BokSmart
WINNERS PLAY SMART

MEDICAL MANAGEMENT OF SUSPECTED SERIOUS ACUTE SPINAL CORD INJURIES IN RUGBY PLAYERS

Dr Robert Dunn

SA RUGBY

ABSA

CHRIS BURGER PLAYERS FUND PETRO JACKSON

Providing coaches, referees, players, and administrators with the knowledge, skills, and leadership abilities to ensure that safety and best practice principles are incorporated into all aspects of contact rugby.

INTRODUCTION

Injury to the spinal cord during rugby is rare but remains an emotionally charged issue, especially at schoolboy level. Quarrie [1] reports an overall 1.4 spinal cord injuries per annum per 100 000 New Zealand rugby players. This has reduced to 0.7 since 2001. This reduction corresponds with the introduction of a local education program but may also have to do with the change of scrumming laws [6, 7]. Previously many of the injuries were incurred in scrumming, but with law changes the average number of scrums per game has reduced by 40%. Now many spinal cord injuries occur during open play and particularly during the tackle.

Fuller [2] followed 12 English Premiership clubs for two seasons and found an incidence of 10.9 spinal column injuries per 1000 player match hours. None were catastrophic, but three were career ending. He confirmed tackles as the major culprit.

In the South African context, Noakes [3] reported a total of 8.3 spinal cord injuries per season during 1990-1997 in the Western Cape alone. Twenty percent were schoolboys. The devastating outcome was death in 8%, tetraplegia in 48% with only 35% recovering significantly.

Efforts to make the game safer include law changes as well as player, coach and referee education. In addition, early recognition and appropriate management of the spinal cord injury are mandatory.

Injury to the spinal cord not only results in motor and sensory loss, but also autonomic dysfunction, which results in the body's inability to regulate blood pressure, pulse and temperature. Breathing efforts are compromised by loss of voluntary muscle control and these factors threaten the patient's life. The initial management revolves around injury recognition, minimising secondary spinal cord injury, support of essential physiological functions, and avoidance of related complications.

Definitions:

Cervical – neck

Complete SCI – total loss of spinal cord function at a given anatomical level.

Dermatomes – the area of skin that is supplied by a specific nerve.

Incomplete SCI – partial loss of spinal cord function at a given anatomical level, with residual sensory or motor function distal to the lesion.

Neurological – relating to the nerve function.

Paraesthesia – a sensation of "pins and needles" in the distribution of the nerves affected. This may be confined to one region of one limb if a single nerve is involved to diffuse involvement of both or all limbs.

Paraplegia – complete loss of motor (power) function in the lower limbs, i.e. legs, with preservation of normal upper limb function, if the spinal cord is involved.

Prognosis – future clinical outcome.

Spinal Cord Injury (SCI) – damage to the spinal cord which manifests in a loss of motor and/or sensory function.

Tetraplegia – complete loss of motor (power) function in both upper and lower limbs.

Thoracic – torso.

Diagnosis:

The diagnosis is made on the basis of clinical assessment and special investigation.

The initial evaluation is made on the field when a player complains of neck / back pain with associated neurological symptoms. Significant cervical or thoracic pain with focal tenderness of palpation of the spinous processes and a restricted range of cervical motion suggests a significant spinal injury.

Neurological symptoms may be as subtle as paraesthesia (pins and needles) in the limbs to loss of sensation and motor function.

A complete neurological examination by a doctor is required to ascertain whether there is in fact neurological compromise and, if so, to what degree. This requires testing of all dermatomes for sensation and appropriate muscle groups for power. The presence of a sensory level is delineated in the case of a SCI. This manifests at a skin level where there is normal sensation proximal (towards the head), whereas distal (towards the feet) it is altered or absent. The patient is log-rolled and a rectal examination done to confirm the presence or absence of peri-anal sensation, anal tone and voluntary sphincter function. Should this be absent the SCI is regarded as complete as there is no residual cord function below the lesion. Should any of these be present, the lesion is incomplete with a better predicted outcome (prognosis). The interpretation will be dealt with under Grading of Injury.

The patient should be medically stabilised before further investigation as discussed below.

The first special investigation is X-ray. Commonly the injury is to the cervical area. This can be localised both on the location of the pain and the anatomical lesion from the clinical examination.

