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REVIEW ARTICLE

Floating injuries : a review of the literature and proposal for a universal classification

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It is tempting to describe any structure or body part which is not in continuity with its adjacent structures as 'floating'. The indiscriminate use of this word has led to description of complex injury patterns, surgeries, congenital anomalies, functional deformities or even normal anatomical structures by a single vague term '*floating*'. The article stresses the importance of proper description of an injury pattern, after enlisting some of the 'floating' entities described in the literature. When the term 'floating' is used to describe an injury in a limb, we suggest use of the proposed universal classification system to prevent ambiguity, help in prognosticating and scientific comparison of results in such injuries.

INTRODUCTION

The term 'floating' has been used quite vaguely in the literature to describe various injury patterns /surgical procedures and even congenital anomalies. When the term is used to describe an injury pattern, it commonly implies that a joint/bone has lost its continuity at adjacent ends either as a result of fractures, fracture dislocations or pure dislocations and hence has become 'floating'. We enlist here a few of the floating entities described in the literature and the actual pattern/configuration of that particular entity. The article tries to highlight the improper and vague use of the term "floating" in the literature for description of various injuries and proposes a simple universal classification for these so described injuries in limbs.

REVIEW AND DISCUSSION

A review of literature shows that various authors have ascribed numerous meanings to the word 'floating' by attaching various body structures with it. Table I gives a comprehensive list of 'floating' structures depicted in the literature.

The word 'floating' has been utilised virtually in its literally sense/dictionary description of 'moving about or out of usual location' (table I) (*23*). As is evident from table I, it has been used to describe complex injury patterns, surgeries, congenital anomalies or even normal anatomical structures (table I). So vague is the use of this term that some authors have used the term 'floating' in the title of their article without using it again in their whole manuscript (*6*).

Where the term 'floating' is in common usage for description of a particular injury pattern, it does not specify the exact components of the injury and often underdescribes their true extent. For example the term 'floating elbow' may or may not be an

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Table I. — The ‘Floating’ entities

No.	Term	Category	Actual description	Special features
1.	Floating Forehead (*15*)	Operation	The operation is meant for treating brachycephaly in infants. The surgery involves fronto-orbital advancement without posterior fixation. The supraorbital bar and forehead is remodeled and advanced. Fixation is to the frontal process of zygoma with no attachment to the cranium.	The operation procedure is well described and documented.
2.	Floating pterous bone (*17*)	Injury pattern	The fracture line runs through the middle ear, separating the petrous apex from its lateral and inferior bony attachments. Clinical findings include hearing loss, VI and VIIth cranial nerve paresis.	Rare injury. Occurs when the elastic paediatric skull is subjected to large compressive forces.
3.	Floating maxilla (*6*)	Injury pattern	It represents maxillo-facial fractures. Also known as middle third fractures of the face. The fracture line is described to pass transversely, comminuting the nasal bones, through the maxillary sinuses below the orbital margins and the maxillo-zygomatic sutures and downwards outwards to the pterygoid fossa on either side, and lastly through the lamina of the sphenoid. Clinically, the face is mutilated and the nose disfigured.	Due to direct severe violence.
4.	Floating clavicle (*5*)	Injury pattern	Panclavicular dislocation. In this injury both sternoclavicular ligaments and coracoclavicular ligamentous structures are disrupted.	Severe injury. May be associated with neurovascular deficit and pleural injury.
5.	Floating shoulder (*9*)	Injury pattern	The fracture of the ipsilateral clavicle and the surgical neck of the scapula with or without extension into the glenoid.	Severe injury. May be associated with ipsilateral rib fractures, pleural injury, neurovascular injuries including brachial plexus injury.
6.	Floating humerus (*1*)	Functional deformity	Following total scapulectomy for malignant disease, in which the entire scapula, glenoid fossa and coracoid process are removed, resulting in a destabilised upper limb that is no longer attached to the chest.	
7.	Floating elbow (*22*)	Injury pattern	Ipsilateral fracture of both bones of the forearm and fracture of the humerus with or without concomitant elbow injury.	Result of high energy trauma, may involve extensive soft tissue degloving, neurological deficit and vascular injury.
8.	Floating radius (*22*)	Injury pattern	Combination of a Monteggia fracture dislocation and a Galeazzi fracture dislocation in the same limb. A combination of the fracture of the proximal third of the ulna with dislocation with or without fracture of the radial head in conjunction with a fracture of the distal radius with dislocation of the distal ulna.	Severe injury, interosseous membrane is disrupted and resulting radial segment is devoid of stabilizing effect of either bony or soft tissue support.
9.	Floating index metacarpal (*21*)	Injury pattern	Traumatic simultaneous palmar dislocation of the metacarpophalangeal joint and dorsal dislocation of the carpometacarpal joint of the index finger.	Severe injury.
10.	Floating thumb (*10*)	Congenital anomaly	A small slender thumb that appears to dangle from the radial border of the hand. Typically there are two phalanges, a fingernail, no metacarpophalangeal joint and no first metacarpal.	

