Supracondylar humeral fractures in children - have we stopped thinking?

Christopher Colton & Fergal Monsell

Although it is unlikely that Hippocrates corresponded in Latin, we respect his attributed *primum non nocere* as a central tenet of medical practice. Those of us who undertake the management of distal humeral fractures in children would do well to hold to this.

We also benefit from the wisdom of Santayana who told us that “Those who cannot remember the past are condemned to repeat it”, yet supracondylar humeral fractures in children appear to be exempt from the rules and reason that govern the contemporary management of other injuries.

The purpose of this essay is to examine the conventional dogma associated with this common fracture, and to question some of its firmly-held beliefs, even should this require the sacrifice of sacred cows.

The authors’ view is that preservation of neurological function, the prevention of further neurological injury and the avoidance of ischaemic muscular damage are of fundamental importance in management.

Good function is to be expected in the majority of cases and the current paradigm of prevention of cosmetic deformity at all costs is not only illogical, but also potentially harmful.

Neurovascular Injury

The management of neurovascular complications of this fracture generates much heated debate, which is perhaps not surprising, as the consequences of permanent neurological injury, or a critically ischaemic limb, are devastating.

Nerve injuries are common and are estimated to occur in 12% to 20% of all such displaced fractures, with the anterior interosseous nerve predominating2-5.

The majority will recover without treatment and the difficulty arises in identifying those that require exploration. Formal documentation of neurological and vascular function at the time of presentation is the first standard for practice in BOAST 116.

Frequent reassessment during the period following reduction and stabilisation, whether by open or closed means, is also necessary to identify an iatrogenic injury, which has a reported incidence of 2% to 6% in some series7,8.

Ramachandran et al.9 recommended exploration of any nerve injured during reduction and stabilisation, whether by open or closed means, is also necessary to identify an iatrogenic injury, which has a reported incidence of 2% to 6% in some series7,8.

Christopher Colton & Fergal Monsell

Although it is unlikely that Hippocrates corresponded in Latin, we respect his attributed *primum non nocere* as a central tenet of medical practice. Those of us who undertake the management of distal humeral fractures in children would do well to hold to this.

We also benefit from the wisdom of Santayana who told us that “Those who cannot remember the past are condemned to repeat it”, yet supracondylar humeral fractures in children appear to be exempt from the rules and reason that govern the contemporary management of other injuries.

The purpose of this essay is to examine the conventional dogma associated with this common fracture, and to question some of its firmly-held beliefs, even should this require the sacrifice of sacred cows.

The authors’ view is that preservation of neurological function, the prevention of further neurological injury and the avoidance of ischaemic muscular damage are of fundamental importance in management.

Good function is to be expected in the majority of cases and the current paradigm of prevention of cosmetic deformity at all costs is not only illogical, but also potentially harmful.

Neurovascular Injury

The management of neurovascular complications of this fracture generates much heated debate, which is perhaps not surprising, as the consequences of permanent neurological injury, or a critically ischaemic limb, are devastating.

Nerve injuries are common and are estimated to occur in 12% to 20% of all such displaced fractures, with the anterior interosseous nerve predominating2-5.

The majority will recover without treatment and the difficulty arises in identifying those that require exploration. Formal documentation of neurological and vascular function at the time of presentation is the first standard for practice in BOAST 116.

Frequent reassessment during the period following reduction and stabilisation, whether by open or closed means, is also necessary to identify an iatrogenic injury, which has a reported incidence of 2% to 6% in some series7,8.

Ramachandran et al.9 recommended exploration of any nerve injured during reduction and stabilisation, whether by open or closed means, is also necessary to identify an iatrogenic injury, which has a reported incidence of 2% to 6% in some series7,8.
and pulseless hand following supracondylar humeral fracture, at a mean interval of three months following injury, were found to have an established ischaemic contracture of the forearm and hand. They recommended “urgent exploration of the vessels and nerve in the child with pink, pulseless hand, not relieved by reduction, with persistent and increasing pain, suggestive of a deteriorating neurological injury and critical ischaemia”.

The authors’ view is that the majority of the recommendations made by Ramachandran et al. should inform decisions on nerve exploration9.