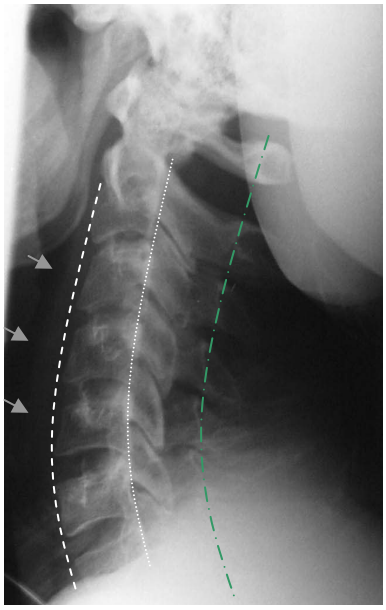
A cervical X-ray series consists of an Anterior-posterior view of the neck, and open mouth view and a lateral view. The lateral view should extend from the base of the occiput to T1. Should the distal spine not be visible due to the presence of the shoulders, it should be repeated with manual traction on the arms. Failing this, a Swimmer's or Flying Angel view should be performed.

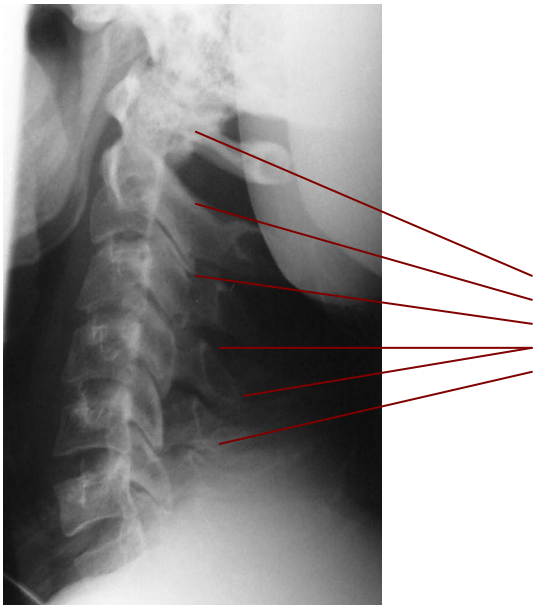
The X-rays should ideally be assessed by a radiologist but often it is the treating clinician that is faced with the interpretation first. The lateral view is the most useful but injuries can be missed in up to 30% of cases.

A simple approach is to assess the 5 lines, 4 vertical and one of convergence.

- soft tissue line
- anterior body line
- posterior body line
- spino-laminar line
- convergence of the spinous processes

When viewing the soft tissue line, there should be less soft tissue shadow than half a vertebral body down to C6, with up to one body width acceptable below this (grey arrow). There should be a smooth, uninterrupted line running down the anterior aspect of the cervical vertebral bodies from C1 to T1 (white dashed). Likewise for the posterior body line (white dotted) and spino-laminar line (green dashed). A disruption in any of these would suggest loss of spinal column integrity. The lines of convergence are drawn along the axis of the spinous process and should meet posterior to the neck. If they diverge an injury is suspected.





The AP view should be assessed for a rotatory deformity. This is suggested should there be deviation of the spinous process from the midline. The spinous process is shown with the white arrow.

Should the X-rays be interpreted as normal and there is no neurological deficit, dynamic views would be indicated. This involves lateral flexion / extension views where the patient is asked to maximally flex his neck forward and backwards and X-rays taken at the extremes. The patient should not be assisted with movement as pain will limit this to within a safe zone. These X-rays are reviewed for signs of instability. This includes evidence of listhesis (forward slip) of 3.5mm or more, kyphosis of greater than 11° and loss of the normal contours.

In the case of neurological deficit a MRI scan is required (if available). This is the only way the neurological and other soft tissue structures can be visualised. It provides the information to make a confident diagnosis and plan safe treatment. Occasionally, if an MRI scan is not readily available one may be forced to manage certain injuries without it. This is a compromise and not the ideal.

Grading of Injury:

The injury is graded in terms of two aspects, viz. the integrity of the vertebral column and the neurological status of the spinal cord.

Column integrity

As regards the column integrity, it is essential to decide if the spine is stable or not. Should there be evidence of instability; further spinal cord function is at risk as the spine no longer has the resistance to physiological forces. Instability can be a result of bony or ligamentous injury. Ligamentous injuries are more dangerous as they are not immediately visible on X-ray but rather suggested by change in alignment. This is more subtle than a fracture.

