STABILITY OF THE CERVICAL SPINE AFTER CONSERVATIVE TREATMENT

By Dr. DAVID C. BURKE, M.B., B.S., D.P.R.M. and Dr. T. S. TIONG, M.B., B.S., B.Med.Sc.

Spinal Injuries Unit, Austin Hospital, Heidelberg, Victoria, Australia

Abstract. 175 patients with cervical spine and spinal cord injuries were admitted to the Spinal Injuries Unit, Austin Hospital, in the five-year period from the 1 July 1968, to the 30 June 1973. Only 4.2 per cent of the patients required delayed spinal fusion for instability after a conservative treatment regime.

INTRODUCTION

CHESHIRE (1969) reviewed the results of a personal series of 257 patients who had suffered injuries to the cervical spine and spinal cord admitted to the Spinal Injuries Centre, Victoria, in the nine years from the 1 July 1959, to 30 June 1968. The majority of these patients had been treated conservatively, that is by skeletal traction and/or manipulation of the cervical spine under general anaesthesia or simple immobilisation in a cervical brace or collar. He found a late instability rate of only 7.5 per cent of patients with neurological injury treated by conservative means.

One of these authors (D. C. B.) participated in the treatment of a number of the patients reported by Cheshire (1969) and has carried on essentially the same treatment techniques to the present day. The purpose of this paper is to study the results of a conservative treatment regime for spinal cord injuries over the next five years after Cheshire's report to see if there has been any change in the instability rate with further experience.

CLASSIFICATION

The classification used by Cheshire (1969) has been followed basically but with some slight modifications (Table I). An extra group, 3 (e), has been added to the extension-rotation injuries. This is a group of fracture-dislocations, and include the injuries first described by Forsyth (1959, 1964), that is hyperextension injuries masquerading as flexion injuries. This group also includes true posterior fracture-dislocations, as illustrated in Figure 1. There were three cases of the former in this series, and three posterior fracture-dislocations.

We have also elected to group Cheshire's Groups 5 and 6 together as one miscellaneous group, Group 6.

One patient presented with two distinct skeletal injuries in association with neurological damage. He was a 23-year-old man who was water skiing on an inland river in Victoria in March 1971, when he struck his head on the bottom after falling from his skis in shallow water. He was immediately tetraplegic and presented to this Centre with a complete tetraplegia below the seventh cervical segment. X-rays demonstrated a compression fracture of the body of the seventh

TABLE I
Classification of cervical spine injuries

1. Atlanto-axial injuries.
2. Flexion-rotation injuries:
 - (a) Anterior subluxation
 - (b) Unilateral dislocation or fracture-dislocation
 - (c) Bilateral dislocation or fracture-dislocation
3. Extension injuries:
 - (a) Extension disruption of normal spines and spines affected by cervical spondylosis.
 - (b) Extension disruption of a spine affected by ankylosing spondylitis.
 - (c) Extension injury of a normal spine, or a spine affected by cervical spondylosis, but no bony injury or ligamentous disruption.
 - (d) Complete instability in apparent extension injuries.
 - (e) Extension injuries leading to fracture-dislocation.
4. Vertical compression injuries.
5. Cervical spinal cord concussion.
6. Miscellaneous.

cervical vertebra and evidence of a hyperextension injury between the fifth and sixth, and sixth and seventh cervical vertebrae (fig. 2). It was considered that he had suffered a combination of vertical compression and hyperextension forces in the accident, possibly as two separate incidences in time. Because this patient has two separate skeletal injuries, either of which could be responsible for his neurological injury, and either of which could lead to late instability, he has been included twice in the classification, in Group 3 (e) and Group 4. His spine was managed conservatively, by skeletal traction, and fused satisfactorily (fig. 3).

Using the above classification, the total number of cases was 176. The relative incidences of these injuries has been listed in Table II.