The controversy surrounding the limb with potential ischaemia is in our view, due in part, to the surrogate methods of assessment of limb perfusion. The fundamental goal is to avoid muscle ischaemia with consequent contracture, and assessment must assess muscle perfusion, albeit indirectly. Pulse, digital colour, capillary refill and mechanical methods, including pulse oximetry, do not satisfy this requirement. The simplest clinical test for evolving muscle ischaemia is pain on passive digital extension and/or flexion.

In our view, the decision to explore a vascular injury or decompress a muscle compartment should be based largely on the presence and deterioration of muscle stretch pain in the period following injury or reduction of the fracture.

We consider that the majority of fractures can be managed without exploration of the neurovascular structures and have highlighted specific clinical situations in which rapid exploration is required.
Reduction and Fixation

As early as 1903, Prof. Niehans of Bern used intramedullary pinning to stabilise displaced supracondylar humeral fractures in children, but after open reduction.

In 1988, Pirone stated: “Percutaneous Kirschner-wire fixation is advocated as the method of choice for the majority of (such) displaced fractures”.

In 1984, Laderhauf stated: “Today, the preferred treatment of displaced supracondylar humerus fractures in children is immediate closed reduction and percutaneous fixation with two or three lateral pins. In case of instability of the medial column, a medial pin may be used, but possibility of iatrogenic ulnar nerve injury should be considered”.

Closed reduction with transcutaneous pinning has now become the promulgated orthodoxy for such fractures and BOAST states that: “These injuries require early surgical treatment; ideally on the day of admission... surgical stabilisation should be with bicortical wire fixation”.

Such dogma deserves careful and thoughtful re-examination as the therapeutic pendulum appears to have become stuck at one of its poles.

Quality of reduction

For successful intraosseous pinning, the reduction must be anatomical. The cross-sectional form of the humerus at the fracture site is dumbbell-shaped and if these dumbbells are imperfectly aligned, the target area for safe intraosseous pin insertion is greatly limited (Figure 1).

Extracortaneous pin insertion risks damage to important anatomical structures, as well as increasing the chances of a failed fixation. For this reason alone, reduction must be achieved to an anatomical, or near-anatomical position and requires careful monitoring with image intensification. Whereas these problems need not necessarily contraindicate closed reduction and intraosseous pinning, such valid caveats are rarely stressed.

Powered insertion of Kirschner wires generates heat in the tissues and an important point that passes largely unstated is that the pins should be inserted with an oscillating drill or by hand in health systems where such equipment is unavailable. Thermal injury of the physis, through which the pins are inserted is a danger, especially if multiple attempts are made to insert any one pin.

Hunter and Slongo stated: “When placing (inserting) wires across the growth plate, repeated drilling, starting several wires from a single point, and very peripheral insertion must be avoided to minimise damage to the proliferation zone.”

As educators of future generations of orthopaedic and fracture surgeons, we must condemn multiple passes of a wire across the physis in an attempt to stabilise an imperfectly reduced fracture. Such a technique of multiple physeal penetrations, in other anatomical situations, is sometimes exploited to secure epiphysiodesis.

Cubitus varus

It is not unreasonable to examine current practice in the context of why reduction and fixation are so strongly advocated. With the exception of cases with vascular and neurological deficits, surgery is performed exclusively to avoid cubitus varus following malreduction.

Cubitus varus rarely, if ever, results in any functional deficit. It is purely a cosmetic problem in most, if not all cases and usually only evident when the patient is standing in the “anatomical position”.

In 1986, Ippolito et al. reviewed 22 patients with cubitus varus following such fractures treated non-operatively, and none had a functional deficit. Similarly, Labelle et al. found no functional deficit in 63 patients with residual cubitus varus.

The presence of such deformity often worries uninformed parents, but most will be reassured by knowing that this can be corrected at any time, but preferably at skeletal maturity, by a planned geometric osteotomy via healthy soft tissues.

The debate has not yet been joined over what degree of varus malunion is acceptable. There is a gathering medicolegal storm over whether malaalignment leading to cubitus varus is negligent and therefore compensatable.

In a medico-legal context, supporting a position that any residual deformity is negligent is illogical and redefines *reductio ad absurdum*.

If this be agreed, the surgical profession needs to recognise that it is sometimes better to treat such fractures without immediate operative intervention, recognising the likelihood of subsequent cubitus varus, which may or may not require later surgical remedy.

