The Treatment of Recent Spinal Trauma was the subject of the 3rd Traumatology Seminar organized by the Pitié-Salpétrière Hospital in Paris. One of the presentations dealt with

Lower Cervical Spine Sprains

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INTRODUCTION

Sprains of the cervical spine are injuries that involve the intervertebral soft tissues (discs and ligaments). The incidence of these injuries is very high. The sprains are caused by craniocervical trauma in flexion, in extension, or in a pattern where flexion follows extension (whiplash injury). Depending on the severity of the ligamentous lesions, sprains may be classified as either benign or severe. Benign sprains are due to a stretching or minimal tearing of the ligaments; they do not cause instability at the affected level. Severe sprains, on the other hand, are due to ligamentous tears, which cause instability. The diagnosis is based upon radiographic criteria. The distinction between the two grades of sprain may be difficult.

BENIGN SPRAINS

Benign sprains of the cervical spine are soft-tissue lesions of a cervical motion segment that do not affect the stability of the spine. In its mildest form, the sprain will cause stretching of a ligamentous structure. In its most severe form, it will cause a tear, which will not, however, involve the posterior longitudinal ligament (PLL).

A distinction is made between flexion injuries, which may involve a rupture of the posterior spinal ligament complex (supraspinous ligaments SSL, interspinous ligaments ISL, ligamenta flava LF, facet joint capsules FJC); and extension injuries, in which the anterior longitudinal ligament (ALL) may be torn.

Mechanism

The most frequently encountered mechanism is craniocervical trauma in extension-and-flexion, in a seat belt-wearing car driver or passenger. A study recently conducted in Quebec by Spitzer et al [29] showed that these injuries tend to occur at low speeds (< 60 km/h); in the driver rather than the passenger (75% vs. 25%); in females (60%); and in younger subjects (35 years). In cars, head restraints have been compulsory in the United States since 1968; this has led to an 18% drop in the incidence of spinal trauma (O'Neill et al [22]); however, benign sprains have not been completely abolished. After all, there is still a distance between the occiput and the head restraint, which allows the cervical spine to be jerked into hyperextension in the event of a rear-end impact. From this hyperextended position, the head rebounds forward, causing a flexion injury. Bourbeau et al [7] reported that neck sprains were relatively more numerous among belted occupants compared with unbelted ones, with a relative risk estimate of 1.68. However, they noted that the more serious injuries to the cervical spine were more prevalent among the unbelted occupants. Among the improvements considered were air bags combined with a better seatbelt support.

Benign sprains may also occur in non-vehicular situations, e.g. as sports or domestic injuries (fall from a standing height; falling down stairs).

Diagnosis

At the clinical examination, a typical history will be given, and the patient will complain of neck pain. The radiographic examination of the spine allows fractures and dislocations to be ruled out. However, normal-looking radiographs do not mean that the patient may not have suffered a severe sprain, since such a sprain may only manifest itself later on, when the initial pain and muscle spasm will have subsided. Patients whose only complaint is neck pain may have a stiff spine or loss of the normal spinal curvature. A careful search must be made for signs indicative of a severe sprain: haematoma of the prevertebral soft tissues, horizontal or angular displacement, facet joint surface exposure, and widening of the interspinous distance ("fanning"). A vertebral body compression fracture or a fracture of a spinous process will also provide clues. If there is any doubt as to the nature of the sprain, the lateral films of the cervical spine should be repeated after an interval, with dynamic views taken in maximum spinal flexion.

Transient or permanent quadriplegia in patients with normal-looking radiographs has been seen in a very small number of cases, following extension injuries (Argenson [3]). This condition is due to the spinal cord being temporarily pinched between the posterior inferior margin of the displaced body and the vertebral arch of the subjacent vertebra. In young subjects, a search should be made for a congenitally narrow spinal canal (Torg [31]).

Management

The established treatment consists in immobilization in a soft collar, and the use of analgesics until pain relief has been obtained. Often, the patient will have to be off work. Most of the current treatments are not based upon scientific evidence. The study by Spitzer et al [29] showed a high incidence of benign sprains ("whiplash-associated disorders") in Quebec (70 new traffic accident-related cases a year per 100,000 inhabitants). The authors felt that the management of the condition should be improved, since it is known that patients may develop chronic pain that will persist for months and even years. The recommendations were early manipulation and mobilization by trained persons; soft cervical collars should be discouraged; analgesics should be given for less than a week; and patients should be encouraged to return to their usual activities and to work as soon as possible.

