Avulsed posterior edge of the tibia
EARLE’S OR VOLKMANN’S TRIANGLE?

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The term Volkmann’s triangle for the avulsed posterior edge of the tibia in fracture-dislocations of the ankle is incorrect. Volkmann did not publish any articles relating to the posterior edge of the tibia. Credit should go to Henry Earle, who was an outstanding British surgeon of the first half of 19th century. He described avulsion of the posterior edge of the tibia in 1828. In 1823 he also published a monograph entitled Practical observations in surgery in which he described a specially designed bed for the conservative treatment of proximal fractures of the femur.

On the basis of a publication in 1875, the avulsed posterior edge of the distal tibia, in cases of fracture-dislocation of the ankle was termed Volkmann’s triangle although other authors gave credit for this observation to Earle in 1828. In order to clarify this issue a study of the original sources was undertaken.

History of the description of avulsion of the posterior edge
A detailed description of the history of fractures involving the posterior edge of the tibia can be found in an outstanding study on fracture-dislocations of the ankle by Lauge. The features of the fractured margin of the articular surface of the tibia had been described by Cooper, Earle, Adams, Dupuytren, Magain, Nélaton, Thaon, Gurlt and Richard, on the basis of post-mortem findings. Lauge deals in detail with Volkmann’s article and reprints his line drawings. He states that Volkmann described two types, one of which is avulsion of the anterior edge of the tibia. This was termed Volkmann’s triangle by all German authors and in Lauge’s view is incorrect. The second type of fracture occurs when the fracture line passes sagittally and separates the lateral part of the distal tibia. Lauge did not agree with Volkmann’s explanation of the mechanism of this fracture. Furthermore, he stated that he had not seen this type of fracture.

The first AO monograph of 1965 used the term ‘Earle-Volkmann type’, but in the latest issue of 1990 only Volkmann’s triangle was mentioned. Weaver used Earle’s name for the avulsed posterior edge of the tibia and he associated avulsion of the anterior edge with Volkmann.

Hamilton wrote in 1984 that Volkmann was apparently the first to describe avulsion of the anterolateral fragment of the distal tibia. He published Volkmann’s original line drawings which were reprinted from Lauge’s publication. Kelikian and Kelikian cited one of Volkmann’s works of 1875, in which there was a brief description of avulsion of the lateral part of the tibia in the sagittal plane.

Zwipp in 1994 was correct when he noted that avulsion of the posterior edge of the tibia was first described by Earle and today is wrongly ascribed to Volkmann. Nevertheless, later in his text he used the term Volkmann’s posterior fragment.

Original description by Sir Astley Cooper (1819)
Cooper’s description of fracture-dislocations of the ankle is usually dated 1822 when his work A treatise on dislocations was published, but an identical text can be found as early as 1819. In the part dealing with Dislocation of the ankle-joint he describes “a case of a very obese lady who fell and sprained her ankle”. The foot dislocated dorsally, but reduction was not successful. Several years
later this patient died and Cooper had the opportunity to study the injured ankle at post-mortem. “The articular surface of the lower part of the tibia was divided into two; the anterior part was seated upon the os naviculare, the posterior upon the astragalus; these two articulatory surfaces formed at the lower extremity of the bone, had been rendered smooth by friction.” The line drawing (Figs 1 and 2 in his book) as well as the description show, however, that this was a distal tibial pilon fracture rather than a fracture-dislocation. In addition, the avulsed edge was not seen on the line drawing. Credit is also given to Cooper for the description of the avulsed anterior edge of the tibia. Both the drawings and the description clearly showed that this case was not a typical fracture-dislocation, but a compression fracture of the distal tibia. They showed an avulsed anterolateral edge of the distal tibia.