Debate is urgently necessary over the degree of acceptable cubitus varus and if we surgeons neglect to do this, the legal profession will exploit such inattention.

Alternative management strategies

It has to be recognised that many children with displaced supracondylar humeral fractures are treated in health-care settings where resources such as image intensification are unavailable and the use of “closed” pinning without such control is hazardous, for all the reasons explored above.
The alternative options would then be open reduction and pinning, splintage after attempted reduction (accepting the risk of cubitus varus), or traction, involving methods that include straight-arm and overhead olecranon traction (Figure 2).

The latter two therapeutic options should not be allowed to fall into the oubliette of paediatric orthopaedic history, for want of a rather broader approach than the current dogma of Pirone, Ladenhauf and the BOA’s standard treatment protocol.

Correction of cubitus varus malunion

In 1959, French described a somewhat crude valgus osteotomy for the correction of cubitus varus18. It unfortunately produced the so-called “chicane” deformity, with excessive lateral condylar prominence, as does any such osteotomy that fails to translate medially the distal humeral fragment.

Regrettably, such ugly corrections are still practised today, thereby exchanging one cosmetic deformity for another. Yun et al. described an ingenious technique19 that corrects distal humeral deformity, without secondary lateral translation (Figure 3).

There is no place in modern surgery for corrective osteotomies to be conducted without detailed preoperative planning and geometric precision. The correction of a cosmetic deformity demands a cosmetically perfect result.

Some authors advocate stabilisation of such osteotomies using external fixation20 and whilst this provides a potentially attractive alternative; it has not become an established part of contemporary practice.

Summary

The majority of perfused but pulseless hands can be managed expectantly, provided there is no evidence of evolving muscular ischaemia.

The majority of peripheral nerve injuries, which are caused at the time of injury and present at the time of first assessment, can also be managed expectantly, provided there is no evidence of neuropathic pain, or deterioration over a period of 8 to 12 hours.

The current dogma of reduction and transcutaneous pinning of all displaced supracondylar humeral fractures in children should be approached in a more analytical fashion than the simple ex cathedra statements that abound. It is a demanding surgical procedure with risks for patients of the unwary and formulaic surgeon, and there are alternative management strategies for under-resourced health care systems.

Attitudes to cubitus varus malunion, in both surgical and medicolegal contexts, bear careful scrutiny and osteotomies to correct cubitus varus malunion require meticulous planning and precise, geometric execution.

Christopher Colton is Professor Emeritus in Orthopaedic and Accident Surgery at the University of Nottingham and was a Consultant Orthopaedic, Trauma and Paediatric Orthopaedic Surgeon at Nottingham University Hospital for more than 20 years. He was an ABC Travelling fellow, BOA President, Founding Trustee and Lifetime Honorary Member of the Board of Trustees of the AO Foundation. He is currently enjoying life as an educator, boulevardier and master diver.

Fergal Monsell is a Consultant Orthopaedic Surgeon at the Royal Hospital for Children in Bristol. He was an ABC travelling fellow, Past President of the British Limb Reconstruction Society and a Member of the Politburo of the Society for Children’s Orthopaedic Surgery. He is a member of the editorial board of the Bone and Joint Journal and specialty editor for paediatrics. He is married to Ros, has three grown-up children and to his credit is a lifelong Spurs supporter.

Correspondence

Email: colton1937@gmail.com
Email: fergal.monsell@btinternet.com

References

References can be found online at www.boa.ac.uk/publications/JTO or by scanning the QR Code.

Figure 2: Overhead traction via an olecranon screw. The arm is elevated, thereby reducing pain and swelling: the forearm falls naturally into pronation, encouraging the correction of varus.

Figure 3: Yun osteotomy: A triangle of bone is excised as shown in the left hand diagram: the angle at B is the desired angle of valgus correction. The distal humeral fragment is then rotated and medially translated so that the original point A is moved to point C. The pair of diagrams on the right show how the longitudinal axis of the humeral diaphysis now passes through the lateral portion of the trochlea – the anatomical norm – and the osteotomy if stabilised with crossed pins.
References

1. Santayana G. Life of Reason Vol 1, Ch XII. Flux and Constancy in Human Nature, 1905