Course

The course of benign sprains may be protracted. Posterior neck pain may persist, and patients may display any one, or all of, the symptoms described by Barré and Liéou, at the beginning of the century: occipital headaches, dizziness, ringing in the ears, vision and memory problems; the latter may form part of a full-blown depressive syndrome. The pathophysiological changes that occur in benign sprains involve various lesions that do not show up on radiographs. These lesions comprise tears in the longus colli muscles; damage to the anterior parts of the sympathetic trunk; capsular tears; bleeding into, and even fractures of, the facet joints, which cannot be detected on the standard cervical spine films. Jónsson et al [16] performed a study with plain radiography (supplemented by CT in certain cases) of the entire cervical spines of 22 traffic accident victims who had died from severe head injuries. The authors compared the results of radiography with the appearance of the cervical spine specimens taken from these patients. They found that, in the lower cervical spine, 198 lesions had been missed, including 77 facet joint and ligamentum flavum injuries, 77 uncovertebral injuries, and 22 disc lesions. Obviously, any overlooked lesions of this kind may subsequently give rise to persistent pain. Similarly, post-traumatic disc degeneration may result in residual pain. Hohl [15] found disc degeneration in 40% of patients who had suffered neck injuries without fracture or dislocation; in these cases, the lesions were thought to have been a sequel to the injury. If the

patient's symptoms are not improved, there should, of course, be a suspicion of a severe sprain - a condition that may not be diagnosed until some time after the traumatic event.

SEVERE SPRAINS

Severe sprains of the lower cervical spine are rare; however, as shown by Braakman and Penning [9] and later by Roy-Camille et al [25, 26], if these sprains are missed, they may result in progressive vertebral luxation and subsequent myelopathy. A retrospective study in 41 patients (44 severe sprains) treated in the Department of Orthopaedics of the Pitié-Salpétrière Hospital (Laporte [18]), and a search of the literature, have made it possible to describe the different diagnostic and treatment patterns of severe spinal sprains.

Pathology

Severe sprains of the lower cervical spine are the result of traumatic tears of the anatomical structures uniting the vertebrae; this disruption allows the vertebrae to be displaced beyond the physiologically normal range. Two adjacent vertebrae and the soft-tissue structures linking them together form what is known as a motion segment (Fig. 1).

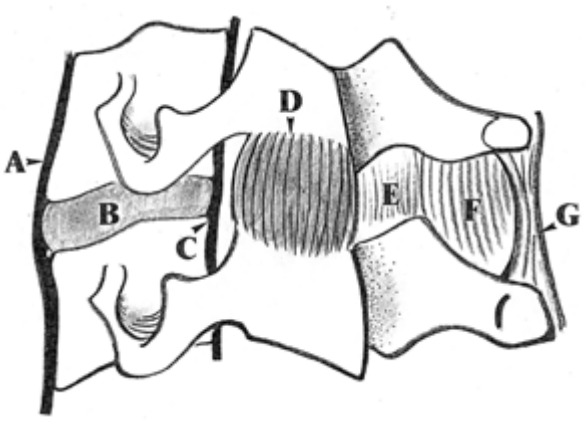

Figure 1: The motion segment

A: anterior longitudinal ligament; B: intervertebral disc; C: posterior longitudinal ligament; D: facet joint capsules; E: ligamentum flavum; F: interspinous ligament; G: supraspinous ligament

In flexion trauma, the soft tissues will be torn in a posteroanterior direction. Thus, the posterior-complex ligaments (SSL, ISL, LF, FJC) will tear first. This is still a benign sprain, because the lesions will be stable. A severe sprain is caused by the rupture of the PLL and the posterior annulus, i.e. when the middle column is affected. To meet the definition of a severe sprain, the vertebral displacement must not be due to a destabilizing bony fracture. The only bony lesions admitted as part of a severe sprain are those caused, as part of the trauma, by avulsion (spinous process fracture) or by compression (vertebral body compression fracture). In extension trauma, the soft tissues will be torn in an anteroposterior direction. The first to tear will be the anterior column structures (the anterior longitudinal ligament ALL, and the anterior annulus), followed by the soft tissues of the middle column. In whiplash injuries, both of these mechanisms are at work, with extension followed by flexion.

