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ORIGINAL STUDY

Scapulothoracic dissociation : level of vascular insult, an indirect prognostic indicator for the final outcome ?

Ramesh K. SEN, Ganesh PRASAD, Sameer AGGARWAL

From the Post Graduate Institute of Medical Education and Research, Chandigarh, India

Scapulothoracic dissociation is the result of severe blunt trauma or sudden forceful traction applied to the shoulder, simulating a traumatic forequarter amputation but with sparing of the skin. This grievous injury results in injury at three levels : neural, vascular and musculoskeletal. Since the neural damage cannot be ascertained in the acute stage of this injury, wheras the vascular injury can be defined, this study aimed to find out any correlation of the eventual neural damage with the level of vascular injury. It became evident, after compilation of the authors' 8 cases and the 37 relevant cases reported in literature, that the patients with subclavian artery injury had more frequently a *complete* brachial plexus involvement, whereas those with axillary artery involvement sustained more often a *partial* plexus injury. This correlation was found to be statistically significant ($p < 0.05$). It is thus concluded that the more proximal the level of vascular injury, the more grave is the neurological damage. This fact can be utilized to prognosticate the eventual outcome of the limb concerned.

Keywords : scapulothoracic dissociation ; vascular injury ; brachial plexus ; functional outcome.

INTRODUCTION

Estrada *et al* (*7*) have described the possible pathogenesis of scapulothoracic dissociation. A distraction force on the upper limb is likely to result first in the avulsion of the nearby shoulder girdle muscles. Subsequently, the stronger acromioclavicular and coracoclavicular ligaments rupture, resulting in separation of the acromioclavicular joint. Disruption of subclavian or axillary artery and brachial plexus can now occur ; the vascular structures give way before the nerves. The patient's life can be threatened because of the concomitant vascular injuries. The limb can remain disabled due to involvement of the brachial plexus. The skin may tear as the scapula is pulled laterally, which then results in a condition called traumatic forequarter amputation (*2*).

Sampson *et al* (*23*), in an attempt to define the role of acute revascularisation in the management of scapulothoracic dissociation, suggested a conservative policy due to the infrequent occurrence of delayed hemorrhage and limb-threatening ischaemia and the usually dismal functional outcome of the associated brachial plexus injury. Witz

■ Ramesh K. Sen, MBBS, MS, DNB, Additional Professor.
■ Ganesh Prasad, MBBS, MS, Senior Orthopaedic Resident.
■ Sameer Aggarwal, MBBS, MS, Assistant Professor.
Department of Orthopaedics, Post Graduate Institute of Medical Education and Research, Chandigarh, India.
Correspondence : Dr Ramesh Sen, Post Box No. 1519, Sector 12, PGIMER, Chandigarh (UT), India-160012.
E-mail : senramesh@rediffmail.com

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et al (*26*) reported that the outcome is not dependent on the management of the arterial injury, but rather on the severity of the neurological deficit. However, on day one of the injury, the neural damage cannot be assessed, whereas the level of the vascular injury can be ascertained through an arteriogram. It is still not known whether the level of vascular injury, i.e. injury to the subclavian or the axillary artery, has any correlation with the severity of the neural damage in terms of it being partial or complete. This study was planned to find any such existent correlation between the level of vascular injury, the level of osseous injury and the neural damage, which may indirectly help in the prognostication of the eventual outcome of the limb involved.

PATIENTS AND METHODS

In a span of 7 years (from 1997 to 2003) 8 cases of scapulothoracic dissociation were diagnosed clinico-radiologically in the authors' hospital, a level I Trauma Centre. The diagnosis was based on extensive soft tissue injury to the supraclavicular and shoulder region, neurovascular deficit, associated bone/joint involvement of the shoulder region and lateral displacement of the scapula as calculated by Kelbel's Ratio (*12*). The Kelbel Ratio (Normal value = 1.07 + 0.04) was calculated on an unrotated postero-anterior view of the chest with the arms by the side.

$$\text{Kelbel's Ratio} = \frac{\text{Rt distance between medial border of scapula and mid-spine}}{\text{Lt distance between medial border of scapula and mid-spine}}$$

The literature yielded 62 case reports ; only 37 mentioned both neural and vascular injury, and also the functional status of the limb. These 37 cases (*4-6,11-12,16,17,19, 20,24,25,28*) and the authors' 8 cases were combined for further analysis**,** resulting in a total of 45 cases**.** In this analysis, the vascular involvement was defined either as subclavian or axillary, as ascertained by an arteriogram ; the skeletal injury was defined as sternoclavicular injury, clavicle fracture, or acromioclavicular injury ; the neurological damage was graded as partial or complete with details of the eventual functional outcome in terms of partial/complete functional recovery or flail limb/amputation performed for neurological reasons.

