PRIMARY RUPTURE OF BRACHIAL ARTERY AND MEDIAN NERVE
IN SUPRACONDYLAR FRACTURE OF THE HUMERUS

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This paper records a case of supracondylar fracture of the humerus in which the brachial artery was completely severed and the median nerve interposed between the fragments, preventing reduction. Reference will also be made to another case, explored three months after injury, in which there had been complete primary rupture of the median nerve.

CASE REPORT

A boy aged seven years was admitted to hospital shortly after falling out of a tree. He was found to have closed fractures of both bones of the left forearm in their lowest thirds,

and a severely displaced left supracondylar fracture in which the upper fragment had at one point penetrated the skin of the grossly swollen antecubital region. There was no pulse at the wrist, but the colour of the hand was good and nerve function normal.

A cautious attempt was made to reduce the fracture. This was unsuccessful: the upper fragment could not be moved back from its subcutaneous position. Accordingly, the small punctum was excised and the antecubital fossa opened anteriorly. The median nerve was found caught and kinked between the fragments, in contact with the jagged edges of the upper. Of the brachial artery there was at first no sign, but after a search its proximal severed end was found and tied. The distal end had disappeared and was not sought further. The expanded lower end of the upper fragment had passed completely through the brachialis, severing the greater part of that muscle. The biceps tendon was intact, although the lacertus fibrosus
had been torn. The median nerve was freed and the fracture was reduced under direct vision. Post-operative progress was uncomplicated. The circulation in the hand was never a source of anxiety, though a palpable radial pulse did not return for two months. There was slight partial sensory impairment in the fingers, and motor weakness of median distribution, both of which recovered after about eight weeks. Eight months after the injury there was full extension of the elbow, flexion to twenty degrees beyond the right angle, and a good range of rotation. Figures 1 and 2 illustrate this case.

OTHER CASES

Rupture of the brachial artery in supracondylar fracture is rare. Three cases were published in 1951 by Spear and Janes of the Mayo Clinic, and since this paper was written one more has appeared, but without clinical history, in a ten-year analysis of the neurovascular complications of supracondylar fracture from the same centre (Lipscomb and Burleson 1955).

<table>
<thead>
<tr>
<th>Age</th>
<th>Injury</th>
<th>Simple or compound</th>
<th>Treatment of artery</th>
<th>Co-existing fractures</th>
<th>Muscle damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Fall from tree</td>
<td>Simple</td>
<td>Nil</td>
<td>Both forearm bones</td>
<td>Not recorded</td>
</tr>
<tr>
<td>14</td>
<td>Car accident</td>
<td>Compound postero-medially</td>
<td>Both ends tied</td>
<td>Nil</td>
<td>Biceps and brachialis ruptured</td>
</tr>
<tr>
<td>12</td>
<td>Fall from bicycle</td>
<td>Compound anteriorly</td>
<td>Both ends tied</td>
<td>Both forearm bones (compound)</td>
<td>Biceps and brachialis ruptured</td>
</tr>
<tr>
<td>6</td>
<td>Fall from tree</td>
<td>Compound (small anterior puncture)</td>
<td>Proximal end tied</td>
<td>Both forearm bones</td>
<td>Brachialis and lacertus fibrosus ruptured</td>
</tr>
</tbody>
</table>

There are no others, although Spear and Janes record their impression that this injury is more common than the scarcity of literature would suggest.

It is interesting to compare the case under discussion with the three previous instances of arterial rupture whose histories are reported. All four were fractures of boys' left arms. Three were compound, though our own case was only barely so. The severity of the fracturing force is illustrated by the fact that three, including the simple fracture, were accompanied by fractures of both forearm bones on the same side. In no case was there any serious circulatory embarrassment or nerve damage. In Table 1 the four cases are listed in the order in which they were described, ours being the last.
It is worth noting that arterial rupture seems rather more common in association with dislocation of the elbow. Twenty-four such cases with main vessel rupture have been published, eighteen involving the brachial artery. Fifteen of these eighteen were included in a review of the literature going back to 1880 (Eliason and Brown 1937); two were published in Britain (Henderson and Robertson 1952); and the other by Spear and Janes along with the three in supracondylar fractures already discussed.

