Tear-drop Fractures of the Cervical Spine.

N.S. Motsitsi, L.N. Bomela.
Department of Orthopaedic Surgery, University of Pretoria, Kalafong Hospital, Pretoria, S. Africa.

Correspondence to: Dr. N.S. Motsitsi, Fax : + 27 12 373 9031, E-mail: silas.motsitsi@up.ac.za.

Tear-drop fractures of the cervical spine are relatively rare injuries. Those involving the upper cervical spine commonly occur in older patients following minor trauma. However, they may occur following major trauma like car accidents, falling from heights and diving into shallow water. They are stable injuries and are treated conservatively with relatively good outcome. They are usually not associated with neurological deficits unless they are associated with injuries at other levels. The cause of neurological fallout is commonly due to associated injuries.

Tear-drop fractures of the lower cervical spine are usually caused by severe trauma including sports. About 83% - 87% of tear-drop fractures due to sports are accompanied by neurological fallout. Tear-drop fractures of the lower cervical spine are regarded as unstable. The management of tear-drop fractures of the lower cervical spine is very controversial. The controversies are: should all these fractures be managed surgically? If so, what is the best surgical approach? Unfortunately, available literature does not offer convincing answers. Current surgical techniques provide acceptable stability, at least according to biomechanical studies. It is still to be established whether these biomechanical findings are confirmed clinically.

Introduction

Tear-drop fractures of the cervical spine are defined as fractures involving the antero-inferior angle of the cervical vertebral body, with the vertical dimension of the triangular fragment being equal to, or greater than the transverse dimension[1]. They are relatively rare injuries. There are two major groups of tear-drop fractures of the cervical spine: those involving the upper (C1-C2) cervical spine and those involving the lower (C3-C7) cervical spine. These two groups also differ with respect to mechanism of injury, the incidence of neurological deficits, management principles and outcome. The purpose of this article is to review the Pathophysiology of tear-drop fractures of the cervical spine, their clinical presentation, radiological features, principles of management and outcome.

Pathophysiology

The management of any clinical pathology is predicated on knowing its Pathophysiology. The Pathophysiology of the two categories of tear-drop fractures is different. It is their Pathophysiology that forms the bases of management approach.

The Upper Cervical Spine.

The vertebra that is commonly fractured is the axis (C2). Tear-drop fractures of the axis forms 3% of the cervical spine trauma[2]. The incidence may be as high as 26%[3]. Hyperextension dislocation of the axis constitutes about 32% of the axis fractures[4]. Fractures of the axis commonly occur in the elderly following minor trauma and tend to be stable[1]. However, they may follow severe trauma: car accidents, falls and diving into shallow water[2]. The mechanism of injury is hyperextension. The tear-drop fracture is caused by avulsion by the anterior longitudinal ligament. The disco-ligamental complex (supraspinous ligaments, interspinous ligament, the joint capsule, the intervertebral disc and the posterior longitudinal ligament) is preserved. This injury pattern makes tear-drop fractures of the axis to be stable injuries. About half of these injuries are associated with injuries at another level[2]. Isolated tear-drop fractures of the axis are not associated with neurological deficits, but associated fractures may cause neurological fallout.

Tear-drop fractures of the atlas (C1) are very rare; no series of these injuries have been reported in the English literature.

Tear-drop Fractures of the Lower Cervical Spine (C3-C7).

They are caused by severe trauma. The incidence is fairly high: 8.8% - 23%[5]. There are two forces that cause tear-drop fractures of the lower cervical spine[1]:

1. **Tension**: this causes disruption of the disco-ligamentous complex (DLC) and thus injury to the posterior column. The posterior column fails in tension.
2. **Compression:** the anterior column fails in compression and causes tear-drop fracture.

The upper cervical column may displace posteriorly leading to anterior compression of the spinal cord. Tear-drop fractures of the lower cervical spine are regarded as unstable. Complete spinal cord injury may occur in 38% - 91% of cases[6]. The majority of spinal cord injuries are incomplete. Anterior spinal cord syndrome accounts for 80% of incomplete spinal cord lesions[7]. Other lesions like Brown Sequard Syndrome may occur.

There may be an additional force in the mechanism of injury of the lower cervical spine: lateral flexion or rotational force. This force causes and additional injury to the vertebral body. The fracture line is orientated in the sagittal plane. The force can cause fracture of the vertebral body and the laminar leading to a 'hemi vertebra'. Laminar fractures may be bilateral. The incidence of laminar fracture may reach up to 84% . The facet can also be involved. This additional fracture pattern further compromises the stability of the injury[8,9].

Tear-drop fractures may also occur in athletes. It is common in most sports. These fractures show two fracture patterns and the incidence of neurology[10]:

1. ***Isolated tear-drop fractures:*** the incidence of neurology is 83%.
2. ***Three - part, two plane fracture pattern***: the incidence of neurology is 87%.