Cervical injuries are defined according to mechanism. This is a combination of compression / distraction forces in either flexion or extension as per the Allan and Ferguson classification [4, 5]. The commonest injuries seen in the rugby context are the Compression Flexion, the distractive flexion and burst injuries. The way the cervical spine is exposed to force rather than the specific event (tackle, scrum collapse) dictates this. A player can dive into a ruck, and depending how he strikes the ground can exert either a compression force or likewise by striking his forehead and his body rolling over, create a distractive force on the neck.

A compression flexion injury results in one of the vertebral bodies being fractured, i.e. collapsing. Depending on the degree, this may be limited to deformation of the superior endplate of the body. Should there be more force applied, the inferior anterior part of the body will fracture, creating the “teardrop” fracture. Despite appearing relatively innocuous on X-ray, this implies that the posterior ligamentous structures have been disrupted and the fracture is unstable. In the extreme case, the

teardrop fractures right off, the body retrolistheses (moves backwards) through the spinal canal and transects the spinal cord.

In distraction flexion injury, there is a stretching out of the posterior ligamentous structures, which include the interspinous ligaments and the facet joint capsules. This allows the facet joints to dislocate. This may be one or both. With this there is disruption of the anterior disc tissue creating instability. Should the injury be limited to a unifacet dislocation, the incidence of severe neurological injury is low. A bifacet (both facets) dislocation is evidenced by more than 50% body width anterior translation on the lateral X-ray, compressing the spinal cord with a higher incidence of neurological injury. This type of injury is usually the one that requires urgent intervention as SCI may be reversible once compression relieved.

Neurological status

This is important to classify the extent of the injury to be able to succinctly communicate to a referral centre, as it may effect management in the early phase. The ASIA (American Spinal Injury Association) system is utilised.

The assessment is based on determining the level of injury and the extent of injury. The former requires knowledge of anatomy but for ease, key muscle groups are marked on the ASIA chart (appended). Muscle groups are examined and the level is based on the last normal function level, i.e. full power. Once this is determined, residual distal function is sought. This may be an area just below the lesion, termed a zone of partial preservation, or maintained function throughout the rest of the body. The latter is far more important prognostically [23, 24, 25], because if there is sensation or motor function maintained distally, there is a much better chance of recovery. The lesion is deemed complete if there is no residual distal function and incomplete if it is present. Care must be taken to assess voluntary motor function to command. Sensation must be critically assessed by asking the blinded patient to indicate which leg is being touched as opposed to “can you feel”. The rectal examination is mandatory in this assessment. All this should be charted on the ASIA score sheet.

The physician should be careful not to interpret anterior chest sensation as preservation of thoracic sensation, as the supraclavicular nerves from the cervical region can supply this area.

Once this assessment has been done a neurological diagnosis of last functional level, zone of partial preservation (ZPP) and complete/incomplete should be documented.

Preferred list of medical facilities:

It is important that every school / club determines an appropriate hospital in case of suspected spinal cord injury. Facilities vary widely from region to region and access may depend on financial status of the patient.

It is pointless taking a patient with no insurance to a private medical facility if the treating doctor is unable to access the expensive imaging modalities. This results in delays while the transfer of the patient to a state facility is arranged.

The degree of spinal injury may dictate the level of care. Should the patient complain of a painful neck but no complaints or evidence of spinal cord involvement, i.e. no paraesthesia or sensory disturbance and full voluntary muscle power, it is likely only X-rays will be required. There is also no extreme urgency, so a stepwise approach can be adopted. This patient can then be taken to a facility where X-rays are available, but not necessarily MRI. This is more applicable in the state environment as most private centres have an MRI, but it may not be available on the weekends. The chosen hospital should be at least a level 2, with specialist staff available to interpret the X-ray.

Should there be any neurological symptoms, it would be best to attend a hospital with MRI capabilities as well as spinal surgical resources. In the state service this may be limited to Level 3 services such as in the Western Cape. It should be ascertained that the private hospital in the school's vicinity has Spinal surgical capabilities before utilising their services, in order to avoid delay.