Original description by Henry Earle (1828)

This description relates to a 53-year-old man who sustained a severe injury of his right ankle after being knocked off the pavement by two men. He was admitted to St Bartholomew’s hospital where Earle worked. Examination showed the following. “There was found to be dislocation of the tibia forwards, and a comminuted fracture of the fibula. The muscles of the limb were acting spasmodically with great violence. The dislocation of the tibia was reduced, and the leg put up in splints. Twelve leeches to be applied to the part, and cold clothes.” One day later “Mr Earle desired the splints to be removed that he might examine the parts. The moment they were taken off, the spasmodic action of the muscles instantly dislocated the tibia again. Apply the splints again . . . and administer 35 drops of the tincture of opium at bed time . . . On the fourth day after the injury the patient was found to be feverish and restless. The restlessness became worse on the eighth day after the injury”, and he not only again dislocated the tibia, but forced its extremity through the integuments, which had become thin and inclined to slough, thus making it compound. Inflammation and suppuration of the cellular tissue have taken place. The limb is considerably swelled, the muscles act spasmodically most powerfully, and the parts are in an extremely irritable condition. Mr Earle has made an incision on the outside of the fibula, and also a small one in front of the tibia, about the junction of its lower third, through which pus has been evacuated”.

However, the patient at first refused the suggested amputation, but because of his deterioration finally agreed on the 18th day after injury. It was immediately performed but he died from sepsis on the 23rd day after the injury.

One day before the patient died, Earle and Stanley dissected the amputated limb. “The tibia dislocated forwards, with a small portion of its posterior edge fractured and retained in situ – considered perfectly novel. The fibula fractured into many pieces, and its extremity driven forward also, upon the astragalus. The internal lateral ligament in a sloughing state, the anterior capsule torn through, the cartilage of the upper surface of the astragalus absorbed. The external lateral ligament entire, the outer side of the fibula denuded of its periosteum for two inches and half.”

The article is interesting for the contemporary manner of citation by first stating the name of the hospital followed by the name of the patient. The names of the authors are not given, but later in the text there is mention of the attending surgeons, Earle and his assistant Stanley. Other articles in this issue of the Lancet are in a similar format. As a result, authorship can be only judged from the details in the text.

Thus neither Lauge nor Weber mentioned Earle’s christian name and Kelikian and Kelikian used the wrong initial “J”. Earle’s correct first name Henry is only noted in subsequent publications such as that by Cordasco, in connection with the conservative treatment of fractures of the neck of the femur.

Description by Robert Adams (1835-6)

In volume I of The cyclopaedia of anatomy and physiology of man Adams describes in the “Chapter on ankle joint, abnormal condition”, the case of a 53-year-old woman who two months previously suffered from “the partial dislocation forwards of the tibia, combined with a simple fracture of the fibula”. The woman subsequently died and the post-mortem proved that “the internal malleolus itself had been broken, and small portion of the back part of the edge of the articular cavity of the tibia was avulsed”. The description of this case is of value since, it is supplemented by two line drawings of the injured limb (medial and lateral sides) and by two pictures of the bones. The case is very similar to that of Earle who is mentioned several pages earlier by Adams in connection with the work of Pott. In addition, Adams discussed the case of a “complete dislocation of the tibia forwards” treated by Cooper and did not agree with some details of his description.

Original description by Volkmann of 1875

In the chapter dealing with open fractures of the tibia in his monograph, Volkmann described the case of a 38-year-old man who suffered a fracture of the distal tibia and fibula. In the region of the medial malleolus the skin was perforated and the wound communicated with the ankle. Because of infection the distal part of tibia and fibula were resected and the whole of the talus removed (Fig. 1). Healing took one year, in the author’s view with a satisfactory functional result. Examination of the resected joint revealed a fracture of the fibula three inches proximal to the tip of the lateral malleolus, avulsion of the tip of the medial malleolus and avulsion of 7 cm of the lateral aspect of the tibia with the fracture line passing almost precisely in the sagittal plane.

Volkmann further discussed this type of fracture which he did not consider had been previously described. He thought that it had been produced by forced pronation and abduction resulting in either diastasis of the tibiofibular joint or, to avulsion of the lateral aspect of the tibia. The
fracture line passed obliquely from the lateral side distally and medially, in the sagittal plane. Figure 2 shows different fracture lines and he described two other cases in which he had resected these wedge-shaped fragments because of infection. He stated that the skin was often punctured on the medial side. In a footnote he described a case in which anterior dislocation of the foot caused avulsion of the anterior edge of the tibia and the fracture line was coronal. He did not mention whether or not it was combined with damage to the malleoli.

The drawings and descriptions suggest that Volkmann primarily reported examples of avulsion of the lateral aspect of the distal tibia in the sagittal plane. These were compression (pilon) fractures as demonstrated in his original drawings. He did not describe avulsion of the posterior edge of the tibia, but only avulsion of the anterior edge.