Rupture of the median nerve in supracondylar fracture is even rarer than arterial rupture. Apparently only a single case has been reported—by Bristow (1923), who explored the elbow three months after injury on account of ischaemic contracture. He considered at operation that the nerve had been divided "not at the time of the accident, but rather at the subsequent manipulation."

A recent case, for which I am indebted to Mr J. S. Ellis and the staff of the Treloar Hospital, is thus of some interest. This occurred in an eight years old girl, operated upon three months after supracondylar fracture, on account of a persistent median palsy. On admission there was malunion, with postero-lateral displacement of the distal fragment and a tender bony spur on the medial side (Fig. 3). At operation the spur was exposed and a fibrous cord found crossing it superficially. This cord connected a neuroma some two inches proximal to the spur with the distal stump of the median nerve about one inch below the spur. Both spur and cord were excised, and end-to-end suture of the median nerve was performed. After operation there was no detectable motor or sensory change, and this fact, coupled with the operative findings, entitles the case to be considered one of complete primary nerve division. It is similar to Bristow's case in that it came to operation three months after injury, and differs in being uncomplicated by ischaemic contracture.

The remarkable capacity of the median nerve to remain unscathed in the presence of severe damage to its immediate neighbourhood is also evident in posterior dislocation of the
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either. Eliaison and Brown (1937) could find only one proven case of median nerve division—
reported by Holl in 1880—and this despite the occurrence among their cases of "rupture in
different combinations of nearly every tendon or muscle anterior to the elbow."

Partial injuries and irritations of the neurovascular bundle are, of course, more common
and in the case of arteries more dangerous in their effects. Even so, it is exceptional to find
damage of any kind to the median nerve in supracondylar fracture. Siris (1939), reviewing
330 cases, 244 of which had bad posterior displacement and twelve of which were compound,
had not a single case of median nerve damage. Watson-Jones (1930) had no case in a series of
eighty-seven such fractures, although he states elsewhere (Watson-Jones 1943) that 15 per cent
of these fractures are accompanied by median or ulnar nerve contusion. Platt (1928) described
four cases of injury to the nerve, all with full recovery save one occurring in conjunction with
Volkman's ischaemic contracture. Lipscomb and Burleson (1955) recorded seventeen nerve
injuries in 108 cases of extension-type supracondylar fracture. Two patients had involvement
of more than one nerve, so that altogether there were eleven radial, seven median and two
ulnar lesions among the seventeen patients. All were partial injuries with complete recovery,
save one which had persistent intrinsic muscle weakness in the hand. Four were explored
surgically, but the operation in each case consisted of neurolysis of an intact nerve. In the
same series there were—apart from complete ruptures—nine instances of involvement of the
brachial artery including one of ischaemic contracture.

ANATOMICAL CONSIDERATIONS

In a displaced extension-type supracondylar fracture the sharp upper fragment first
embeds itself in the brachialis. If the force is sufficiently severe, the muscle will fail to arrest
the forward-driven shaft which will then enter the antebrachial fossa and, after encountering
the biceps tendon, usually pass medially among the neurovascular structures. Operative
experience in both supracondylar fracture and dislocation of the elbow confirms this
observation for which there are two anatomical reasons. First, the position and direction of
the biceps tendon, which at fracture level is a smooth cord lying just lateral to the anterior
border of the humerus—that is, on the steeply inclined antero-lateral surface of that bone,
at the top of the slope, and with its direction towards an insertion still more laterally placed.
Secondly, the mechanism and direction of the fracturing force which, with the elbow extended,
will tend to direct the humerus medially in relation to the forearm, because of the carrying
angle.

I believe that these factors will usually govern the initial displacement and the relations
of the upper fragment to the soft tissues, irrespective of whether the distal fragment later
becomes medially or laterally displaced. Siris (1939) found medial and lateral displacement
of the distal fragment in equal frequency, and it is not uncommon to find the position change
from one to the other during the course of ordinary manipulative reduction. But once the
proximal fragment has completely penetrated the brachialis and come to lie among the
neurovascular structures, movement of the distal fragment to one side or the other—though
it may still occur—can do nothing to relieve the danger of the position. In the case described
the humerus passed between the biceps and the median nerve, severing the intervening artery
and lacertus fibrosus, and finally came to lie under the skin with the nerve behind it in the
path of reduction.