Acute Spinal Cord Injury medical management protocol

Once the injured rugby player arrives in hospital he is assessed by the treating physician. ATLS protocol is followed in terms of emergency management. As the SCI patient can be physiologically unstable, s/he is best managed in a high care environment. A dedicated Spinal unit is the best. Continuous monitoring of physiological function is necessary with mechanical ventilation available.

The patient should be well immobilised on a firm board to avoid secondary injury. The patient should be supine in a neutral position. Should there be an obvious neck deformity, gentle in-line traction may be necessary for comfort and immobilisation. No forced movement should be performed and movement should be limited if there is pain associated. Preferably a soft thin mattress should be between the board and the patient to prevent pressure sores developing.

Logrolling, turning the body in unison, should be performed when examining the patient. This involves three personnel, one with a head grip, one on the shoulders and the other on the pelvis, avoiding any

spinal torque when rotating the patient. This allows examination of the back of the neck and torso and facilitates pressure care.

Intravenous access must be obtained and fluids administered to maintain an adequate blood pressure. Patients with SCI lose their vascular tone, increasing capacitance and therefore develop neurogenic shock. They will only transiently respond to fluid resuscitation and this should be limited to avoid pulmonary oedema. Cervical SCI patients may not be able to respond with a tachycardia as there is disconnection of the spine and sympathetic plexus.

A mean blood pressure of more than 70 mmHg is necessary to maintain cord perfusion and minimise the secondary injury. The use of adrenalin may be necessary.

Adrenalin 4 amps in 200 ml normal saline diluent can be infused, titrated against the blood pressure. Typically this is infused at 3-10 drops/min (60 droppers). Occasionally with high cervical lesions there is a higher requirement, necessitating a double strength mixture, i.e. 8 amps Adrenalin in 200 ml Normal Saline at 1- 10 drops per minute.

Should there be a persistent bradycardia (< 40 bpm), Atropine 0.5 mg IV can be administered.

The use of high dose steroids is a management choice. There is little evidence of any clinically significant benefit and complication rates remain high. If the physician uses steroids, the NASCIS protocol should be followed, i.e. 30mg/kg Depot Medrol over 15 minutes followed by 5.4mg/kg per hour for 24 hrs if within 4 hours of injury and 48 hours if within 8 hrs. After 8 hours, even the proponents see no benefit.

A urinary catheter should be placed to assess urine output as well as avoid complications from retention related to the SCI.

As these patients frequently develop an ileus, they are placed nil per os and a nasogastric tube passed.

They are at risk of gastritis and Ulsanic 1g 6 hourly administered per os or via the NGT.

The patient should be assessed for respiratory difficulty. Frequently those patients with a high cervical lesion may fatigue with the increased efforts of diaphragmatic breathing and become hypercapneic. Oxygenation is also challenged by atalectasis and possible pulmonary oedema. All patients should receive face mask Oxygen to maintain spinal cord oxygenation and if there is deterioration, supported by face mask CPAP or intubation in extreme cases. It is preferable to intubate early rather than await extensive atalectasis and pneumonia, as this will only prolong the course of ventilation. There is often reluctance to intubate these patients due to perceived poor prognosis, but it should be remembered that

in the early phase of spinal shock, there is cord swelling / spinal shock and once this resolves there may be a dramatic improvement. The patient must be given the benefit during this period [22].

Once the patient is stable physiologically, radiographic investigation is required to assess the injury. This will involve X-rays as discussed above as well as an MRI scan (as neurological injury as well). A CT scan is indicated should there be a suspicious lesion on X-ray that requires further delineation. This is more applicable in the patient with a suspicion of vertebral column injury but no neurological injury.

In the ideal world an MRI is required to assess the SCI. Should this not be available the treating physician needs to decide whether to transfer the patient to another facility or proceed without one. This is a very complex and controversial argument. If it is clear that the patient is deteriorating neurologically or has a neurological complete lesion and the X-rays confirm a dislocation, it would be reasonable to proceed to closed reduction. There is some weak evidence to suggest early reduction in bifacet dislocations improves outcome so one would prefer not to delay. In a patient with minimal neurological deficit and a dislocation, there is a risk of deterioration with closed reduction [9], and a pre-reduction MRI is preferable to exclude a disc herniation [10, 11]. Although rare, it is a cause for concern.

Should there be a fracture (compression teardrop), there is no reduction required but in-line traction with callipers will assist in realigning the spine.

