Comparison of a long spinal board and vacuum mattress for spinal immobilisation

M D Luscombe, J L Williams

Objectives: This study was designed to compare the stability and comfort afforded by the long spinal board (backboard) and the vacuum mattress.

Methods: Nine volunteers wearing standardised clothing and rigid neck collars were secured on to a backboard and vacuum mattress using a standard strapping arrangement. An operating department table was used to tilt the volunteers from 45 degrees head up to 45 degrees head down, and additionally 45 degrees laterally. Movements of the head, sternum, and pubic symphysis (pelvis) from a fixed position were then recorded. The comfort level during the procedure was assessed using a 10 point numerical rating scale (NRS) where 1=no pain and 10=worst pain imaginable.

Results: The mean body movements in the head up position (23.3 v 6.66 mm), head down (40.89 v 8.33mm), and lateral tilt (18.33 v 4.26mm ) were significantly greater on the backboard than on the vacuum mattress (p<0.01 for all planes of movement). Using the NRS the vacuum mattress (mean score=1.88) was significantly more comfortable than the backboard (mean score=5.22) (p<0.01).

Conclusions: In the measured planes the vacuum mattress provides significantly superior stability and comfort than a backboard.
It was shown that the vacuum mattress prevents significantly more movement in the longitudinal and lateral planes when subjected to a gradual tilt. Perceived comfort levels are significantly better with the vacuum mattress than with the backboard.

**DISCUSSION**

Reviews on spinal immobilisation have focused mainly on the use of the long spinal board and its association with pressure injury, unsatisfactory immobilisation and positioning, and the pain that it can cause.

The pressure injury problem has been looked at by Lovell in terms of the high interface pressures that develop at contact points while a casualty resides on a backboard, possibly leading to pressure sores in those who have sustained injury to the spinal cord. This may be compounded by peripheral vasocstriction occurring in the wet/cold prehospital environment. The amount of time casualties remain on backboards (sometimes averaging more than three hours), can exacerbate the problems of pain and pressure. Ambulance journeys and waits in accident and emergency may be lengthy and there may be long distances involved in mountain rescue/prehospital transport. As a partial solution it has been recommended that the backboard should be removed as soon as possible after arrival in accident and emergency departments, ideally after the primary survey and resuscitation phases, while ATLS recommends removal from the backboard after two hours.

Other studies have looked at the patient position obtained during immobilisation on a long spinal board and found it to be suboptimal. The backboard may force the neck into a relative kyphosis and in paediatric treatment, it has been demonstrated that no single method with a backboard will actually place the head in the neutral position. Modifying the backboard with padding may improve position and comfort, although this is dependent upon where the padding is placed. Lerner found that a 2 cm occipital elevation placed the adult casualty in a more favourable position for cervical immobilisation. However, this did nothing to reduce the severity and incidence of occipital pain. Conversely for young children, a recess for the occiput or a pad to raise the chest prevents undesirable cervical flexion.

In addition to pressure injury and poor immobilisation, the backboard may be the cause of pain even in otherwise healthy volunteers, leading to unnecessary investigations/radiographs and potential ambiguity regarding the cause of the pain. The evidence suggests that the backboard itself is not ideal and far from a “gold standard”, and that modifying it produces equivocal results. This has led to the suggestion that the backboard “should not be the preferred surface for the transfer of patients with spinal injuries”. These problems have led to studies involving other splint systems. In one study seven support surfaces for the spinally injured were investigated. Two of these were vacuum splint devices, and other studies have compared vacuum splints and backboards in terms of the degree of stability and comfort afforded to the casualty, and the speed of immobilisation at the scene. The vacuum mattress has been shown to dramatically reduce sacral interface pressures from the potentially ischaemic levels generated with the backboard. In this study and in previous ones, the amount of movement in longitudinal and lateral tilts is significantly reduced by the vacuum mattress and it proved considerably more comfortable than the backboard. These findings may justify the conclusion that the “vacuum splint is a more effective and more comfortable...