Fracture-dislocation following Hyperextension Injury. Three of the patients included in Group 3 (e) fall into the group of hyperextension injuries masquerading as flexion injuries, first described by Forsyth in 1959. One of these patients was a 24-year-old man admitted 15 hours after the truck he was driving ran into a flock of sheep and ran off the road and hit a tree. He presented a very incomplete tetraplegia in association with a forward dislocation of the fourth cervical vertebra on the fifth cervical vertebra with a fracture-dislocation of the right posterior intervertebral joint (fig. 4). As he had a soft tissue injury to his forehead, and there was a very clear history of hyperextension injury from the patient, this was considered to be an injury of the type described by Forsyth. Treatment was commenced with insertion of head tongs and application of skeletal traction, but in view of little change in the alignment of the cervical spine over the first week and his very incomplete neurological lesion it was decided to perform an open posterior reduction. At operation, it was noted that the posterior ligamentous complex between the fourth and fifth cervical vertebrae was intact, and the fracture-dislocation of the right posterior intervertebral joint was confirmed. It was considered that these operative findings confirmed Forsyth's explanation of these

TABLE II
Incidence of cervical lesions

Classifications	Number	Late admissions	Early death	Early surgery	Number studied
I	6	I	I	0	4
2 (a)	16	0	I	I	14
2 (b)	20	2	4	0	14
2 (c)	21	I	7	0	13
3 (a)	16	0	2	0	14
3 (b)	5	0	0	0	5
3 (c)	12	0	3	0	9
3 (d)	0	0	0	0	0
3 (e)	6	0	I	I	4
4	51	I	4	0	46
5	16	0	0	0	16
6	7	0	0	0	7
Total	176	5	23	2	146

injuries, that there was no evidence of a flexion or flexion-rotation injury in view of the intact posterior ligamentous complex, and that his theory of a hyperextension injury was almost certainly the correct one. The spine in this man was partially reduced and internally fixed by wiring of the laminae of the fourth and fifth cervical vertebrae. Cervical traction was continued for eight weeks. The spine ultimately fused and the patient made a full neurological recovery.

By a strange coincidence the next patient who was considered to present with this syndrome was also injured when the truck he was driving ran into a flock of sheep. He gave a clear history of striking his forehead on the roof of the cabin of his truck, and presented with a gross bilateral forward-dislocation of the sixth cervical vertebra on the seventh. Fractures of both the lateral articular masses of the sixth cervical vertebra were noted. It was not possible to reduce this man's spine by cervical traction, but in view of the complete tetraplegia with which he presented the dislocated position was accepted. His spine consolidated satisfactorily in the displaced position. There was no neurological recovery.

The spine of a third patient who presented with the Forsyth type of injury is illustrated in Figure 5. This man, who was clearly injured by a hyperextension mechanism to the cervical spine from the history of a building falling on him and the soft tissue injuries to his forehead, presented with an incomplete tetraplegia of an acute central cervical spinal cord syndrome. The cervical spine was in normal alignment, but there were fractures of the spinous processes of the sixth and seventh cervical vertebrae. It is considered that this patient demonstrated a lesser degree of skeletal injury than the preceding two, but was caused by the same hyperextension mechanism. It is postulated that the arc of force described by Forsyth had not been severe enough, or perhaps continuous enough, to push the upper vertebra forward on the lower ones, and thus present as a forward-dislocation as in the first two cases.

The other three patients in Group 3 had posterior fracture-dislocations of the cervical spine as illustrated by the post-mortem specimen (fig. 1). This young man presented a few hours after a motor car accident with a complete tetraplegia below the fifth cervical segment, together with fractures to the mandible and maxilla, and facial lacerations. He died a few days later of respiratory failure.

It is not considered that these injuries are similar to the injuries described by Forsyth, except that they are also predominantly caused by a hyperextension force to the cervical spine. It seems likely that there is also a degree of vertical compression in these injuries. Another patient with this pattern of injury has been already described as having two separate injuries to his cervical spine, and the X-ray (fig. 2), shows the posterior dislocation of the sixth cervical vertebra on the seventh. All three of these patients had stable skeletal lesions due to impaction of the upper vertebra backwards on the lower, and all three had complete and irreversible spinal cord paralyses. The two surviving patients in this group fused satisfactorily on a conservative regime of treatment (fig. 3). It is felt that the third patient who died in the acute stage, would similarly have fused had he survived, as his spinal fracture-dislocation was impacted (fig. 1).

