

The significance of rotation in fracture-separation of the articular pillar of a lower cervical vertebra

A clinical and cadaveric study

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We report 13 fracture-separations of an articular pillar at the lower cervical spine in 12 patients. There were 9 men and 3 women with a mean age at injury of 32 years, with involvement of C4, C5 and C6 vertebrae. Neurological symptoms were present in 9 patients, 2 were classified as ASIA A and 7 as ASIA D. The average magnitude of rotation of the articular pillar was 24° (10°–36°). 4 patients with neurologic deficit and a rotated articular pillar of more than 25°

were operated on, while 8 patients, 3 of which had a rotation of more than 25°, had closed treatment. Patients were followed from 8 months to 15 years (mean 9 years). Patients who had closed treatment and/or with a rotated fractured articular pillar of more than 25° had less satisfactory results. This observation was affirmed by cadaveric studies which showed that rotation of more than 25° is an additional factor of instability in a fractured articular pillar.

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A fracture-separation of the articular pillar is a separate clinical entity which involves 2 separate fractures, 1 anterior of the pedicle and another posterior of the lamina, resulting in a floating articular process which may lead to instability and anterior displacement of the fractured vertebra. Fracture-separations of the articular pillar are uncommon, ranging from 1.5% to 8% of all cervical spine trauma (Korres et al. 1993, Gehweiler et al. 1980).

Today, most authors believe that, due to the inherent instability of this injury, the appropriate management is surgery (Judet et al. 1970, Serge 1979, Roy-Camille et al. 1988, Korres et al. 1993, Shanmuganathan et al. 1996). We tried to better define the cause of the instability with particular emphasis on the role of the articular mass, coexisting injuries to the soft tissues, as well as the mechanism of the injury.

Patients and methods

From 1970 to 1994, 12 patients with 13 fracture-separations of an articular pillar at the lower cervical spine were treated at the Orthopaedic Department, University of Athens Medical School. These injuries comprised 2% of all the cervical spine injuries treated in our Department. There were 9 men and 3 women with

a mean age of 32 (20–55) years. All injuries were from high velocity motor vehicle accidents. 10 patients were treated immediately, while 2 were admitted on the 2nd and 6th day after injury. In 4 cases the lesion was at C4, in another 4 at C5 and in the remaining 5 at C6.

12 of the fractures were type I and 1 type II, according to the Dosh classification (1985). In 6 cases we noted sliding of the incumbent vertebra, 4 at the C5–C6 and 2 at C6–C7 level. Rotation of the isolated articular pillar in the sagittal plane was measured from lateral radiographs as the divergence of the longitudinal axes of the articular pillars and averaged 24° (10°–34°) (Figure 1). 12 patients had complete neurologic deficit (ASIA A), 7 had partial deficit (ASIA D), while 3 had no deficit. Associated injuries were found in 7 cases, with 3 at different levels in the cervical spine.

4 patients with neurologic deficit (1 ASIA A, 3 ASIA D) and a rotated articular pillar of more than 25° underwent posterior cervical fusion using Roy-Camille plates. 1 patient (ASIA D) was operated on after 2 months of failed closed treatment (Figure 2). 8 patients, 3 with a rotation of more than 25°, had closed treatment by cranial skeletal traction for 6 weeks followed by a 4-post brace for 6–8 weeks. 3 of the patients with closed treatment demonstrated par-



Figure 1. Lateral view of a fracture-separation showing rotation of the fractured articular pillar, with an angle of 25° between its axis and the axis of the opposite intact articular pillar.

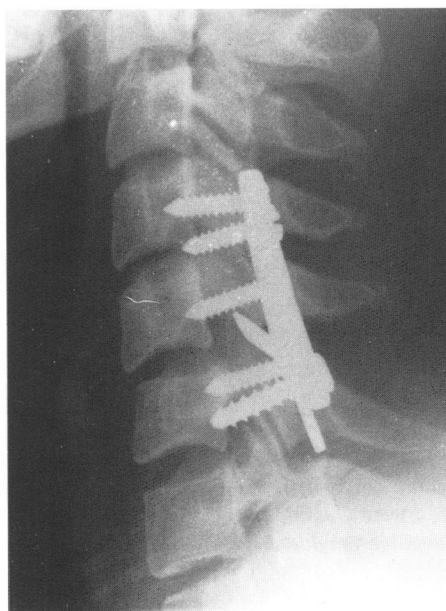


Figure 2. 5.5 year postoperative lateral radiograph management of a fractured articular pillar by posterior fusion and Roy-Camille plates. The kyphotic deformity was not completely corrected.

tial neurologic impairment (ASIA D) and 1 had complete deficit (Asia A).

