THE OS TRIGONUM

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In 1882 Shepherd reported three cases of fracture of the posterior process of the talus, which he had found while working in the dissecting room. In each case the fragment of bone consisted of the posterior part of the tubercle of the talus lateral to the groove for the tendon of the flexor hallucis longus, and had attached to it the posterior fasciculus of the lateral ligament of the ankle joint. Shepherd believed that the fragment of bone was pulled off by this ligament and tried to reproduce the fracture by forcibly manipulating several ankle joints in the anatomy room, but failed in his attempts. He dismissed the idea that the small ossicle he had found could be due to an ununited epiphysis, for the talus developed from one centre and he had never seen a secondary centre. Turner (1882) pointed out that the occasional existence of a distinct ossicle representing the posterior border of the talus, ascribed to a fracture by Shepherd, was known to anatomists, and he demonstrated a case of a separate ossicle which had a groove in it for the tendon of the flexor hallucis longus. He quoted several authorities who had described the ossicle. Gruber had reported its presence in 1864 and described it as a talus secondarius. Stieda (1869) had mentioned its presence in the left foot of a man. Both Stieda and Gruber regarded the ossicle as representing a modification in development, the talus in these cases having two centres of development. Turner therefore believed that this ossicle owed its origin not to a fracture of the talus but to a secondary centre of ossification for the posterior part which had not fused with the general body of the bone. Bardeleben (1885) considered the accessory talus met with in the human tarsus to be an example of a distinct os intermedium tarsi. The os intermedium tarsi he regarded as homologous with the carpal lunate bone and he called it the os trigonum, the talus of the higher mammals being composed of this os trigonum fused with the general mass of the talus. There is still no unanimity among anatomists as to the origin of the talus in the evolution of the tarsus, the only definite agreement being that it is a compound bone phylogenetically (Schaeffer 1941). Bennett (1887) reported that he had met with this small ossicle in the dissecting room and had always regarded it as a fracture, but after reading the articles by Shepherd, Turner and Bardeleben he was inclined to modify his views, while still believing that it could occur as a fracture of the tubercle of the talus. He quoted a case in which he had found the ossicle separate on the right side, whereas on the left side there was a deep groove marking off the tubercle from the rest of the bone although there was not a complete separation. In his opinion these two examples showed clearly that the meaning of the deep notch was the tendency to the development of a separate ossicle.

Moullin (1901) had seen on several occasions a separate ossicle immediately behind the posterior border of the talus. In one case a severe sprain had occurred and the presence of the os trigonum suggested the possibility of a fracture as well. Keith had informed him that the bone was found as a separate ossification centre in 3–4 per cent of subjects, but he believed that it might be more frequent. Like Shepherd and Bennett, he believed that the tubercle could be pulled off by the posterior fasciculus of the lateral ligament of the ankle. Discussing rarer ossifications seen radiographically, Holland (1921) pointed out that the posterior part of the talus was drawn out normally into a projection and might show very prominently. The os trigonum, when present, was situated at the back of the upper surface of the talus and might simulate a fracture of this projecting piece of bone. He had no doubt that it was a distinct ossicle. It had not been known ever to give rise to symptoms. The true
bone was usually symmetrical and should be seen in the other foot. Bizarro (1921) found the os trigonum present in seven out of 100 feet radiographed. It was often difficult to determine from the radiographs whether the bone was entirely separate or not. Meisenbach (1928) described a fracture of the os trigonum in a patient who fell while playing squash rackets. He believed that the os trigonum appeared more frequently than was recognised and that its fracture was not unusual. Köhler (1935) noted the confusion that this small bone had given rise to, among both clinicians and anatomists. When first seen it was believed to be a fracture, but when attention was drawn to the fact that it was an inconstant accessory bone every broken-off posterior process of the talus was taken for an os trigonum and the presence of a fracture denied, even when the process was typically fractured and the healthy foot was normal. He distinguished the two conditions as follows: if one found behind the talus a shadow in both feet—round, oval or three-cornered—it was an os trigonum; but if there was a smaller triangular shadow separated by a narrow indistinct space from the rounded-off posterior process, it was a fractured process, especially if the healthy foot showed a process without a line of fracture. He noted that fracture of the process was not rare, especially in active adults. Iusem (1948) found radiographs of little value in distinguishing a fractured os trigonum, except when subsequent union occurred. He found that the ossicle was not always bilateral and therefore this feature could only be of relative diagnostic value. Often after a true fracture a condition indistinguishable from an os trigonum had been found.

