

the ferric form of haemoglobin with intravenous MB.<sup>11</sup> Treatment with MB is advised when the MetHb level is >30%–40% but each case must be treated individually on clinical grounds and symptoms. The recommended dose is 1–2 mg/kg given intravenously over five minutes. The different doses (both within the recommended range) used in our two patients were at the discretion of the attending emergency physician.

MB acts as a substrate for the enzyme NADPH-MetHb reductase. The reduced MB produced by the action of this enzyme in turn reduces MetHb back to haemoglobin. NADPH is a necessary cofactor for the enzyme and is produced using G6PD (from the hexose monophosphate shunt). In people with G6PD or NADPH-MetHb reductase deficiency MB is ineffective and alternative treatments such as exchange transfusion, hyperbaric oxygen, or packed cell transfusion must be used.<sup>4, 12</sup>

Pulse oximetry in the presence of methaemoglobinaemia is inaccurate. This device uses light absorbance at two wavelengths (660 nm and 940 nm) to calculate the relative concentration of oxy-haemoglobin and deoxy-haemoglobin. MetHb absorbs more light at both wavelengths than do the other two forms of haemoglobin but has a disproportionately greater absorbance at 660 nm. When MetHb concentration reaches 65% or more of the total haemoglobin concentration, the 660 nm to 940 nm light absorbance ratio approaches 1.27. This generates a (falsely high) SaO<sub>2</sub> reading of 80%, even though the maximum possible value is 75%.<sup>13, 14</sup>

Co-oximetry avoids this problem by using spectrophotometric techniques to estimate the oxy-haemoglobin percentage of total haemoglobin concentration in the blood sample. It measures light absorbance at four different wavelengths to calculate relative concentrations of oxy-haemoglobin, deoxy-haemoglobin, carboxy-haemoglobin, and MetHb.<sup>15</sup>

Arterial blood gas analysis can also be misleading. Values obtained are a measure of the dissolved oxygen in the sample and not of the oxygen bound to haemoglobin. Calculations of oxygen saturation are based on the assumption that all haemoglobin present has the capacity to carry oxygen. Thus in the presence of a high MetHb concentration, calculated pO<sub>2</sub> levels will be an overestimation and may mask severe tissue hypoxia.<sup>16</sup>

The use of volatile nitrites as drugs of misuse make them a possible cause of methaemoglobinaemia presenting to the emergency department. These are known on the street as “poppers”. The composition of the liquid varies including amyl, butyl and isobutyl nitrite. A high level of awareness and index of suspicion is required to diagnose the condition and successfully reverse potentially fatal sequelae associated with its misuse.

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## Avulsion of the triceps tendon

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**A**vulsion of the triceps tendon is the least common of all tendon injuries.<sup>1</sup> In a review of 1014 tendon ruptures over a nine year period by Anzel *et al.*,<sup>2</sup> 2% constituted the triceps tendon. The rupture could be partial or complete with or without associated fractures. The usual mechanism of injury is fall onto an outstretched hand but can occur after direct contact injuries. Although ruptures at the musculotendinous junction have been reported, the commonest location is the osseo-tendinous insertion. We report a case of triceps avulsion in a 42 year old heavy manual worker treated by open surgical repair.

#### CASE REPORT

A 42 year old man presented to the accident and emergency department with pain in his left elbow when he landed awkwardly on it while carrying a barrow of soil up a plank, three feet high and slipped. Clinical examination revealed diffuse swelling and tenderness in the region of the left elbow. A definite gap was palpable just above the olecranon and weakness of arm extension was clearly evident. Lateral radiograph of the elbow showed a “flake” fracture of the olecranon. A diagnosis of complete rupture of the triceps was made. Through a posterior midline incision, the area of rupture was



**Figure 1** Lateral radiograph of the injured elbow showing the "flake" fracture avulsed from the olecranon.

exposed and the flake of bone with the triceps tendon was reattached using two k-wires reinforced with a circlage wire. Postoperatively the arm was immobilised in a back slab at 80 degrees for four weeks after which active flexion was commenced. Extension was permitted after a period of eight weeks. The k-wires had to be removed at three months after the operation. One year after the operation he has full range of movement of the elbow with complete recovery of the triceps power.

## DISCUSSION

Being comparatively uncommon, triceps injuries are frequently missed in a normal accident and emergency setting. Triceps avulsion should be suspected in patients presenting with pain and swelling about the elbow after trauma. It usually follows indirect trauma but can be seen after a direct blow or fall on the elbow. Injury to the triceps can also be sustained in a variety of sports including weight lifters and body builders. It has also been described in patients with hyperparathyroidism and in haemodialysed patients with renal failure.<sup>3</sup>

Clinical examination will reveal swelling and a palpable gap proximal to the olecranon. Significant loss of range of motion of extension and strength usually suggests a complete rupture. This may be difficult to elicit because of the pain, swelling, and muscle spasm.

Roentgenographic examination usually reveals a "flake" fracture, which is an avulsion fracture of the olecranon (fig 1). Careful inspection of the radiographs and if necessary oblique views of the elbow should be requested to rule out other fractures. Levy *et al*,<sup>4</sup> described radial head fractures associated with triceps ruptures in two reviews. Ultrasound examination or magnetic resonance imaging may be needed if the diagnosis is uncertain.

Complete avulsion rupture of the triceps needs surgical exploration and repair. Reattachment of the triceps tendon to



**Figure 2** Lateral radiograph of the elbow showing the reattachment of the avulsed tendon using k-wires and circlage wire.

the olecranon via drill holes within the olecranon is usually successful. If the avulsed flake of bone is of reasonable size fixation may be attempted as in our case (fig 2). Neglected ruptures and ruptures at the musculotendinous junction will require more extensive procedures including V-Y advancement and tendon grafting.<sup>6</sup>

Avulsion of the triceps tendon is a rare injury. It can occur after direct or indirect trauma and is usually at the osseo-tendinous junction. A high index of suspicion, physical examination for a palpable gap and "flake" fracture on lateral radiograph will aid in diagnosis. Surgical repair will usually yield excellent results.

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