Cadaveric studies: To assess the role of the mechanism of injury on spinal instability, we studied 6 fresh cadaveric cervical spines. A similar fracture-separation of the articular pillar of the C5 vertebra was created with strong scissors. To assess the effect of injury on the amount of articular pillar rotation and displacement of the injured vertebra, cervical spine specimens were manually loaded with simultaneous compression-rotation and hyperextension forces with or without sequentially cutting the capsules of the neighboring joints, the anterior longitudinal ligaments and the intervertebral disks (Figure 3).

Results

The results were classified as satisfactory when there were no symptoms and the radiographs showed no signs of instability and as unsatisfactory when symptoms were present due to either aggravation or no improvement of the initial clinical symptoms. The results at follow-up were correlated to the degree of rotation of the fractured articular pillar.

Of the 4 patients with a neurological lesion and a rotated articular pillar of more than 25° who were treated surgically; 3 with incomplete lesions (ASIA

D), recovered fully, while 1 patient (ASIA A) remained unchanged. At follow-up fusion was solid, reduction was maintained and no complications due to the implants were noted. With exception of the tetraplegic patient, the clinical picture was satisfactory.

8 patients, 4 with neurological impairment, had closed treatment. 1 patient with complete neurologic impairment remained unchanged and died 8 months after injury. A second patient with a rotated articular pillar of 28° still complains of radicular symptoms (ASIA D) while the remaining 2 were asymptomatic (ASIA E). The later had rotated articular pillars of 12° and 20°, respectively. Of the 4 patients who had no neurologic impairment, 1 patient with a rotated articular pillar of 30° showed an increased kyphotic deformity at the injured level and developed radicular signs. The remaining 3 with rotated articular pillars of 10°, 18° and 20°, respectively, had satisfactory clinical and radiographic outcome.

Cadaveric studies: Manually applied simultaneous compression, extension and rotation only slightly altered the position of the fractured articular pillar in fresh cadaveric spines. Sequential dissection of the capsules, anterior longitudinal ligaments and intervertebral disks produced a horizontal shifting of the fractured articular pillar (Figure 3). The magnitude of rotation was related to the severity of damage to the anatomical elements.

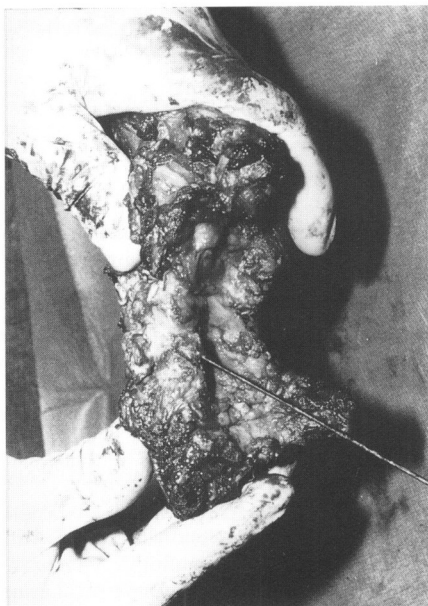
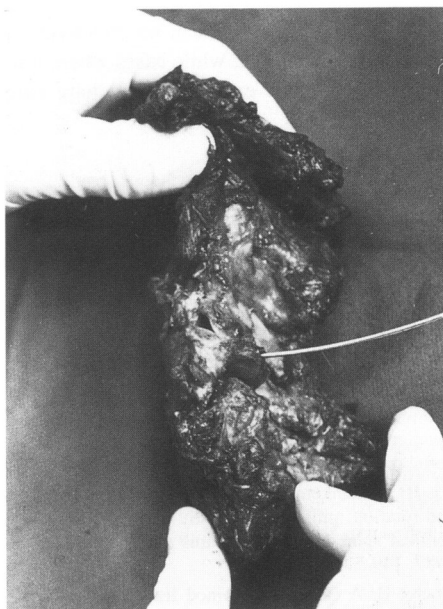


Figure 3. Fresh cadaveric cervical spine with a fracture-separation of the articular pillar showing no displacement after loading.



Dissection of the capsules, anterior longitudinal ligament and intervertebra disc produced rotation of the fractured articular pillar when loaded in hyperextension, compression and rotation. K wire indicates the axis of the articular pillar.

Discussion

A fracture-separation of the articular pillar, as first described by Judet (1970), is defined as a simultaneous fracture through the lamina and the ipsilateral pedicle, resulting in a free "floating" articular pillar. This type of injury occurs predominantly in the lower cervical spine and rarely in the upper cervical spine (Jeanneret 1985, Korres et al 1987). Diagnosis which is based mainly on lateral radiographs, although the AP view is also helpful (Scher, 1981), can be missed if there is no rotation of the articular pillar.