The presence, however, of a palpable subcutaneous spike of bone in the antebrachial
fossa does not necessarily mean that this dangerous anatomical situation has been reached,
for the whole expanded end of the broken shaft may not have passed through the brachialis;
in which case, when reducing forces are applied, the ensheathing muscle fibres will guide it
safely backwards as the scabbard guides a homing sword. That reduction does in fact
generally occur thus is affirmed by Charnley (1950), who considers that temporary incarceration
of neurovascular structures is a common accompaniment of severe displacement, though in
most cases unlikely to cause permanent damage provided the surgeon releases them by applying traction before attempting to flex the elbow. Radiographs, with good soft-tissue visualisation, may sometimes help in deciding this point; in the films of the case described it can be seen that the entire lower end of the shaft has passed through the muscle shadow to occupy a subcutaneous position.

**DANGERS OF MANIPULATION**

The necessity for accurate reduction on the one hand and the dangers of manipulation on the other have been stressed by many authorities. Bristow's opinion that his case of ruptured median nerve was caused by the manipulation rather than the fracture is balanced by Platt's remark that "prevention of median nerve involvement is largely a problem concerned with the efficient reduction of supracondylar fractures." Again, Fairbank (1936) stated that in his experience Volkmann's ischaemic contracture was excessively rare without unreduced gross displacement, and Griffiths (1940) on the same subject wrote that "the first symptom of the arterial block dates more often from a manipulation than from the fracture itself." Are there, then, circumstances in which the dangers of closed manipulation are so great that open reduction should be advised?

**OPEN REDUCTION**

Before attempting an answer it is worth recalling the axiom propounded by Fagge (1936) that if the deformity is really reduced, the fragments impinge so firmly that movement at the elbow takes place before movement at the fracture. From it he inferred that one should never depend upon a particular position for the maintenance of alignment, and it was his practice, if he could not secure reduction with the elbow at a right angle, to perform open operation.

It was stated by Charnley (1950) that, using a technique of manipulation based on anatomical knowledge of the fracture, there should never be any necessity for open reduction, except for nerve or arterial complications. This is a sound working guide and nearly, but I think not quite, always true, especially where several previous manipulations have been tried. In such circumstances a careful open operation may well be preferred to continuous traction or mechanical traction, as advocated by Böhler (1935), Madsen (1955) and others.

Absence of the radial pulse, it is generally recognised, can occur without any true impairment of circulation in the hand, or fear of Volkmann's contracture. Such absence, which may persist for days or weeks, despite good reduction and an otherwise normal hand, is not therefore of itself an indication for operation. If, however, it is accompanied by pale, flexed fingers, painful when passively extended, the signs of early ischaemic paralysis are present and demand immediate surgical intervention.

Girdlestone (1936) defined his objectives at operation as threefold: to evacuate the haematoma, to safeguard the neurovascular bundle and to obtain accurate reduction. With these in mind, I have ventured to enumerate the criteria that demand operation as follows. 1) Compound fractures; 2) antecubital tension, extreme in degree or unrelieved by reduction; 3) ischaemia of the hand or suspicion of Volkmann's contracture, especially if persisting after reduction; 4) uncertainty about the position, especially suspected anteposition, of the upper fragment relative to the neurovascular structures, depending upon whether penetration of brachialis is complete or incomplete; 5) nerve palsy associated with incomplete reduction (Platt 1928); 6) failure of closed reduction under full general anaesthesia (Girdlestone 1936); 7) failure to secure a stable closed reduction with the elbow at a right angle (Fagge 1936).

**SUMMARY**

1. A case, believed to be the fifth on record, of supracondylar fracture with rupture of the brachial artery is described.
2. The relative immunity of the median nerve in these injuries is discussed, with brief reference
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...to a recent case of complete rupture. Only a single previous report of this complication could be found.

3. It is suggested that these injuries are less uncommon than the number reported would indicate.

4. The anatomy of severe displacement is discussed, with special reference to the role of the brachialis.

5. The danger of closed reduction when the relationship of the upper fragment to the neurovascular bundle is in doubt is stressed.

6. The indications for open reduction are given.

I am very much indebted to Mr James Ellis and Mr F. Wilson Harlow for their helpful and kindly criticism of this paper.

REFERENCES