TREATMENT

The treatment of 175 patients with 176 lesions consisted of skeletal traction alone in 75 patients, skeletal traction plus manipulation of the cervical spine under general anaesthesia in 28 cases, and cervical collar or simple rest in bed in 70 patients. Two patients were treated by early operative intervention.

The methods of treatment were essentially the same as those used by Cheshire. The line of skeletal traction was varied from case to case to achieve the best alignment of the cervical spine and was usually continued for six to eight weeks. This was followed by a short period of neck extensor exercises prior to sitting the patient up in a cervical collar. The collar was only discontinued after flexion and extension X-rays at 12 to 16 weeks after injury showed the spine to be stable. Patients treated by collar alone were usually nursed in bed for shorter periods than those

FIG. 1

Sagittal section of a specimen of the cervical spine of a young man showing posterior dislocation of the fourth cervical vertebra on the fifth cervical vertebra. The spinal cord has been transected.

FIG. 2

Lateral X-ray of a cervical spine showing a compression fracture of the body of the seventh cervical vertebra and posterior displacement of the body of the sixth cervical vertebra on the seventh cervical vertebra. There is also abnormal widening of the intervertebral disc space between the fifth and sixth cervical vertebrae indicating damage to the anterior longitudinal ligament between these vertebrae.

FIG. 3

Lateral X-ray of the cervical spine of the same patient as in Figure 2 one year later, showing solid bony union between the sixth and seventh cervical vertebrae.

FIG. 4

Lateral X-ray of the cervical spine of a patient with a fracture-dislocation of the fourth cervical vertebra forward on the fifth cervical vertebra.

FIG. 5

Lateral X-ray (tomogram) of the cervical spine of a patient showing fractures of the spinous processes of the sixth and seventh cervical vertebrae, but no malalignment of the cervical spine.

FIG. 6

Lateral X-ray of the cervical spine of a young man following reduction of a subluxation between the fifth and sixth cervical vertebrae by cervical traction. The X-ray was taken in the first few hours following admission and commencement of traction.

treated by traction. The patients were nursed on a sorbo rubber pack bed, and turned manually two-hourly by medical orderlies.

One of the patients requiring surgical management was a 64-year-old woman who presented 13 days after a motor car accident with an anterior subluxation of the seventh cervical vertebra on the first thoracic vertebra. In view of a history of apparent neurological deterioration, it was decided to perform an anterior decompression and fusion between the seventh cervical and first thoracic vertebrae. Another reason for deciding on a surgical approach was the fact that she had a large infected haematoma of the scalp which prohibited the insertion of head tongs.

The other patient, who was subjected to an early operation was the man previously described with the hyperextension injury masquerading as a flexion injury with unilateral fracture-dislocation of the fourth cervical vertebra on the fifth cervical vertebra. He had an open reduction and internal fixation as described.

TABLE III
Incidence of late instability

Classification	Number	Late instability	Percentage
I	4	0	0
2 (a)	14	1	7
2 (b)	14	2	14
2 (c)	13	0	0
3 (a)	14	0	0
3 (b)	5	0	0
3 (c)	9	0	0
3 (d)	0	0	0
3 (e)	4	0	0
4	46	1	2
5	16	0	0
6	7	0	0
Total	146	4	2.8

RESULTS

In studying the results of a conservative regime of treatment it is necessary to exclude a number of patients for various reasons. As with Cheshire (1969) we have excluded patients who were admitted more than 15 days after injury, as in such cases the prime responsibility for treating the cervical spine is not our own. We have also excluded two patients who were subjected to early surgical management of the spine. It is interesting to note that in Cheshire's series there were 12 patients subjected to early surgery. We have also elected to exclude patients who died within three months of injury, as insufficient time had passed to consider whether or not their spinal fracture or fracture-dislocation was stable. Thus, 30 patients are excluded on these grounds, reducing the total studied to 146 (Table II).

