experiment was to study whether a high IAP develops sufficiently fast in trained judo experts exposed to heavy unexpected loading of the trunk.

METHODS

Ten expert judo and jujitsu fighters participated in the study (Table 1). In a “mock-up” patient-handling situation the patient would unexpectedly fall, forcing the judo fighter to try to grasp the patient and resist the fall. Situations without unexpected falls were recorded as controls. One of the authors (weight 75 kg, height 178 cm) acted as patient in all experiments.

Table 1: Participant data.

<table>
<thead>
<tr>
<th></th>
<th>Females n = 5</th>
<th>Males n = 5</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>23 19-26</td>
<td>28 18-36</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168 163-174</td>
<td>179 170-196</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>65 58-70</td>
<td>79 68-105</td>
</tr>
<tr>
<td>Valsalva IAP (mmHg)</td>
<td>191 163-218</td>
<td>291 236-331</td>
</tr>
</tbody>
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IAP was measured intragastrically with a pressure transducer on the tip of a catheter. The participant’s maximal IAP was obtained from three maximal Valsalva maneuvers.

The load on the low back (L4/L5 compression) was quantified using a 3D biomechanical dynamic multi-segment model of the lower part of the body including feet, legs, thighs, and pelvis according to Skotte et al. (2002). The patient-handling situation was videotaped with 50 Hz by five cameras, and digitized semi-automatically with the Peak Motus 4.3 system. Ground reaction forces were measured with 1000 Hz in three directions by two AMTI force platforms with the participant standing with one foot on each platform (Figure 1).

Figure 1: Experimental set-up and location of reflective markers.

To describe the timing between IAP and compression development, the time gap between the IAP curve and the compression curve at 90% of peak compression and peak IAP, respectively, was calculated (Figure 2). Only patient-handling situations where the fighters succeeded in preventing the fall are presented.

RESULTS AND DISCUSSION

Patient fall significantly increased peak compression (p<0.001) and peak IAP (p<0.001) compared to the control situation (Two-way ANOVA). The average peak IAP increased from 21 mmHg (SD ±12 mmHg) to 137 mmHg (SD ±27 mmHg), which corresponded to 59 % of the participant’s maximum IAP recorded during Valsalva maneuvers. The average peak compression at L4/L5 level increased from 2169 N (SD ±535 N) to 5391 N (SD ±1314 N), which is considered far beyond safe limits according to the NIOSH guideline (Waters et al. 1993) for maximal allowable compression (Figure 3).
Figure 3: Peak IAP plotted against peak compression. The dot and dash line indicates NIOSH safe limits.

Figure 4 shows an example of the close timing between development of IAP and L4/L5 compression during a patient fall.

The average time gap for all analyzed patient falls was -7 ms (SD ±108 ms) indicating that a high IAP develops sufficiently fast to play a significant role when the low back structures have to cope with large unexpected loads (Figure 5).

Figure 4: Development of a judo expert’s IAP and compression during a patient fall.

Figure 5: Time gaps for all 39 analyzed patient falls. Negative time gap appears when IAP is developed first.

As the participants were well trained the results on timing between IAP and compression forces cannot directly be taken as an expression of that of the normal nursing personnel. Abdominal muscle training can increase the rate of IAP development (Cresswell et al. 1993).

SUMMARY

Biomechanical evaluation of low back loading in judo experts exposed to heavy unexpected trunk perturbations revealed that IAP may have the potential to act as a spinal stabilizer during patient handling situations. A high IAP was developed fast and apparently time-locked in relation to the load on the low back.

REFERENCES