A severe sprain may be diagnosed on the grounds of the subluxation of one vertebra on the vertebra below. This pattern may be found immediately following the traumatic event, or at some time thereafter. This subluxation provides evidence of the rupture of the middle column; this injury will not heal. Severe sprains are dangerous because they may be difficult to diagnose: Cervical spine radiographs obtained immediately after the accident may not show anything abnormal, even in the presence of a severe sprain. In order not to miss the condition, serial radiographs should be taken, or dynamic views obtained under well-defined conditions (Bisserie [6]).

Incidence

According to Allen [1], severe sprains account for 7.2% of all severe injuries of the lower cervical spine; Argenson [2] found a rate of 10%; while Louis and Castera [20] reported a rate of 21.6%. Between 1980 and 1995, we saw 44 cases of severe sprains of the cervical spine, i.e. 3-4 cases a year (Laporte [18]). Jónsson et al [17] performed a 5-year follow-up of a group of 50 patients who had suffered whiplash injury while driving, and in whom the emergency radiographs had not shown any abnormalities. Only two of these patients underwent surgery for a severe sprain, while eight others were operated on for traumatic disc herniation. In a prospective study at Pittsburgh conducted over a two-year period, Wilberger and Maroon [35] found eight cases of significant ligamentous instability of the lower cervical spine in a total of 1,451 cervical spine trauma patients examined emergently; this would mean a rate of four new cases a year, and of 0.5% of all cases with cervical spine injuries. Thus, severe sprains appear to be comparatively rare. Many patients may be examined unnecessarily with dynamic radiography; it would, therefore, be desirable to have more precise diagnostic criteria for the detection of the condition in the Accident and Emergency Department.

Mechanism

Allen [1] considered severe sprains to be compressive flexion injuries, unlike luxations, which result from isolated hyperflexion. Driving accidents produce the largest number of severe sprains, followed by falls at home and by sports accidents. We have seen 28 road traffic accidents (20 involving four-wheeled vehicles, 7 involving two-wheeled vehicles, and one case involving a pedestrian); nine falls; and four sports accidents (Laporte [18]).

Severe sprains may also be caused by isolated hyperextension of the cervical spine (Argenson [2]; Sénégas et al [28]).

Patient details

Whereas in other studies of lower cervical spine trauma males have always been found to be predominantly affected, this was not the case in our series: of the 41 patients, 25 were males and 16 females; the mean age was 35 years (range: 13 - 78 years). The age distribution was bimodal, with one frequency peak in the 10-30-year group and another in the over-50-year group. The same pattern was found by Argenson [2] and by Braakman and Braakman [8]. In those two groups, it was interesting to see different mechanisms associated with different age groups: Among the younger subjects, the traumatic event was mainly a road traffic or a sports accident; while among the older ones, the injuries tended to be caused by a fall from a standing height.

Clinical diagnosis

This condition cannot be diagnosed on clinical grounds, since the neck pain is not specific and is a frequently encountered feature after spinal trauma however mild. However, a careful neurological examination must be performed. If any nerve root or cord damage is found, traumatic disc herniation should be suspected. Of our patients, six had a sensory and motor deficits associated with a severe sprain (1 quadriplegia; five radiculopathies with sensory and motor nerve deficits). Additional

imaging studies with MRI or myelography allowed us in five of these cases to detect a concomitant traumatic disc herniation (Laporte [18]). We feel that a severe sprain may have a less favourable outcome if there is also a herniated disc; disc herniation should be suspected

* **definitely, if there is evidence of complete or incomplete cord damage.**

The central cervical cord syndrome described by Schneider [27] may be more suggestive of spinal cord oedema or ischaemia; however, it may be associated with a herniated disc (Rizzolo [24]).

Préobajenski's anteroinferior syndrome, characterized mainly by diplegia of the upper limbs and pronounced pyramidal irritation below the level of the lesion, is usually caused by anterior spinal ischaemia. However, it should be borne in mind that it may also be due to anterior compression by a herniated disc (Rizzolo [24]).