In Table III it will be noted that four patients required delayed surgery. These were the only patients who demonstrated instability after a period of conservative treatment of the cervical spine. We accept Cheshire's definition of stability, 'the absence of any abnormal mobility between any pair of vertebrae with or without pain or other clinical manifestations when lateral X-rays of the cervical spine are taken in flexion and extension at the conclusion of conservative treatment for fracture or fracture-dislocation'. As seen in Table III, the instability rate of the 146 patients considered was only 2.8 per cent, but we agree with Cheshire in his discussion that a late instability rate is meaningless if the patients considered include large numbers of inherently stable lesions. If Groups 3 (a), 3 (c), 5 and 6 are excluded the number of unstable or potentially unstable cervical spines is reduced to 95. The corrected instability rate of this group of patients, a more realistic estimation of instability, is 4.2 per cent.

Late Instability. Four patients were found to be unstable as previously defined after a period of conservative treatment.

A male aged 22 years was admitted two hours after a diving accident in a swimming pool; he was found to have an incomplete tetraplegia below the sixth cervical segment with a unilateral dislocation of the fifth cervical vertebra on the sixth. He also had a fracture of the antero-superior margin of the body of the sixth cervical vertebra. He was treated initially by the insertion of head tongs and cervical traction in 10° extension for a period of eight weeks. He made a rapid neurological recovery over the first week, but flexion and extension X-rays of the cervical spine taken after eight weeks showed instability at the site of the dislocation. An anterior cervical fusion of the fifth cervical vertebra to the sixth vertebra, led to a successful result with a stable spine and full neurological recovery.

A 16-year-old male fell on the back of his head whilst doing a somersault in a gymnasium class. He was admitted 24 hours after the accident and was found to have an incomplete tetraplegia below the fifth cervical segment with an anterior subluxation of the fifth cervical vertebra on the sixth cervical vertebra and wide separation between the spinous processes of these vertebrae. He was treated initially with traction by head tongs with complete reduction radiologically (fig. 6). The traction was maintained for eight weeks, during which time he made a gradual neurological recovery. However, re-displacement at the subluxation site occurred after removal of the head tongs (fig. 7), and it was impossible to reduce the displacement again with posture. An anterior cervical fusion at the fifth and sixth cervical level was performed with the end result of stability (fig. 8), and eventual full neurological recovery.

A 22-year-old male was involved in a motor car accident causing an incomplete tetraplegia below the sixth cervical segment, with a right-sided dislocation between the sixth and seventh cervical vertebrae. The spine was successfully reduced by manipulation under general anaesthesia on admission, and maintenance of the reduced spine was continued by cervical traction. Re-dislocation of the spine was noted on X-ray after three months, though he had made a considerable, though incomplete, neurological recovery during this period. An anterior inter-body

FIG. 7

Lateral X-ray of the cervical spine of the same patient as in Figure 6 taken eight weeks later showing subluxation of the fifth cervical vertebra on the sixth.

FIG. 8

Lateral X-ray of the cervical spine of the same patient as in Figures 6 and 7 taken one year later, showing solid fusion between the fifth and sixth cervical vertebrae following anterior cervical fusion between these vertebrae.

FIG. 9

Lateral X-ray of the cervical spine of an 11-year-old boy showing a compression fracture with anterior wedging of the body of the sixth cervical vertebrae.

FIG. 10

Lateral X-ray of the cervical spine of the same patient as Figure 9 eight weeks later, showing an increase in the anterior subluxation of the fifth cervical vertebra on the sixth cervical vertebra.

spinal fusion between the sixth and seventh cervical vertebrae was successfully performed.