For both the dislocations and fractures, the head / neck can be immobilised with callipers. For the reduction process, one can start with 5 kg for the head and 2 kg per level, positioned in flexion and under X-ray control reduce the facets. The weights can be sequentially increased but seldom beyond 15 kg. Once reduced, the weight can be reduced to 2 kg. A fracture can be maintained with 2-4 kg. [12, 13, 14]

Once reduced, the definitive management is surgical stabilisation if the skill is available [19-21, 26]. The option of 6 weeks traction in bed followed by 6 weeks in an orthosis is a poor one. During the period there is risk of complications such as bed sores and pneumonia [18]. In addition, there may be instability at the end of treatment and surgery required in any event.

Should the MRI confirm disc extrusion and thus risk of neurological deterioration with reduction, open (surgical) decompression and reduction can be performed from anterior with relative ease.

The spine should be stabilised surgically either by an anterior plate or posterior fixation.

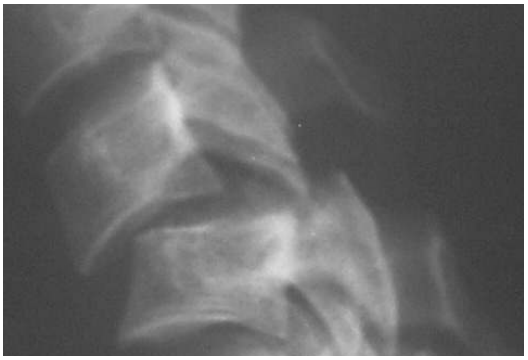
Chest physiotherapy should be instituted twice a day with assisted coughing. Frequent suctioning should be performed.

Pressure care is mandatory with 3 hourly turns. The use of a pressure reduction mattress (e.g. Huntleigh) is recommended in high cervical injuries.

Deep vein thrombosis prophylaxis is advised with TED stockings and a LMWH such as Clexane 40mg or Fragmin 5000U daily sc.

Examples:

Case 1: 18-year-old male presents with a painful neck following a scrum collapse. His neurological examination is normal.



His lateral X-ray demonstrates a listhesis (forward translation) of the C5 on C6 vertebral body. There is a breach in all the vertical lines and the spines are no longer convergent. On closer inspection, it is clear that one set of facet joints are dislocated. There is obliquity of the C6 facets compared to C5 suggesting a rotation between the two. The diagnosis is that of a Unifacet dislocation. As there is no neurological deficit, closed reduction is an option. Cones callipers were applied, initially in flexion and serial weights utilised.

Note the double mattress to allow extension of the neck once reduced.

This series of X-rays demonstrate the dislocated facet distracting, perching and finally reducing into its normal place. Following reduction, an anterior C5/6 fusion was performed with a plate and iliac crest bone graft. This allowed discharge within a few days. An intra-operative open reduction and fusion would also be an acceptable option.

Case 2: 19-year-old male presents with diffuse paraesthesia following injury.

X-rays show teardrop fragment indicative of a compression flexion injury.

The MRI scan indicates increased signal in the fractured body and spinal cord. There is no persistent compression.

There is no need for reduction or decompression. The patient underwent an anterior fusion to re-establish stability. Posterior fusion is an acceptable option.

Case 3: This 25-year-old man presents with an incomplete cervical SCI.

X-ray confirms a C4/5 anterior listhesis and kyphosis. An urgent MRI scan confirms the bilateral facet dislocation (see para-sagittal views) as well as significant disc behind the C4 vertebral body. This puts the cord at risk during reduction.

As the patient was incomplete neurologically, urgent surgical intervention is indicated. An emergency anterior discectomy, open reduction and instrumented fusion was performed.

AUTHOR'S BIOGRAPHY

Dr Robert Dunn (MBChB (UCT) FCS(SA)Orth MMed(Orth)) is the Head of Orthopaedic Spinal services, which includes the Acute Spinal Cord Injury Unit (Groote Schuur Hospital), the Spine Surgery Unit (Groote Schuur Hospital), the Paediatric Spinal Deformity Service (Red Cross Hospital) and a Private Practice (Constantiaberg Hospital). These facilities serve the whole of the Western Cape and complex cases from the Eastern and Northern Cape.