Statistical analysis was done on all 45 cases. A chi-square test and a z-test for proportions were performed to find out any correlation of the level of vascular injury with the severity of the neurological damage, with the osseous injury and with the eventual functional outcome of the limb concerned.

RESULTS

The clinical details of the authors' 8 patients, all males, are reproduced in table I. Their average follow-up was 4.2 years. Their mean age was 32.6 years (range 19-53). Their average Injury Severity Score (ISS) was 16.87 (scale from 0 to 75 = the worst possible case). The mean Kelbel ratio was 1.239 (range 1.086-1.62). Five out of 8 cases had involvement of the subclavian artery and 3 had thrombosis of the axillary artery. All 5 cases with subclavian artery injury**,** except one, had a complete brachial plexus injury. All 3 cases with axillary artery injury, except one, had only a partial brachial plexus injury.

Only 4 out of the 37 case reports, retrieved from the literature, concerned females. Most patients were 20 to 40 years old (range 8-68). Road traffic accidents were the major cause of these injuries (88.6%).

When all 45 cases were considered, the subclavian artery was thrombosed in 32 (71.1%), and the axillary artery was involved in the remaining 13 (28.9%). With the z-test of proportions the association of the level of vascular injury with the osseous injury was not statistically significant. However, using the chi-square test, there existed a statistically significant ($p < 0.05$) correlation between the level of vascular injury and the severity of the neural damage (table II). In other words, in cases with injury to the subclavian vessels, there was a higher incidence of complete brachial plexus injury, whereas the axillary artery was more often involved in partial plexus injuries. There were no other statistically significant correlations.

DISCUSSION

Originally described by Oreck *et al* (*20*) in 1984, scapulothoracic dissociation results from a severe blunt trauma to the shoulder girdle. For example, a distraction force can occur when a motorcyclist

Table I. — Characteristics of 8 patients with scapulothoracic dissociation

Case No	Age	Gender	Type of accident	Inj	Side	Kelbel Ratio	ISS : see*	Hematological status	Neurovasc. Status	Management	Outcome at follow-up
1	34	M	Motor-cycle	Clav	Rt	1.25	6	Stable	Subclavian artery thrombosis ; complete brachial plexus avulsion	Resuscitation ; conservative because of good collateral formation	Flail limb after 2 years
2	53	M	Auto-mobile	Clav	Rt	1.086	29	Stable	Rt subclavian artery thrombosis ; partial brachial plexus injury	Osteosynthesis	Good function, except for fine grasp Rt hand after 3 years
3	22	M	Paper mill rolling machine	AC joint	Rt	1.33	20	Unstable	Rt axillary artery thrombosis ; Rt partial brachial plexus avulsion	Resuscitation ; synthetic vascular graft ; mandibular wiring	Good function, except fingers after 3 yrs
4	39	M	Scooter	AC joint	Rt	1.147	20	Stable	Subclavian artery thrombosis ; Rt complete brachial plexus injury	Conservative because of good collateral formation	Lost to follow-up
5	19	M	Motor-cycle	AC joint	Rt	1.081	11	Stable	Subclavian artery thrombosis ; Rt complete brachial plexus injury	Conservative because of good collateral formation	Lost to follow-up
6	27	M	Motor-cycle	Clav	Rt	1.28	25	Stable	Rt axillary artery injury, complete brachial plexus injury	Osteosynthesis radius and ulna	Flail limb after 2.5 years.
7	37	M	Motor-cycle	Clav	Lt	1.12	6	Stable	Lt axillary artery thrombosis ; partial brachial plexus injury	Vascular repair	Good function after 1.5 years.
8	30	M	Auto-mobile	AC joint	Rt	1.62	18	Stable	Rt subclavian artery thrombosis ; complete brachial plexus injury	End to end vascular anastomosis ; conservative treatment for fractures.	Flail limb after 2 years

* ISS = Injury Severity Score (0 to 75 = worst possible).

attempts to hold the handle of the vehicle while the body is forcibly thrown away. A similar mechanism may be responsible when the upper limb is caught in the belt of a cloth rolling machine. The exact pathogenesis in automobile accidents has not been clearly determined, but is possibly due to direct severe trauma to the anterolateral portion of the shoulder.