An 11-year-old boy was admitted to this Centre after a diving accident in a shallow pool. He suffered a mild incomplete tetraplegia below the sixth cervical segment due to a vertical compression fracture of the fifth cervical body, with slight anterior angulation at that level (fig. 9). He was managed conservatively with a cervical collar and rest in bed. An X-ray taken after eight weeks showed some increase in the anterior subluxation of the fifth cervical vertebra on the sixth (fig. 10). As a result an anterior cervical fusion was performed leading to a stable spine and full neurological recovery.

DISCUSSION

An analysis of the cases of late instability in the 175 patients reviewed, shows that two were patients with unilateral dislocations or fracture-dislocations of the cervical spine, one had an anterior subluxation without dislocation of the cervical spine, and one a compression fracture of a cervical vertebra. In the previous series reported by Cheshire (1969) ten patients were demonstrated to be unstable after a period of conservative treatment, and the largest percentage group of these by far were the anterior subluxations, 21 per cent. As did Cheshire, we found a small percentage of the unilateral dislocations and the vertical compression fractures led to late instability after conservative treatment, but unlike Cheshire there were no bilateral dislocations remaining unstable in this series.

Cheshire discussed the reasons for the high instability rate of anterior subluxations compared to other injuries of the cervical spine. He postulated that these lesions were stages in the same mechanism, the subluxations involving less posterior ligamentous tearing than the dislocations. He felt that the reason for the higher rate of instability probably lay in the inadequacy of the conservative management of the different lesions, rather than in either the lesions themselves or the essential treatment techniques. He also made the point that 15 of the 19 anterior subluxations in his series were associated with minor and rapidly recovering neurological manifestations and a more mobile patient as a result. As a result of the previous findings a more cautious approach to patients with anterior subluxation of the cervical spine has been practised since the publication of Cheshire's report, and the findings in this series suggest that if these injuries are treated *adequately* by conservative means there is no indication for a more aggressive surgical approach in the early stages, which Cheshire suggested might be necessary for this particular group.

In the series presently under consideration it would have been noted that only two patients were subjected to early surgical management of the cervical spine. In Cheshire's series there were 12 patients out of 224 with unstable or potentially unstable cervical spines in whom early surgery was performed. In Cheshire's series four patients had an early open reduction by the posterior approach. Only one of our patients had this procedure, and in fact this is probably an indication of changing attitudes to the management of cervical spine injuries in this Centre as the operation of open reduction on the cervical spine has largely become redundant in recent years since the introduction of closed manipulation under general anaesthesia for dislocations of the cervical spine (Burke & Berryman, 1971).

Another group in Cheshire's series who were subjected to early surgery were his Group 3 (d), complete instability in apparent extension injuries. Three later patients in Cheshire's series with this lesion were managed successfully by conservative methods. There were no patients who fell into this classification in our 175 patients.

There was one patient who had bilateral fractures of the posterior arch of the axis in our group, and she was managed conservatively with a good result. There were no patients in whom manipulation of the cervical spine under general anaesthesia failed, and where it was necessary to fuse the spine immediately in view of an incomplete neurological lesion and the need to protect this from possible deterioration. There were some patients in our series with complete tetraplegia and inadequately reduced dislocations, but who were managed conservatively and who did fuse satisfactorily in the displaced position. We consider these patients to have a stable end result, there being no abnormal movement between the vertebrae at the completion of treatment.

In our series we have found that there has been a lesser inclination to resort to surgery, both in the early and late stages in more recent years compared to the early series reported by Cheshire. The explanation for this is probably that the treatment techniques evolved by Cheshire have improved as the years passed and there has been therefore a lower failure rate of adequate reduction of cervical injuries on admission and a more efficient conservative treatment regime leading to a better later stability rate than previously described. Another factor which should be considered when comparing the two series is that the proportion of vertical compression injuries compared to the flexion-rotation group, was greater in this series than the previous one. One might expect a higher rate of late instability after dislocation as they are potentially more unstable lesions.