REFERENCES

1. Quarrie KL, Gianotti SM, Hopkins WG, Hume PA. Effect of nationwide injury prevention programme on serious spinal injuries in New Zealand rugby union: ecological study. BMJ 2007:334; 1150-3

2. Fuller CW, Brooks JH, Kemp SP. Spinal Injuries in professional Rugby Union: a prospective cohort study. Clin J Sport Med 2007: Jan, vol 17 (1) 10 – 16

3. Noakes TD, Jakoet I, Baalbergen E. An apparent reduction in the incidence and severity of spinal cord injuries in schoolboy rugby players in the western Cape since 1990. SAMJ 1999 89(5); 540-5

4. Allan B, Ferguson R, Lehmann T, O'Brien R. Mechanistic classification of closed indirect fractures and dislocations of the lower cervical spine. Spine 1982;7:1-27

5. Cusick JF, Yoganandan N. Biomechanics of the cervical spine 4: major injuries. Clinical Biomechanics 2002; 17: 1-20

6. Silver JR. The impact of the 21st century on rugby injuries. Spinal Cord 2002; 40: 552-9

7. Quarrie KL, Cantu RC, Chalmers DJ. Rugby Union Injuries to the Cervical Spine and Spinal cord. Sports Med 2002; 32(10): 633-653

8. Bracken MB, Shepard MJ, Holford TR. Methylprednisolone or tirlazad mesylate administration after ASCI: 1 year follow up. Journal of Neurosurgery 1998; 89:699-706

9. Rizzolo SJ, Piazza MR, Cotler JM (1991). Intervertebral disc injury complicating cervical spine trauma. Spine 16:5187-189.

10. Robertson PA, Ryan MD. Neurological deterioration after reduction of cervical subluxation. Mechanical compression by disc tissue. J Bone Joint Surg Br 1992; 74:224-7.

11. Vaccaro AR, Falatyn SP, Flanders AE, et al. Magnetic resonance evaluation of the intervertebral disc, spinal ligaments and spinal cord before and after closed traction reduction of cervical spine dislocations. Spine 1999; 24:1210-7.

12. Lee AS, Maclean JC, Newton DA. Rapid traction for reduction of cervical spine dislocations. JBJS (Br). 1994; 76:352-356.

13. Vital JM, Gille O, Senergas J, et al. Reduction technique for uni- and bi-articular dislocations of the lower cervical spine. Spine 1998; 23:949-954.

14. Keynan O, Dvorak M, Fisher C. Reduction techniques in cervical facet dislocations. Techniques in Orthopaedics 2003; 17:336-44.

15. Carlson GD, Minato Y, Okada A, et al. Early time-dependent decompression for spinal cord injury: vascular mechanisms of recovery. J Neurotrauma 1997; 14:951-62.

16. Delamarter RB, Sherman J, Carr JB. Pathophysiology of spinal cord injury. Recovery after immediate and delayed decompression. J Bone Joint Surg Am 1995; 77:1042-9.

17. Jacobs R. MRI pre- and post rapid heavy weight closed reduction. SAOJ 2006; 5:40-8.

18. Key AG, Retief PJ. Spinal cord injuries. An analysis of 300 new cases. Paraplegia 1970; 7:243-249.

19. Hadley MN, Fitzpatrick BC, Sonntag VK, et al. Facet fracture-dislocation injuries of the cervical spine. Neurosurgery 1992; 30:661-6.

20. Stathoutis B and Govender S. The triple wire technique for bifacet dislocation of the cervical spine injury. Vol. 28, Nr. 2, pp. 123-125, 1997.

21. Doh Koh Y, Lim T, Won You J. A biomechanical comparison of modern anterior and posterior plate fixation for the cervical spine. Spine 2001; 26:15-21.