Injuries to the vertebral and the carotid arteries (thrombosis or dissection) must always be borne in mind in all injuries involving the upper cervical spine and fractures or fracture-dislocation of the lower cervical spine. Carotid artery injury is unusual and tends to be symptomatic[7]. These injuries must always be excluded.

Clinical presentation

Patients who sustain tear-drop fractures of the cervical spine do not have specific ways of presentation. Elderly patients with tear-drop fractures of the axis may give a history of minor trauma like bumping their heads against a wall. Clinical examination may reveal tenderness in the upper cervical spine. There is usually no neurological deficits. The majority of patients will give a history of severe trauma: motor vehicle accidents, diving into shallow water and falling from a height. Those who sustained fractures of the axis will have no clinical neurological deficits unless there are associated fracture(s) at other levels. About two-thirds of patients who sustain lower cervical spine tear-drop fractures as a results of diving have neurological deficits on presentation[6].

Radiological investigations

Radiological investigations are the key to the diagnosis of tear-drop fractures of the cervical spine.

1. Standard Radiological investigations (X-rays).

These are the first lines of investigations. Features that must be noted are:

- Soft tissue shadow: pre-vertebral soft tissue swelling (especially in uninitiated patients) may show either localized or diffuse swelling [1]. Diffuse soft tissue swelling is significant if it extends to at least one level above or below the level of injury.

- The character of the avulsed fragment. The shape of the avulsed fragment is triangular, with the vertical dimension being equal to, or larger than the transverse dimension. This is a critical concept to understand in order to distinguish it from the fragment due to hyperextension dislocation (H D) and the quadrangular fracture. In HD the avulsion is mediated through intact Sharpey fibers which penetrate the former ring apophysis[1]. The fragment originates from the antero-inferior endplate of the involved vertebra. It is small, flat and wedge-like with the vertical height being less than the transverse width[1]. It is rarely found in the upper cervical spine. Patients with this type of injury (HD) almost always have neurological deficits. Quadrangular fractures are due to compression fractures. They resemble tear-drop fractures, but they respond poorly to posterior fusion. Farero and Van Peteghem[11] outline major differences between quadrangular fractures and tear-drop fractures, although some authors use these two terms interchangeably. They are also different from burst fractures[12].

2. **Computed Tomographic Scan (CT – SCAN).**
   It is an ideal method for demonstrating sagittal fracture involving the vertebral body and posterior elements. It is highly recommended that CT - SCAN must always be done in patients with tear-drop fractures of the cervical spine, especially the lower cervical spine**.**
3. **Magnetic Resonance Imaging (MRI).**
   It is the best mode for demonstrating the extend of soft tissue and spinal cord injury. The extend of DLC disruption can be well demonstrated by this modality. It will also exclude any possible mechanical compression to the spinal cord. MRI-Angiography can be added to exclude possible vascular injury.

Management Principles

Management of tear-drop fractures of the upper cervical spine is conservative because these fractures are stable[13,3]. But the management of lower cervical tear-drop fractures is controversial. Scheider and Kahn[14] emphasized that these fractures must always be management surgically. They maintained that conservative treatment leads to late neurological deterioration. The first controversy is whether they should all be operated. Unfortunately, studies available in the English literature are all retrospective, and there are no randomized controlled trials.
Fisher et al[5] reviewed 45 of their patients of whom 24 were treated conservatively and 21 treated operatively. Five of conservatively treated patients had to be operated because of loss of alignment and neurological deficits in two patients. Those whose fractures united on conservative treatment developed significant late kyphosis. All their operated patients had 100% union rate. Cabana and Ebersold[16] treated their 8 patients surgically and had successful outcome. Koivikko et al[17] confirmed better outcome in tear-drop fractures treated operatively compared to conservative treatment. Korres et al[15] in their latest study maintained that not all tear-drop fractures of the lower cervical spine need surgical intervention. They stated that there are certain parameters that need to be taken into account before one decides whether to operate or not which include size of the triangular fragment, the presence or absence of sagital fracture, the presence or absence of retrolisthesis, the magnitude of the retrolisthesis, the presence or absence of dislocation and the presence or absence of locked facet. They proposed a classification system that serves as a guide whether to operate or not.

The second controversy is the surgical approach. The currently favored technique is anterior discectomy, grafting and anterior cervical plating. Posterior procedures like plating and grafting are also surgical options.. Biomechanical studies[18] showed that currently practised surgical techniques provide good or acceptable stability. Future or prospective studies are needed to answer or address the following pertinent clinical questions or issues:

- Comparison between operative and non-operative treatment of tear-drop fractures of the cervical spine using randomized controlled trials.
- Development of classification system for these fractures or validation of proposed classification system(s) currently available.

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