* **if neurological disturbances appear or become worse after surgery.**

* **if there is cervical radiculopathy with sensory and motor deficits.**

Radiography (Fig. 2)

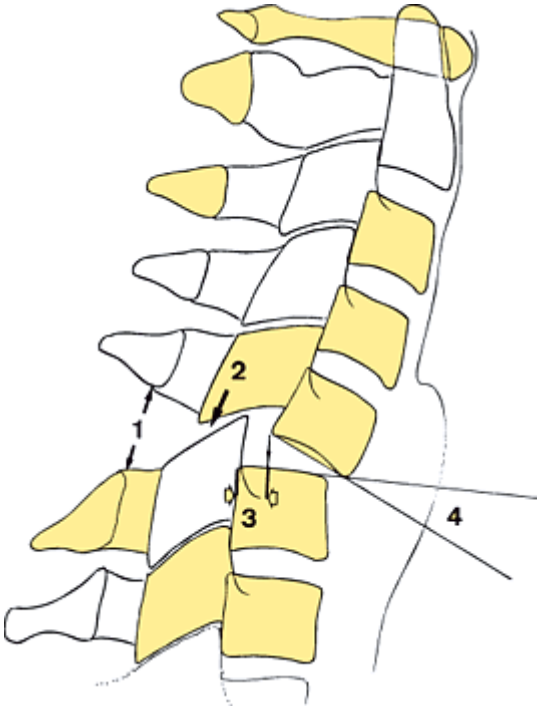

Figure 2: Radiographic features of a severe sprain

1: widening of interspinous distance ("fanning");

2: loss of parallelism between facet joints;

3: horizontal (sagittal) displacement > 3.5mm;

4: angular displacement (sagittal plane rotation) > 11° compared with the adjacent interspaces

The radiological diagnosis may be made from lateral views of the cervical spine in neutral position or on dynamic views, using the criteria established by Bisserie [6] and Roy-Camille et al [25, 26].

For the dynamic views, the patient is awake and placed in a sitting position. For the flexion view, the patient is asked to place the chin on the chest; for the extension view, to lean the head backwards until the occiput touches the top of the back (Bisserie [5, 6]). Dynamic views are indicated whenever the lateral films taken in neutral position provide evidence of a severe sprain without, however, being fully diagnostic. If the diagnosis is obvious from the neutral position film, a lateral view is

taken in extension, to assess the reducibility of the lesion (Bisserie [6]; Roy-Camille et al [25, 26]). The time between the taking of the neutral and the dynamic views depends on how relaxed the patient is. Some authors have suggested that the radiographs should always be taken at predetermined times from the accident. Thus, Argenson [2] proposed six days; Bisserie [6] and Roy-Camille et al [25, 26], 5 - 10 days; and Louis [19], 5 - 21 days. Rather than the observance of a particular time interval, it is the taking of repeat radiographs that will make it possible to establish when the patient can fully flex and extend without being limited by pain. In our study, the diagnosis was made from the neutral-position films in 13 cases (29.5%), and from films taken in maximum active flexion in 31 cases (70.5%). The mean time to diagnosis was 3 months and 1 week. There were three time patterns: Ten severe sprains (22.7%) were diagnosed from the emergency radiographs; 30 (68.1%) were diagnosed within 3 weeks from the accident; while 4 (9.2%) were not diagnosed until a later date, although even the initial radiographs had shown evidence of a severe sprain.

Radiological criteria for the detection of severe sprains have been established by a number of authors (Braakman and Penning [9]; Evans [12]; Green et al [13]; Louis [19]; Roy-Camille et al [25, 26]; Webb et al [32]), however, without any further typing of the abnormalities observed.

According to Bisserie [6] and Roy-Camille et al [25, 26], the diagnosis should be based upon lateral views of the cervical spine in neutral position or with flexion-extension. The following signs should be taken as indicative of a severe sprain: widening of the interspinous distance at one level, as compared with the adjacent levels ("fanning"); exposure of the superior facet joint surface of the vertebra below the lesion, and, above all, an increased joint space at the back; angular displacement (sagittal plane rotation) and horizontal (or sagittal) displacement of a vertebra. Fanning may be noted on an a.p. film. The size of these defects on a conventional radiograph, or the marked worsening of the pattern on the flexion film, are diagnostic.