The above-mentioned case of resection of the ankle was published again by the author in 1875 or 6 (the exact year can only be deduced) in an article on complicated fractures. The issue of priority

Analysis of the above three descriptions shows that Volkmann in no case described a fracture of the posterior edge of the tibia in fracture-dislocations of the ankle. He mentions avulsion of the anterior edge only in two sentences in a footnote and according to Lauge the priority cannot be ascribed to him as this type of injury had been previously described by Cooper, Malgaigne, Richard and Laborie. The cases which he described were most likely to be pilon fractures. However, he was probably one of the first to operate successfully on such an injury and the fracture healed after a year with a good functional result. Although Cooper’s description is older the author describes only breaking of the distal tibia into two parts, anterior and posterior. However, he does not and in fact could not write about other injuries of the ankle as the autopsy was performed several years later. Thus the extent of the injury remains unclear. It might have been a fracture-dislocation of the ankle with a large posterior edge of tibia, as well as a compression fracture of distal tibia (pilon). In contrast, Earle clearly describes a typical fracture-dislocation of the ankle. Adams made a similar description seven years later.

Earle therefore should be credited with the first description of the avulsed posterior edge of the tibia in fracture-dislocation of the ankle and it should be termed the Earle triangle.

A biography of Henry Earle

Whereas Richard von Volkmann (1830 to 1889) made many contributions in surgery and medicine as a whole, Henry Earle (1789 to 1838) has been almost forgotten and is mentioned only occasionally in connection with avulsion of the posterior edge of the tibia although in 1823 he published several interesting articles in Practical observations in surgery, and this book was translated the following
In it Earle expands on fractures of the neck of the femur, citing previous authors such as Paré, to whom he ascribes priority, Desault, Petit, Colles and others. For the treatment of such fractures he designed a fracture bed (Fig. 3) to provide maximum comfort for the patient. Its description and a manual for its use, with slightly different drawings, was published a year later (1824) and also reported in the Lancet. Fourteen years later (1837) the bed was mentioned by Cooper in Principles and practice of surgery. It was a very sophisticated device for its time which apart from the comfort for the patient also allowed treatment of a fracture of the femoral neck in semiflexion.

In other chapters of the book Earle described fractures of the olecranon, deformities of the spine and reconstruction of the urethra. He designed a special bandage for dislocation of the shoulder.

In historical studies dealing with proximal femoral fractures Earle and his bed are mentioned only by Cordasco and his work is not referred to in the outstanding and detailed description by Peltier nor in Bick’s historical monograph.

A description of Earle’s life may be found in the Dictionary of National Biography of 1908. “Henry, Earle... was born 28 June 1789. His mother was the daughter of Percival Pott, the great surgeon. He became a member of the College of Surgeons in 1808, and was appointed house surgeon at St Bartholomew’s Hospital. In 1811 he began practice as a surgeon, and attained some notoriety by the invention of a bed for cases of fracture of the legs. For this invention he received two prizes from the Society of Arts. In 1833 he was made professor of anatomy and surgery at the Royal College of Surgeons, and in 1835-7 he was president of the Royal Medical and Chirurgical Society. Beside twelve surgical papers Earle published Practical observations in surgery, London 1823. The frontispiece of this book has a series of drawings of the bed invented by Earle, and one of the six essays. This essay led to a controversy with Sir Astley Cooper as to whether fracture of the neck of the thigh-bone ever unites. In 1832 Earle published two lectures on the ‘Primary and Secondary Treatment of Burns’. He died of fever 18 January 1838.”

In this respect it should be noted that the disputes between Earle and Cooper were acrimonious as docu-
mented in Earle’s article in the *Lancet*.

The fact that he was not the only one to argue with Cooper is seen in the minutes of a meeting of the *London Medical Society* dealing with *Fractures of the neck of the thigh bone*. Earle should not be forgotten not only because he was the first to describe fracture-dislocation of the ankle with avulsion of the posterior edge of the tibia, but also because of his original contribution to the conservative treatment of fractures of the proximal femur. He was one of the outstanding British surgeons of the first half of the 19th century.

No benefits in any form have been or will be received from any commercial party related directly or indirectly to the subject of this article.

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