**THE TALUS IN THE CHILD**

Examination of the adult talus shows that its posterior aspect consists of two tubercles between which lies the groove for the tendon of the flexor hallucis longus muscle. The lateral tubercle is usually the larger, and it is commonly referred to as the posterior process, although not infrequently the medial tubercle may be just as large. The tubercles vary considerably in size, from small processes hardly discernible in the lateral radiograph to the prominent posterior projection mentioned by Holland. Attached to the lateral tubercle is the posterior fasciculus of the lateral ligament of the ankle joint; the deltoid ligament runs backwards to the base of the medial tubercle.
Secondary ossific centres in childhood—In early childhood the posterior border of the talus is rounded and not drawn out into a projection as in the adult (Fig. 1). Secondary centres of ossification for the processes appear at the posterior margin between eight to eleven years of age, depending on the development of the child. They quickly unite with the main bone—usually within a year of their appearance (Figs. 2 and 3).

![Figure 2](image1) ![Figure 3](image2)

Figure 2—Secondary centres of ossification in a boy of ten. Figure 3—Within the ten-month period of observation the centres had united.

![Figure 4](image3) ![Figure 5](image4)

Figure 4—Two large discrete centres in a boy of nine. Figure 5—Within five months the centres united to form the two posterior tubercles.

So variable are these centres in size, time of appearance and union, that they may easily be overlooked in radiographs. In thirty-five unselected radiographs of young children's ankles evidence of these centres was found in twenty-nine. One centre only may be seen in each ankle, but frequently two are present, corresponding with the medial and lateral tubercles (Figs. 4 and 5). The size and degree of development may vary in the two ankles. If the
projection is not a true lateral the shadow of the fibula may overlap and conceal them (Figs. 6 and 7).

The statement that the appearance of these secondary centres of ossification is usual conflicts with the views of other writers that such centres appear only occasionally and that when a centre does appear it is liable to remain ununited and form the separate ossicle or os trigonum, found in numbers variously estimated at from 3 per cent (Moulin 1901) to 11.4 per cent (Köhler 1935).

**POST-TALAR OSSICLES IN THE ADULT FOOT**

That separate ossicles are found in some adult ankles is an established fact and an explanation of their presence must be sought.

**Detachment of ossicle by repeated minor injury**—When the ankle joint is fully plantar-flexed the posterior aspect of the talus strikes the posterior margin of the tibia and limits the range of movement (Fig. 8). To quote Lambrinudi (1927): "The normal locking of the
ankle joint in full equinus is produced by the posterior tubercle of the astragalus ‘talus’ coming in contact with the posterior margin of the articular surface of the tibia. This is a natural bone block.” The Lambrinudi drop foot operation is based on this principle. In an active person the posterior aspect of the talus must strike the posterior margin of the tibia many times each day, and if the tubercles are large they will strike against the tibia and be compressed there by the calcaneum. This repeated impingement of the tubercle against the

![Fig. 10](image1.png) ![Fig. 11](image2.png)
Fig. 10
Prominent posterior tubercles in a football player aged twenty-one. In the right one (Fig. 10) a translucent line can be made out at the base of the process.

![Fig. 12](image3.png) ![Fig. 13](image4.png)
Fig. 12
Both tubercles show signs of commencing separation. Footballer aged twenty-four.

tibia will lead first to a groove at the point of contact and eventually to separation of the tubercle from the body of the talus. As the process is a gradual one symptoms will be minimal. **Clinical cases**—The manner in which the tubercles become separated and the various stages in the process of separation were first noted in a number of football players, some of whom were complaining of symptoms; the others were examined incidentally. McMurray (1950) described how a football is kicked with the foot in equinus (Fig. 9) in order to control its
direction, and he noted that the strain of the blow is borne largely by the anterior ligament of the ankle. It should be added, however, that the locking mechanism described above must come into play, thus subjecting the tubercles to a degree of controlled trauma against the tibia.

Both ankles of the player whose radiographs are reproduced in Figures 10 and 11 show prominent posterior tubercles. On the right side there is the suggestion of an early line of separation: the left is intact. Another football player, who kicked equally well with either foot, complained of pain in the posterior aspect of the ankles when kicking the ball. Radiographs showed lines of separation through both posterior tubercles (Figs. 12 and 13). Both tubercles were removed with complete relief; at operation on each side the posterior fasciculus of the lateral ligament was found attached to the fragment.