Louis [19, 20] has proposed five criteria, any three of which, on neutral or on flexion films, would suffice to make the diagnosis of a severe sprain:-

1. Horizontal displacement ≥ 3.5mm above C4, and 2.5mm below that level; the measurement being made at the anterior edges of the vertebrae;
2. Fanning at one interspace, as compared with the adjacent interspaces;
3. Loss of parallelism between the facet joints;
4. Loss of contact of the facets ≥ 50%;
5. Angulation of the line of the posterior walls, at an angle ≥ 15°. < /OL>

These criteria have also been adopted by Argenson [2] and Sénégas et al [28].

Some authors (Berquist [4]; Harris [14]; Jónsson et al [17]; Stauffer [30] and Wilberger and Maroon [35]) use the so-called Yale criteria for the diagnosis of subluxation (the term favoured by many English-language writers to denote a severe sprain). These Criteria of Instability in the Lower Cervical Spine were drawn up in 1976, by White et al [34], in order to facilitate the diagnosis and management of lower cervical spine instability. The criteria are based upon anatomical and radiological studies (White et al [33]). The adult cervical spine is deemed to be destabilized if the two conditions listed below are met (Fig. 2):-

- there is > 3.5mm horizontal displacement of one vertebra in relation to the vertebra below, measured at the posterior walls, on a neutral-position or a flexion view, at a tube-to-film distance of 183cm.
- the disc angle measured between two adjacent vertebral bodies is 11° greater than the disc angles of the levels above and below.

An analysis of the records of 41 cases (Laporte [18]) allowed a quantification of the 44 severe sprains diagnosed using the Roy-Camille criteria (Table 1). The affected levels, in decreasing

order of frequency, were C5/C6 (19 cases); C6/C7 (12 cases); C4/C5 (9 cases); C3/C4 (2 cases); C2/C3 (2 cases); and C7/T1 (0 cases). Three severe sprains involved two adjacent levels.

Table 1 Radiological analysis

A - Sprain diagnosed on resting film (13 cases)	
Sagittal plane rotation	10.41°
Horizontal displacement	3.66mm
Facet joint exposure	> 1/2 joint surface
Fanning	16.25mm

B - Diagnosis made on dynamic views (31 cases)		
	Neutral position	Flexion
Sagittal plane rotation	4.2°	
Horizontal displacement	1.2mm	3.6mm
Facet joint exposure	> 1/3 joint surface	> 1/2 joint surface
Fanning	7.8mm	13.6mm

C - Postoperative results	
Sagittal plane rotation	2.75°
Horizontal displacement	-0.17mm
Facet joint exposure	NIL
Fanning	5mm

Indirect signs may also be searched for. An increase in the thickness of the prevertebral soft tissues as a result of haematoma formation is good evidence of disc and/or ligament damage. However, for this to be of diagnostic importance, the lesion must be between C1 and C4, and radiography must be performed within the first two weeks (Penning [23]). Fracture of a spinous process may provide evidence of avulsion of the interspinous ligament, and be associated with a severe sprain. However, such a fracture may also occur in isolation: This is the case with what is known as a clay-shoveller's or coal-shoveller's fracture, which may occur when the neck muscles are being strained while the subject is handling heavy loads (Harris [14]). We found sprain-associated spinous process fractures in four cases (9%). A compression fracture of the anterosuperior corner of the vertebra below the lesion shows the compressive vector force involved in the injury mechanism of severe sprains. Such fractures were found by us in 14 cases (32%) (Laporte [18]). They do not occur in dislocations of the cervical spine (Allen [1]). Thus, like spinous process fractures, compression fractures of the

subjacent vertebra may provide indirect evidence of cervical spine destabilization. This is why Mazur and Stauffer [21] routinely search for spinal destabilization by taking dynamic views whenever a compression fracture is seen.

Severe sprains in extension produce a typical pattern on the lateral view: exaggerated cervical spine lordosis, with gaping of the anterior disc space; backward horizontal displacement; and slipping of the inferior facets of the superjacent vertebra over the superior facets of the subjacent vertebra.

Magnetic resonance imaging (MRI) is used to study the soft tissues at the cervical level. Disruption of the posterior complex may be seen on T2-weighted scans, as an increased signal density between two adjacent spinous processes. The PLL, whose rupture is typical of severe sprains, may be seen at the lumbar level, where it produces the "black stripe sign", though not at the cervical level (Emery et al [11]). In cases of severe sprains in hyperextension, MRI may show tearing of the ALL (Davis et al [10]). MRI is the modality of choice for the investigation of the cervical cord and discs. We use the technique in the search for herniated discs associated with the sprain. It must be performed emergently, prior to surgery, in patients who have a cord syndrome without any bony lesions showing up on the radiographs, or if there is cervical radiculopathy with sensory and motor deficits. We also perform MRI postoperatively in patients with worsening neurological signs and symptoms, or if rot symptoms persists for more than three weeks.

