Hyperflexion sprain of the cervical spine: Follow-up of 45 cases

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To cite this article: Menno Braakman & Reinder Braakman (1987) Hyperflexion sprain of the cervical spine: Follow-up of 45 cases, Acta Orthopaedica Scandinavica, 58:4, 388-393, DOI: 10.3109/17453678709146362

To link to this article: https://doi.org/10.3109/17453678709146362

Published online: 08 Jul 2009.

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Hyperflexion sprain of the cervical spine
Follow-up of 45 cases

Menno Braakman and Reinder Braakman

A long-term follow-up study of a series of 45 consecutive patients with a hyperflexion sprain causing anterior subluxation of the cervical spine shows that conservative management is successful in more than 50 per cent of children and adults. In patients under 16 years of age, usually with involvement of the C2-C4 level, kyphosis may persist for months, but later realignment is common. Primary surgical treatment should be restricted to children with a kyphotic angulation of more than 20 degrees.

In adults with injuries commonly at the C4-C7 level, the failure rate of conservative management indicates that primary surgical treatment should be preferred unless kyphotic angulation is less than 10 degrees. Kyphosis may progress during conservative management and may even result in unilateral interlocking. However, none of the patients with a persisting kyphotic angulation had neck complaints. Neurologic involvement when present was mild and reversible. Posterior wiring and fusion may entail inadvertent inclusion of adjacent segments without, however, causing major residual symptoms.


We have studied a consecutive series of 45 patients with hyperflexion sprain.

Patients and methods

The 45 patients of this consecutive series were referred to one of us (R.B.) between 1960 and 1981. All the patients had characteristic signs of hyperflexion sprain. Twenty-eight patients were males and 17 females. Eleven patients were under 16 years of age (Table 1). The patients were treated with one of the three following methods: 1) Minerva plaster jacket, as a rule for 3 months, which was usually applied before 1975; 2) between 1975 and 1982, bed rest for 4–6 weeks with the head in the hanging position followed by a Somi brace for 6 weeks without subsequent immobilization of the neck; and 3) operation, which was performed as primary treatment in cases of severe angulation, particularly when the lesion occurred at levels C4-C7, and as secondary treatment when a progressive kyphosis developed. Surgical management commonly consisted of metallic or mersilene wiring in combination with posterior fusion using iliac bone. Subsequently, the patients were kept in bed for 6 weeks and then ambulated in a Somi brace or, more recently, already the first week in a Halo vest. One patient underwent anterior fusion.
At follow-up, 11 patients were found to have died of unrelated causes. In 7 of these 11 patients, however, follow-up information about their condition 3-8 years after treatment was available. The remaining 34 patients were interviewed and examined. In addition, control radiographs were taken in all but 3 patients, who refused radiography. The results were considered to be 1) excellent, in cases of normal lordosis or mild kyphosis (<8°) with normal mobility at the injured level; 2) good, in cases of normal alignment or a mild kyphosis (<8°) but with an immobile segment; 3) moderate, in cases of fusion of two or more segments but without complaints; and 4) poor, in cases of progressive kyphosis or unilateral interlocking.
Results

**Levels C2-C4.** Eleven patients, aged between 11 and 18 years, were injured at the C2-C4 levels. Later, 3 also showed signs of hyperflexion sprain at an adjacent level. None of the 11 patients had a neurologic deficit. All the patients were initially treated conservatively, and the end result was excellent or good in 7 patients; 3 regained normal cervical lordosis and mobility, albeit with the spinous process of C2 elongated caudally (Figure 1). In the other 4 patients, the damaged intervertebral segment lost mobility.

Four patients developed progressive kyphosis and pain, and 2 of these were operated on with moderate results. One patient underwent wiring with an immobile segment as the ultimate outcome (Figure 2), and in the remaining patient, not operated on, kyphosis persisted without complaints; the segment became immobile.

**Levels C4-C7.** Thirty-four patients were injured at the C4-C5, C5-C6, or C6-C7 level. One patient was under 16 and 7 were between 16 and 20 years of age.

Seven patients had a root lesion; 2 had a mild reversible contusion of the cervical cord; and 1 had a progressive central cord lesion. Twenty-four patients were initially treated closed and 10 underwent primary surgery (Table 2).

Seven patients were treated with a Minerva plaster cast. Two had excellent results without loss of mobility in the damaged segment; in 1 the segment became immobile. One patient developed spontaneous unilateral interlocking and spontaneous fusion. In 3 patients the kyphosis increased, and they were operated on.

Bed rest as the primary treatment was chosen for 8 patients. One patient died after 2 weeks; in 4 the result of treatment was excellent or good. One patient was ambulated after 1 week and developed unilateral interlocking; another showed progressive kyphosis when ambulated after 4 weeks. Both of these patients were operated on. The remaining patient (Figure 3), who initially appeared to have no abnormalities on the lateral radiograph, developed a progressive kyphosis with a central cord lesion. He underwent a laminectomy and a posterior fusion. Now, 14 years later, he is well with only mild residual symptoms.

Six patients wore a Somi brace for 6 weeks to 3 months. In 3 the segment became immobile; 2 developed a progressive kyphosis and were subjected to wiring and fusion; in 1 the result is unknown.

Three patients refused treatment. Two developed progressive kyphosis; one refused operation and was well after 2 years despite severe kyphosis; the other patient was operated on. The remaining patient had normal mobility and normal lordosis after 1 year.