Previous studies have suggested that the mechanism of injury producing these fractures include hyperextension-rotation (Forsyth 1964, Scher 1981, Harris and Monroe 1987), hyperflexion-rotation or hyperflexion-distraction forces (Shanmuganathan et al. 1996). In our study, all injuries were due to hyperextension-rotation injury of the cervical spine after a motor vehicle accidents. The high incidence of associated injuries in these patients, and the severity of the injury, strongly indicates the application of multiple forces at the moment of the accident. The instability of the injury is manifested as a result of the displacement of the superior or more often the subjacent aspect of the fractured vertebral segment, in addition to the rotation of the isolated articular pillar in the sagittal plane to a more horizontal position (Serge 1978).

Inferior displacement is commoner, involving 6 cases compared to 2 with displacement of the superior vertebra. This may be explained, in part, by the greater forces acting on that level.

It appears that displacement or rotation of the vertebral segment is related to the severity of the injury. This hypothesis was supported from our study of fresh cadaveric cervical spines where vertebral displacement or rotation of the fractured articular pillar could not be created when the anterior longitudinal ligament, the capsule and the intervertebral disk were intact. This is compatible with previous studies in which the importance of the intervertebral disk in this injury was emphasized (Fuentes et al. 1987). Rotation of the fractured articular pillar of more than 30° has been associated with neural or vascular lesions (Judet 1970, Fuentes et al. 1987). Similarly, in our study the magnitude of rotation of the fractured articular pillar, especially when it was greater than 25°, was found to adversely affect the final result. This is maybe due to coexisting soft tissue lesions which produce a more unstable injury.

Operative treatment of fracture-separations of the articular pillar with a rotation of more than 25° was associated with an excellent outcome, as compared to closed treatment for similar cases which showed less favorable results. These results suggest that fracture-separation of the articular pillar with rotation in the

sagittal plane less than 25° can be effectively managed by closed treatment, while cases where rotation of the articular pillar exceeds 25° require surgical management.

References

- Forsyth HF. Extension injuries of the cervical spine. *J Bone Joint Surg* 1964; 46A: 1792-6.
- Fuentes JM, Benezech J, Lusszie B, Bloncourt J. Fracture-separation of the articular Process of the inferior cervical vertebra: a comprehensive review of 13 cases. In: *Cervical spine I* (Ed. Kehr P, Weidner A). Springer-Verlag, Strasbourg. 1987: 227-231.
- Gehweiler JA, Osborne RL, Becker RF. The radiology of the vertebral trauma. WB Saunders Co. Philadelphia 1980.
- Harris JH Jr, Edeiken-Monroe B. Simultaneous hyperflexion and rotation: pillar fractures. In: *The radiology of acute cervical spine trauma*. Williams and Wilkins, Baltimore 1987: 149-57.
- Jeanneret B. A case of combined fracture of anterior and posterior arch of the atlas due to extreme lateral bending, case report. In: *Cervical Spine I* (Ed. Kehr P, Weidner A) Springer-Verlag, Strasbourg, 1985: 218-53.
- Judet R, Judet J, Roy Camille R., Zerah Jh, Sailant G. Fracture du rachis cervical: Fracture séparation du rachis cervical. *Rev Chir Orthop* 1970; 56: 155-164.
- Korres DS, Sotopoylos C, Togangi D, Loupas D. Unilateral fracture of anterior and posterior arches of the atlas. *Acta Orthop Hell* 1987; 38: 192-3.
- Korres DS. Injuries of the cervical Spine. *Litsas, Athens* 1993: 161-5.
- Serge M. Fractures-séparations des massifs articulaires du rachis cervical. propos de 30 cas. Thèse en médecine, Paris. 1978.
- Serge M. Les fractures-séparations des massifs articulaires du rachis cervical inférieur. In: *Rachis cervical traumatique non neurologique. Premières journées d'Orthopédie de la Pitié*. Masson, Paris. 1979: 116-22.
- Roy-Camille R., Mazel C, Mariambourg G, Saillan G. Les fractures-séparations du massif articulaire du rachis cervical inférieur. *Premières journées d'Orthopédie de la Pitié*. Masson, Paris 1988: 104-7.
- Scher AT. Articular pillar fractures of the cervical spine. Diagnosis on the anteroposterior radiograph. *S Afr Med J* 1981; 60: 968-9.
- Shanmuganathan K, Mirvis SE, Dowe M., Levine AM. Traumatic isolation of the Cervical Articular Pillar, Imagined Observations in 21 patients *Am J Roentgenology* 1996; 166: 897-902.