Management

Attempts to treat severe sprains conservatively have not been rewarding (Roy-Camille et al [25, 26]); this is why, in our series, any severe sprains that had been diagnosed were treated with surgery (Laporte [18]). Treatment consisted in the fixation or fusion of the affected level. In all cases, a posterior approach was used; in four cases, this was combined with an anterior approach. Treatment through a posterior approach allowed the lesion to be reduced and fixated with two Roy-Camille® plates with screws routed into the pillars. Hibbs' technique of lamina freshening was employed 25 times. In four cases, discectomy was also performed, to remove a traumatically herniated disc that was causing neurological impairment. The disc level was then fused using an interbody iliac graft; in two cases, the construct was protected with a Roy-Camille® staple. After surgery, the patients wore a rigid collar for an average of two months.

The patients were followed up by clinical examination and radiographic evaluation. They were last reviewed on average at 29 months (range: 6 - 60 months). Pain and spinal mobility were rated on a scoring system from 0 to 3.

The following results were observed: Eighty-five per cent. of the patients did not report any pain, or had only very occasional pain; 82.9% had minimally restricted or full spinal mobility. Thus, 73.1% may be considered as having had a good or excellent result, with 21.9% having no pain, and having spinal mobility at least as good as before the accident. However, these figures are subject to criticism, since pain and mobility were not always accurately quantifiable, because of the subjective nature of these parameters.

In the patients with a less than good or excellent outcome, the reasons were as follows:

- *Extent of the surgical procedure:* Of the four patients who were managed with fusion via a combined posterior and anterior approach, three had a fair, and one had a poor result. Another two patients with a fair result had undergone two-level fixation. In all these cases, the extent of the procedure was dictated by the associated lesions: the patients concerned had either severe sprains involving two levels, or severe sprains plus disc herniation.

- *Multiple-level lesions:* Three of the five patients concerned had a fair result.
- *Age:* Five of the patients over 50 years of age (50%) had a fair result, while such a result was seen in only 5 of the patients under 50 years (16%).

Of the patients who had neurological damage before surgery, 70% made a full recovery; 93% were improved. All the patients with isolated sensory manifestations recovered. The pain appears to be due to a narrowing of the intervertebral foramina, which is abolished when the subluxation is reduced. In motor nerve root damage, the prognosis is more guarded than in cases with purely sensory problems. It is, however, important to bear in mind the cause of the radicular problems: four of the five patients with motor root involvement had a sprain-associated herniated disc. In such cases, it would be preferable to use an anterior approach, which allows the disc to be excised as completely as possible, and reduction to be maintained by the use of interbody fusion.

The radiological results were assessed on lateral neutral views, sometimes with dynamic imaging. The anterior displacement was found to be abolished. Sagittal rotation was seen to be on average 2.75°. Partial failure of the construct was seen in four patients. The quality of the graft could not be assessed. The levels adjacent to the fusion had not become unstable by the use of a posterior approach: there were only five cases of progressive kyphosis, which was slight (< 5°). It must be emphasized that the preservation of stability will depend on the quality of the surgery performed. A preoperative scout radiograph is essential; the incision is made in such a way as not to impair the muscle blood supply; and the exposure is confined to the affected cervical level.

The complications encountered were five infections (four superficial suppurations, and one deep infection), and neurological in one case (postoperative hemiplegia following a CVA). In one case, the hardware was removed to treat a deep infection.

We did not use the anterior approach other than for the treatment of disc herniations associated with severe sprains. We cannot, therefore, compare the two approaches in the light of our series of patients. The anterior approach may be used by itself for discectomy followed by anterior interbody fusion (Argenson [2]).

We have established the following management policy:

- *For severe flexion sprains without neurological manifestations or with neurological symptoms confined to pain radiating into the arms*, we will use fixation of the affected level through a posterior approach, using two Roy-Camille® plates, without bone grafting, but with freshening of the laminae (Fig. 3).
- *For severe flexion sprains with marked neurological manifestations*, we perform MRI to search for associated disc herniation. If a herniated disc is seen, fusion via an anterior approach, with removal of the disc, insertion of a graft, and anterior fixation should be done. In such a case, it may not be necessary to use the posterior approach as well (Fig. 4).