### Table 1 Volunteer selection

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Mean weight (kg)</td>
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### Table 2 Movement (mm)

<table>
<thead>
<tr>
<th></th>
<th>Vacuum mattress</th>
<th>Backboard</th>
<th>p Value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head up</td>
<td>3.33 (0–15)</td>
<td>18.88 (5–35)</td>
<td>&lt;0.01</td>
<td>8.25 to 22.86</td>
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<tr>
<td>Head down</td>
<td>9.44 (0–30)</td>
<td>39.66 (10–85)</td>
<td>&lt;0.01</td>
<td>10.47 to 48.86</td>
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<tr>
<td>Lateral tilt</td>
<td>3.88 (0–15)</td>
<td>8.88 (0–15)</td>
<td>=0.16</td>
<td>2.44 to 12.22</td>
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<tr>
<td>Chest up</td>
<td>7.77 (0–30)</td>
<td>30.44 (15–45)</td>
<td>&lt;0.01</td>
<td>15.35 to 29.98</td>
</tr>
<tr>
<td>Chest down</td>
<td>5.55 (0–20)</td>
<td>42.22 (20–75)</td>
<td>&lt;0.01</td>
<td>23.08 to 50.25</td>
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<tr>
<td>Lateral tilt</td>
<td>6.66 (0–25)</td>
<td>27.22 (0–40)</td>
<td>&lt;0.01</td>
<td>8.18 to 32.93</td>
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<tr>
<td>Pelvis up</td>
<td>8.88 (0–25)</td>
<td>20.55 (0–35)</td>
<td>=0.06</td>
<td>0.63 to 23.97</td>
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<tr>
<td>Pelvis down</td>
<td>9.44 (0–25)</td>
<td>40.77 (10–95)</td>
<td>&lt;0.01</td>
<td>13.31 to 49.36</td>
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<tr>
<td>Lateral tilt</td>
<td>2.22 (0–10)</td>
<td>18.88 (0–50)</td>
<td>=0.03</td>
<td>1.41 to 31.92</td>
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### Table 3 Mean movement (mm)

<table>
<thead>
<tr>
<th></th>
<th>Vacuum mattress</th>
<th>Backboard</th>
<th>Difference</th>
<th>p Value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head up</td>
<td>6.66</td>
<td>23.30</td>
<td>16.64</td>
<td>&lt;0.01</td>
<td>9.61 to 38.78</td>
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<tr>
<td>Head down</td>
<td>8.33</td>
<td>40.89</td>
<td>32.56</td>
<td>&lt;0.01</td>
<td>15.90 to 69.20</td>
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<tr>
<td>Lateral tilt</td>
<td>4.26</td>
<td>18.33</td>
<td>14.07</td>
<td>&lt;0.01</td>
<td>6.66 to 29.42</td>
</tr>
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qualities. A combination of systems may confer benefit. How-

port of a trauma casualty, but that each system has its own

system appears to provide the ideal for extrication and trans-

situations (mountain crags, motor vehicle entrapments,

backboard's ability to “scoop” casualties from all manner of

planes. The backboard has good longitudinal rigidity whereas

the vacuum mattress will collapse if supported solely at each

end, with potentially disastrous results. While this is not the

recommended carrying technique it means that it may not be

carried by two persons alone, limiting its use for a paramedic

crew.

The speed of extrication is no different between the

backboard and the vacuum mattress and the safety and abil-

ey of extrication using the vacuum mattress is poorer. The

backboard’s ability to “scoop” casualties from all manner of

situations (mountain crags, motor vehicle entrapments,

and then sliding them on its slippery surface, facilitates extri-

cation. Conversely the non-uniform surface, large size (when

spread out) and comparatively high friction surface of the

vacuum mattress makes its use as an extrication tool more
difficult.

The backboard is permanently rigid and cannot suffer cata-

strophic failure, such as a loss of vacuum in the vacuum mat-

tress. This may be a problem in the mountain rescue environ-

ment with rough rocky surfaces leading to puncture of the

vacuum mattress. In contrast the paramedic environment may

be less arduous but the everyday use of the vacuum mattress

may lead to wear and tear.

If the two systems were combined then perhaps a safer

splint would develop. This could be by either extricating on the

long spinal board and then placing the board with the casualty

into the vacuum mattress, or by extricating the casualty onto

the backboard and then log rolling off the backboard and on to

the vacuum mattress.

The former is favoured by Edale Mountain Rescue team

although we speculate that while more stable if tilted, the dis-

advantages as regards comfort and position on the backboard

are still present. However, the removal of the casualty from a

stabilising device with a further log roll would increase the

risk of problems, especially as the log roll itself has been

shown to present the greatest possibility of spinal movement

certain spinal injuries.18

What is clear from this and other studies is that no single

system appears to provide the ideal for extraction and trans-

port of a trauma casualty, but that each system has its own

qualities. A combination of systems may confer benefit. How-

ever, before disregarding one system in favour of another,
careful consideration should be given to the advantages and
disadvantages of each, as the potential for serious injury is

great. The vacuum mattress provides a solution to some of the
drawbacks of the long spinal board.

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