Table I. — Continuation

No.	Term	Category	Actual description	Special features
11.	Floating sternum (*20*)	Surgical complication	Following repair of pectus excavatum. Defined as a sternum in which the only bony attachment to the chest wall is via the manubrium. It is caused by either too extensive resection of the costal cartilages and perichondrium during correction of pectus excavatum or by failure of proper regrowth and reattachment of new cartilage to the sternum.	Rare complication.
12.	Floating ribs (*18*)	Injury pattern	In relation to flail chest. They are avulsion fractures caused by a sudden vigorous contraction in different directions of pull.	Severe chest trauma.
13.	Floating ribs (*23*)	Normal anatomy	Refers to the XI and XII ribs, which do not articulate with the sternum.	
14.	Painful floating ribs syndrome (*7*)	A painful syndrome	Due to abnormal mobility of a rib that has lost the normal cartilaginous connection with that above it. Usually the X^{th} rib is involved.	
15.	Floating lumbar spine fusions (*2*)	Segmental spinal fusion procedure	Operation for fusion in cases of L4-L5 instability without including lumbosacral joint.	
16.	Floating pelvis (*13*)	Injury pattern	Combination of bilateral traumatic dislocation of the hip with lumbar ligamentous disruption at L4 L5 level.	Severe injury
17.	Floating acetabulum (*24*)	Injury pattern	Both column fracture and a T fracture with the longitudinal limb of the T occurring in the ilium superior to the hip joint in the coronal plane. Therefore no portion of the articular surface of the hip remains attached to the axial skeleton.	Severe injury
18.	Floating hip (*14*)	Injury pattern	Ipsilateral pelvic and femoral fractures.	Severe injury
19.	Floating knee (*12*)	Injury pattern	Ipsilateral fracture of the femur and tibia with or without intraarticular extension into the knee.	Severe injury
20.	Floating tibial talar complex (*19*)	Injury pattern	Ipsilateral anterior dislocation of knee and medial subtalar dislocation of foot.	Case report
21.	Floating ankle (*16*)	Injury pattern	Intact ankle mortice with a distal tibial fracture and ipsilateral foot fracture.	Violent trauma or blast injuries in military personal
22.	Floating metatarsal (*11*)	Injury pattern	Concomitant Lisfranc's dislocation and plantar metatarsophalangeal dislocation of the hallux.	Isolated case reports

injury involving the elbow joint. This combination of ipsilateral fracture of humerus and forearm bones is often a result of high-energy trauma. There may be associated neurovascular injury or extensive soft tissue loss requiring a multispeciality surgical approach. The injury may involve the articular surfaces of the elbow joint as well. Overall, the floating elbow is an exceptionally complex injury and the management can result in various complications like nonunion, infection, myositis ossificans, loss of elbow motion and forearm rotation causing long-term functional disability of the involved limb (*22*). Thus the term 'floating elbow' is an extra simplification of the injury components and description of these complex and severe injuries by such a term can at best be only 'catchy' but grossly insufficient. The above discussion also holds true for various other injury patterns described by the term.