The patient usually has a massive soft tissue swelling around the shoulder girdle ; the skin is intact and there is a neurovascular deficit. On the other hand, when there is partial or complete

Table II. — Level of vascular insult, its correlation with neural damage, and final outcomes : a, b and c, in 45 patients

Level of Vascular Injury	Type of neural damage Complete	Partial	a. Amputation for vascular reasons	b. Partial to complete neurological recovery	c. Flail limb or amputation due to flailness
Subclavian art. n = 32	24	08	09	03	20
Axillary art. n = 13	04	09	04	03	06

disruption of the skin and the perithoracic soft tissues, the injury is termed "open traumatic forequarter amputation", an entity which has long been recognized (*1,8,13*), and first described by Belchier (*2*) in 1737. Scapulothoracic dissociation must also be differentiated from scapulothoracic dislocation or locked scapula, which has less devastating vascular and neurological effects (*10,18*).

Morris and Lloyd (*16*) specified that the Y-view or oblique view of the scapula in question may be of value when frontal chest radiographs are of indeterminate significance. In patients with an unstable cervical spine injury, where such views are not possible, a CT-scan is of immense utility (*12,16,25*). Kelbel *et al* (*12*) added that if exploration of the brachial plexus is not carried out at the time of arterial repair, electromyography and cervical myelography, performed respectively 3 and 6 weeks after injury, can facilitate the diagnosis of nerve root avulsion. It is important to identify the nature of injury so that prognosis can be determined accurately, and appropriate rehabilitation initiated. CT and MRI can also evaluate the brachial plexus, possibly obviating myelography, although the efficacy of each is unknown in acute traumatic brachial plexus injuries. MRI angiography is a promising new modality which might be applicable in the future.

The present study aimed at establishing an eventual correlation between the level of vascular insult and severity of neural damage. By compiling all relevant data, such a correlation was found. Indeed, in cases with injury to the subclavian vessels, there was a higher incidence of complete brachial plexus injury, whereas in cases with axillary artery involvement the brachial plexus injury was more likely to be partial. This can be explained on an anatomical basis. When the force is concentrated proximally, tearing the subclavian vessels, the brachial plexus is severed more, probably due to the greater fixity of the plexus to the cords at that level. However, when the force is concentrated at the level of the axillary vessels, it injures a more mobile part of the plexus, resulting in a partial neurological deficit.

A partial brachial plexus injury has a relatively good prognosis, and musculotendinous transfers may be done at a later stage, if required (*9,14,15, 21,27*). If a complete disruption of the brachial plexus exists, primary amputation should be considered (*20,27*), because functional recovery cannot be expected. Above elbow amputation is most commonly recommended. Clements *et al* (*4*) formulated a treatment algorithm after thorough assessment of the neurovascular injury sustained. Glenohumeral arthrodesis, in conjunction with amputation, is advocated by some authors to facilitate early prosthetic fitting (*20,27*), but Rorabeck (*21*) found no advantage to the arthrodesis of the shoulder. The best functional outcome in case of flail arm may result from above elbow amputation (*3*). Early prosthetic fitting (*7*) and physical and psychological rehabilitation are of prime importance.

CONCLUSIONS

Estimating the severity of the neural damage incurred at the time of admission is difficult, since scapulothoracic dissociation is the result of severe blunt trauma. This study demonstrates that a statistically significant ($p < 0.05$) correlation exists between the level of vascular injury and the severity of the neural damage. Indeed, complete brachial plexus injury is more frequent in case of injury to the subclavian vessels, whereas partial plexus injury is common in case of injury to the axillary

artery. This fact may predict the type of nervous injury and thus the eventual outcome of the limb concerned. However, larger scale studies are needed.

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