Figure 3: Severe sprain C5-C6. The resting film looks normal (3a); the flexion film on Day 15 is diagnostic (3b); surgical treatment via a posterior approach (3c)

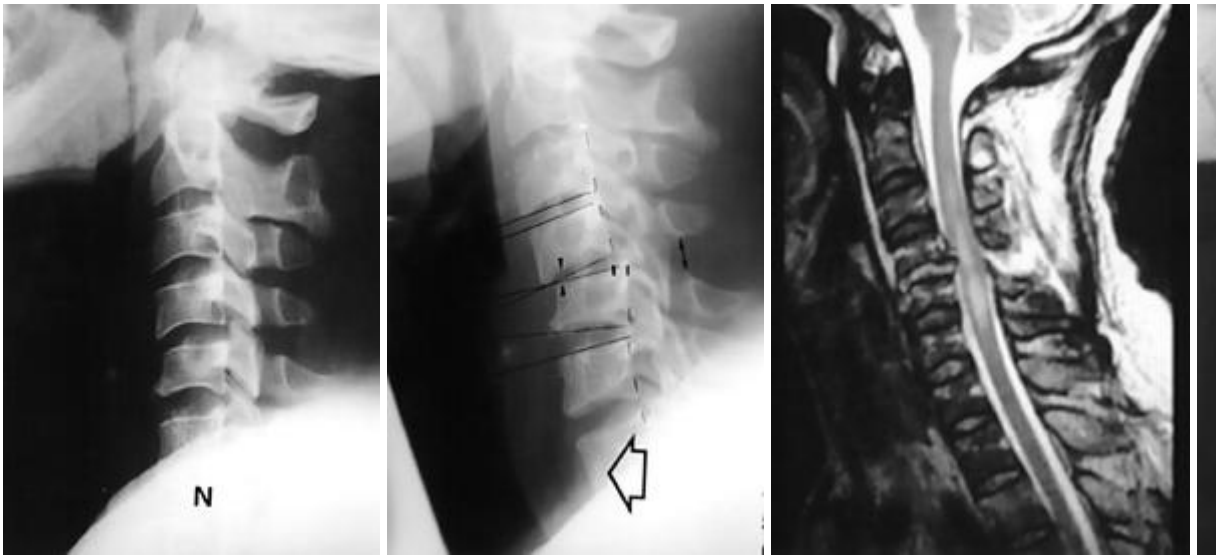

Figure 4: Severe sprain C4-C5, with upper limb diplegia. The resting film looks normal (4 diagnostic (4b); MRI shows a traumatic disc herniation with anterior cord compression and (4c); treated with combined anterior and posterior fixation and discectomy (4d).

The crux of the problem is diagnosing a severe sprain. There are borderline-unstable cases in which it is difficult to tell whether the PLL is torn. The Yale criteria may be used to resolve the question. The patients must be observed closely in order to see whether the lesions progress, in which case the injury would be considered to be a severe sprain. Some authors, such as Wilberger and Maroon [35], have suggested more selective criteria for patients at risk, since they feel that reevaluation in all patients would be a formidable and expensive undertaking. According to these authors, surgical treatment should be used if the angular displacement exceeds 5° and the horizontal displacement is greater than 1.5mm. Perhaps MRI will soon be able to tell more clearly and on the day of the accident whether the PLL is torn; at present, this modality can, apparently, only show posterior column involvement (Emery et al [11]).

Severe extension sprains must be treated surgically. Fusion via an anterior approach would be the most logical technique, since it is mainly the anterior structures that are affected (Argenson [2]).

CONCLUSION

Sprains of the lower cervical spine are frequently encountered in orthopaedic practice. In these patients with persistent neck pain, the diagnosis of a severe sprain cannot be made on the strength of clinical examination only. Lateral radiographs of the cervical spine, in neutral position and in maximum flexion, remain the gold standard. However, while these views will provide evidence of a severe sprain, they need not be produced in each and every patient. In severe sprains, surgery is mandatory. The injured level must be managed with bilateral plating, since malunion may occur otherwise.

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