It is interesting to compare these results with those of Dall (1972) who reviewed the X-rays of a series of patients treated in Capetown. He found radiographical instability in 36 per cent of unilateral dislocations and fracture-dislocations, and 14 per cent of bilateral dislocations, but that only a small percentage of the patients with radiographical instability were clinically considered to require stabilisation procedures. Frankel *et al.* (1969) reviewed a large series of patients treated at Stoke Mandeville Hospital. Of 218 patients with cervical spinal cord injuries only two developed instability after being allowed out of bed. One became stable after six months immobilisation in a collar, and the other was subjected to spinal fusion at another hospital. However, it was noted that Stoke Mandeville tend to keep their patients in bed longer than is our practice.

CONCLUSIONS

In view of the results achieved in our 175 patients it is concluded that an adequate conservative treatment regime is the treatment of choice for the vast majority of cervical spine injuries where the spinal cord is injured.

SUMMARY

In a review of 175 patients with cervical spine and spinal cord injuries treated in the Spinal Injuries Unit, Austin Hospital, Heidelberg, between 1968 and 1973

only two patients were treated by operative procedures on admission, the remainder by conservative techniques.

After excluding delayed admissions, inadequate follow-up and the inherently stable lesions, only 4.2 per cent of the patients required delayed spinal fusion for instability. It is considered that these results vindicate the conservative approach to cervical spinal cord injuries.

RÉSUMÉ

Dans une étude de 175 malades souffrant de lésions de l'épine cervicale et de la moelle épinière traités au Centre de lésions spinales, à l'hôpital Austin de Heidelberg, entre 1968 et 1973, seuls deux malades furent traités par des méthodes opératoires dès leur admission, le reste le furent par des méthodes conservatoires.

Après avoir exclu les cas d'admissions tardives, de suivi insuffisant et les lésions stables inhérentes, seulement 4,2 pour cent des malades exigeaient une fusion spinale tardive pour cause d'instabilité. Il est considéré que ces résultats justifient l'approche de conservation pour les lésions de la moelle épinière cervicale.

ZUSAMMENFASSUNG

Nur zwei unter 175 Patienten mit Verletzungen des Zervikalmarks, die im Spinalzentrum Melbourne zwischen 1968 und 1973 behandelt wurden, waren bald nach der Einweisung operiert, alle übrigen wurden konservativ behandelt. Nur 4.2 per cent hatten Fusion wegen Instabilität. Diese Resultate bestätigen die ausgezeichneten Resultate der konservativen Behandlung von zervikalen Rückenmarksverletzungen und sie stellt die Methode der Wahl in der weitaus grossen Mehrheit in der Behandlung von traumatischen Verletzungen des Halsmarks dar.

Acknowledgements. The authors wish to thank their orthopaedic and neurological colleagues who contributed so much to the treatment of these patients, and would like to acknowledge the wonderful contribution that Dr. David Cheshire has made to the treatment of spinal cord injuries.

REFERENCES

- BURKE, D. C. & BERRYMAN, D. (1971). The place of closed manipulation in the management of flexion-rotation dislocations of the cervical spine. *Journal of Bone & Joint Surgery*, **53B**, 165.
- CHESHIRE, D. J. E. (1969). The stability of the cervical spine following conservative treatment of fractures and fracture-dislocations. *Paraplegia*, **7**, 193-203.
- DALL, D. M. (1972). Injuries of the cervical spine. *South African Medical Journal*, **46**, 1083-1090.
- FORSYTH, H. F., ALEXANDER, E., DAVIS, C. & UNDERDAL, R. (1959). The advantages of early spine fusion in the treatment of fracture-dislocation of the cervical spine. *Journal of Bone & Joint Surgery*, **41A**, 17-36.
- FORSYTH, H. F. (1964). Extension injuries of the cervical spine. *Journal of Bone & Joint Surgery*, **46A**, 1792-1797.
- FRANKEL, H. L., HANCOCK, D. O., HYSLOP, G., MELZAK, J., MICHAELIS, L. S., UNGAR, G. H., VERNON, J. D. S. & WALSH, J. J. (1969). The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. *Paraplegia*, **7**, 179-192.