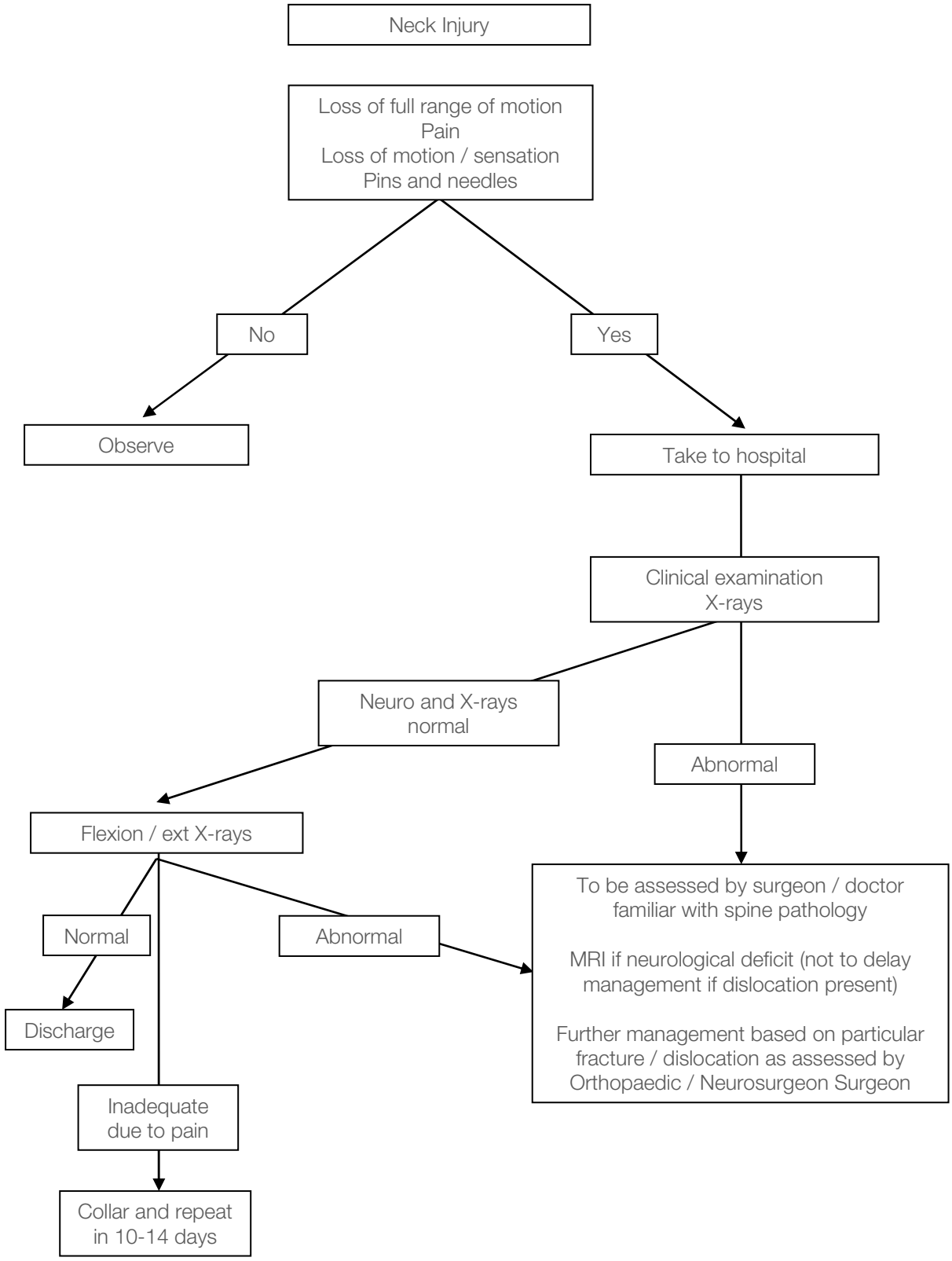
22. Burns AS, Ditunno JF. Establishing prognosis and maximizing functional outcomes after spinal cord injury: a review of current and future directions in rehabilitation management. Spine 2001; 26:S137-45.

23. Lintler DM, Knight RQ, Cullen JP. The neurologic sequalae of cervical spine facet injuries. The role of canal diameter. Spine VO18. No. 6, pp. 775-779, 1993.

24. Kenneth A, Gerhardt MS. Spinal Cord Injury outcomes in a population based sample. Journal of Trauma 1991; 31 (11) 1529-1535

25. K Frielingsdorf, RN Dunn Cervical injury outcome – a review of 101 cases. SAMJ March 2007: vol 97, no 3 p 203-207

26. Storm M, Dunn RN. Unifacet cervical fractures. SAOJ Spring 2007 Page 14-22




SA RUGBY


ABSA


CHRIS BURGER
PLAYERS
FUND
PETRO JACKSON


BokSmart
WINNERS PLAY SMART