Nine patients had a primary operation with fusion of two or three segments in all. In 9 of the 11 patients subjected to secondary fusion, two or more segments became immobile despite the aim of fusing only the damaged segment.

Discussion

The diagnosis hyperflexion sprain is often missed on initial examination, and especially if the sprain is mild and the radiographs are taken with the patient in the recumbent position. This was the case in 6 of our patients. Muscle spasm is often present initially (Hubbard 1974) causing loss of cervical lordosis or even leading to arcual kyphosis.

Lateral radiography of the cervical spine with the patient sitting and the neck in midposition should be repeated after spasm and pain have disappeared. This will reveal the kyphotic angulation because the gravitational center of the skull is anterior to the vertical axis of the spine (Penning 1968, Webb et al. 1976). Flexion examinations are, however, not necessary. They may be hazardous because the hyperflexion sprain is an unstable injury sometimes causing interlocking, as found in 2 cases.

Slight angulation may result from hyperflexion sprain, but is not a reliable diagnostic criterion, particularly at the C2-C3 level; anterior displacement of C2 over C3 may represent normal variation, such as in pseudosubluxation of the C2-C3 segment (Cattell & Filtzer 1965, Braakman & Penning 1971).

There is a relationship between age and level of injury (Allen et al. 1982). In 16 children with a hyperflexion sprain reported by Chagnon & Blery (1982) and Penneco et al. (1984), 13 injuries were at the C2-C4 level and only three
Hyperflexion sprain of the cervical spine

Figure 1. Case 1. Male, aged 13 years, hit his head in a road-traffic accident.
B. Progressive kyphosis during bed rest. Note the calcification of the interspinous ligaments of C2-C3. The patient was ambulated after 6 weeks of bed rest.
C. 14 years later. The neck in flexion. Fusion of C2-C3 with a caudal elongation of the spinous process of C2. The interfacetal joints of C2-C3 are ankylosed and the disc of C2-C3 has almost disappeared.

Figure 2. Case 7. Male, aged 12 years, hit his head while diving into shallow water.
A. Kyphotic angulation at C3-C4, with mild wedgelike compression fracture of C4 and C5 (and C6?).
B. Persistent kyphotic angulation after primary wiring of the spinous processes at C3-C4 and wearing a plaster jacket for 4 months.
C. Eight years later: realignment; C3-C4 is immobile.
Table 2. Results of non-operative and operative treatment for hyperflexion sprain of the cervical spine. Number of cases subject to secondary operative treatment in parenthesis

<table>
<thead>
<tr>
<th>Segment</th>
<th>Non-operative</th>
<th>Operative</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excellent</td>
<td>Good</td>
<td>Poor</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>normal mobility</td>
<td>mild kyphosis</td>
<td>immobile</td>
<td>progressive kyphosis</td>
</tr>
<tr>
<td>C2–C4</td>
<td>11</td>
<td>3</td>
<td>5</td>
<td>3(3)</td>
</tr>
<tr>
<td>C4–C7</td>
<td>34</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>6</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

Figure 3. Case 32. Male, aged 68 years. Car accident. Central cervical cord lesion on admission to hospital.
A. On admission. No abnormalities, suggesting a hyperextension injury of the neck.
B. With ambulation after 2 weeks, a marked kyphotic angulation at C5–C6 without interlocking. Subsequent neurologic deterioration. Laminectomy and lateral posterior fusion.
C. 12 years later. Excellent fusion at levels C2–C7. Mild paresis of hands.

below C5. Also in our series there was a close correlation between age and level of injury. All the patients with lesions at the C2–C4 levels were under 18 years of age, whereas the majority (13/20) of those with lesions at the C4–C7 levels were over 40 years of age.

The neurologic injury in hyperflexion sprain is usually mild and reversible (Allen et al. 1982). Only one of our patients had a persistent mild central cord lesion.

Reduction of the angulation of hyperflexion sprain can easily be achieved by placing the patient with the head hanging over the end of the mattress (Braakman & Penning 1968). The result of this procedure can be checked radiographically. The choice of methods to maintain reduction depends on the extent of ligament damage. Nonoperative management was successful in only 18 of our 32 patients. The result was not related to age or type of closed treatment (Table 2). It is, indeed, questionable whether prolonged bed rest or application of a Minerva jacket or collar is of any use.

In children with C2-C4 injuries, initial anatomic
results of conservative treatment are often disappointing, but long-term results in cases with angulation less than 20° are good, both anatomically and clinically. Gradually, the angulation disappears under partial calcification of the posterior ligaments and elongation of the spinous process of the vertebra above the damaged segment (Figure 1). In the majority of young patients, mobility of the affected segment remains normal. A previous follow-up study (Braakman & Penning 1968) disclosed substantial arrest in the growth of surgically fused vertebrae. Therefore, we consider fusion in patients under 16 years of age indicated only in cases with more than 20° of angulation.

In adults, commonly with injuries below C4, acceptable results may be obtained without operation in more than half of the cases. However, in the remaining patients kyphosis reappears or may even increase after months of wearing a Minerva jacket, as was reported by Cheshire (1969). We even observed development of interlocking in 2 patients during bed rest and treatment in a plaster jacket, respectively. There is no later realignment of the cervical spine, as in many children. The failure rate with conservative management in adults is so high that primary fusion by bone grafting, using either the posterior or anterior approach, seems preferable.

References

Acknowledgements
Thanks are due Dr. G. Blaauw for helpful comments, to Mrs. B. S. Vollers-King for language editing, and to Mrs. B. A. A. Koehorst for secretarial help.