The term 'floating' has also been utilised for describing different injuries into one head. The term 'floating hip' in one series is used to describe two different groups – one group with femoral fracture with an ipsilateral unstable vertical shear, or 'open book' pelvic fracture (*14*). The other group includes the femoral fracture with an acetabular fracture. There were differences in surgical procedures, instrumentations and morbidity in the two groups (*14*).

Despite these drawbacks, the term "floating" is widely prevalent and in common usage. There have been many attempts to clear up the ambiguity of this term, at least for some particular injury patterns, by classifying them (*12*). The five-part classification by Letts *et al* (*12*) for paediatric floating knee injuries is quite descriptive and standardised. It is now universally accepted for classifying paediatric floating knee injuries (*3*). Simpson and Jupiter (*22*) proposed a general classification and suggested that there should be three categories of floating joints : 1) skeletal disruption above and below an articulation without direct injury to the intermediate joint ; 2) combined skeletal and direct articular injury ; 3) skeletal injuries with or without direct articular injury including neurovascular and soft tissue damage/injury which affect ultimate functional outcome.

We believe that any description of a floating injury should specify the fracture site, joint involvement and an assessment of soft tissue injury. This is essential so that the true extent of skeletal and soft tissue injury can be specified, which would help in predicting long term functional outcome and make the comparison of results obtained at different centers for these kind of injuries more accurate and scientific. We propose a universal classification for floating injuries of extremities incorporating the above features (table II). For example, S_1 J_0 O_0 represents a diaphyseal injury with minimal soft tissue injury having a relatively good prognosis while S_3 J_2 O_{3c} would indicate a severe limb injury where there is fracture at metaphyseal levels with intraarticular extension at both fracture sites and extensive soft tissue loss including a vascular insult with a grave prognosis (table II).

This classification is easy to interpret, provides for treatment planning and prognosticating patients. The classification presently lacks the

Table II. — Proposed universal classification for floating injuries in extremities

Site **(S)**	Joint involvement **(J)**	Open **(O)** (Gustilo's classification) (*8*)
0 One side fracture only e.g. floating shoulder	**0** Without intraarticular extension	**0** (for closed injuries)
1 Both diaphyseal	**1** One component intraarticular	**1**
2 One diaphyseal and the other metaphyseal	**2** Both component intraarticular	**2**
3 Both metaphyseal		**3** a, b, c

direct evidence of outcome prediction and inter-observer reliability. However, it is a well-known fact that articular involvement in any fracture calls for a guarded prognosis. The latter part of the classification is based on Gustilo's classification of open injuries, which is also well correlated with outcome. We expect that with a more scientific intercentre comparison of results using this classification by various trauma institutions, these shortcomings can easily be overcome. Most importantly, the classification will quantify the vague description the term "floating" offers. This classification has another limitation : it deals only with extremity floating injuries. It cannot be utilised to classify injuries like floating pterous bone, floating maxilla, floating pelvis etc. However, this is in concordance with our previous suggestion that one should refrain from describing complex injuries by the general term 'floating'.

CONCLUSION

The injuries described by the term 'floating' usually represent complex injuries which result from high-energy trauma (table I). They are usually associated with major soft tissue and neurovascular complications. Often these injuries are open in nature and concomitant ligamentous injuries may coexist. The use of this short descriptive term is imprecise and misleading and its routine use is not recommended unless standard classifications are proposed and universally accepted (e.g. Letts *et al*'s classification for floating knee injuries in children (*12*)). There should be no hesitancy to describe the injury pattern in full.

During radiological assessment of a joint in a trauma setting, it is essential to include in the study the joints proximal and distal to the obvious deformity to timely detect other injuries, as a more obvious injury often masks other injuries. A femoral shaft fracture can be associated with hip fracture in 5 to 30% of the cases and knee injuries in 18% of the cases, and these associated injuries can easily be missed if radiographs of pelvis and knee are not included (*4, 25*).

The management of dislocations/fracture combination should follow the guidelines established for individual lesions. As a general rule, it is preferable to operatively stabilise both fractures. Where dislocations are present, they should be reduced as soon as possible. Where articular injury is present, operative reduction and stable internal fixation of the articular fragments is advisable even with open wounds. Open fractures should be debrided and stabilised with external fixators.

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