A third player complained of pain behind the right ankle, and a rounded separate ossicle was seen behind the talus (Fig. 14). In the left ankle, which was symptomless, a small loose ossicle was present and a definite line of separation was noted at the base of the prominent posterior process (Fig. 15). At operation the ossicle was removed from the right ankle. It had no ligamentous attachments and resembled a disc-shaped loose body. Five years later both ankles were symptomless, but the process of separation had extended a stage further in the left ankle (Fig. 16).

In another player examined incidentally rounded separate ossicles were present in both ankles; there were no symptoms attributable to the separated processes (Figs. 17 and 18).

These cases illustrate the various stages in the process of separation. The first case shows a line of cleavage in one process. In the second case both processes are beginning to separate. The third case corresponds to the one quoted by Bennett in which he found a separate ossicle in the right foot and a deep groove in the left one. In the fourth player both processes are quite separate. A separate ossific process has also been observed in a woman who had a drop-foot resulting from poliomyelitis in childhood, and in whom the talus was constantly impinging against the back of the lower end of the tibia.

**Detachment of ossicle by sudden violence**—The example quoted by Turner of a separate ossicle consisting of both tubercles and the groove for the tendon of the flexor hallucis is likely to have been due to a more severe form of injury. A man of fifty-three who had fallen from a height and injured his ankle demonstrated such an ossicle (Fig. 19). When the foot was placed in equinus the point of contact of the process against the tibia could be visualised.
(Fig. 20). The patient was not seen until several weeks after his injury and at the first examination this fractured process was regarded as an os trigonum.

When the prominent process is subjected to sudden uncontrolled violence—as when the heel catches on a step while going downstairs—it is fractured with immediate symptoms of pain and tenderness deep to the tendon calcaneus. A patient injured his ankle in this way falling from some steps. The fracture line was plainly visible (Fig. 21), and no doubt would exist about the diagnosis if such a case were seen early. This patient was treated by a plaster for ten days, and thereafter by a supporting bandage, and he returned to work after three weeks. Two years later there were no symptoms referable to the fractured process. Radiographs showed, however, that not only had the small fragment of bone failed to unite, but the edges of the fracture line had become smoothed off, the fragment had altered its shape and the appearance no longer suggested a fracture, but was characteristically that of the so-called os trigonum (Fig. 22).

Fig. 17
Rounded separate ossicle present in both ankles of a footballer aged twenty. Both ankles symptomless.

Fig. 18

Fig. 19
Figure 19. Posterior part of talus consisting of both tubercles and groove for the flexor hallucis longus tendon broken off by an injury. Figure 20—Foot in equinus to show point of contact with the tibia.

Fig. 20

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PERSISTENCE OF A SECONDARY CENTRE AS A SEPARATE OSSICLE

In an active young person a secondary centre may occasionally be prevented from uniting with the body of the talus. A boy of fourteen reported with an injury to his left leg, sustained while playing football. Behind the talus there was a rounded ossicle (Fig. 23); in the right ankle the posterior process was complete. A below-knee plaster was worn for four weeks. When it was removed the ossicle had united with the main bone (Fig. 24) (several oblique views confirmed the union). In this case the ossicle had probably not been separate but had been united to the talus by a synchondrosis.

**Fig. 21**—Fracture of the left posterior tubercle in a man of forty-one who fell down some steps. The line of fracture is clearly seen. **Fig. 22**—Two years later the tubercle is quite separate, the fracture line has smoothed off, and the tubercle is becoming more rounded. The appearance does not now suggest a fracture.

**Fig. 23**—Left ankle of a boy of fourteen who sustained an injury playing football. A small rounded ossicle is present with a line of demarcation from the talus. **Fig. 24**—After immobilisation in plaster the process has undergone bony union.

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CONCLUSIONS

From this study the writer believes that secondary centres of ossification for the posterior part of the talus are a normal feature. Owing to their situation and liability to injury against the articular margin of the tibia, the centres may in the first instance be prevented from union, but this happens infrequently. Köhler noted that the incidence of the so-called os trigonum increased with age but could offer no explanation of this fact. It is logical to believe that the process of separation is more likely to have been completed with the advance of years. The separated processes may not be so harmless as other writers have suggested. In five cases operative excision of the fragment was considered necessary for the relief of symptoms.

SUMMARY

1. Previous papers on the subject of the os trigonum are reviewed.
2. Evidence is produced to show that the posterior part of the talus normally develops from separate centres.
3. An explanation is given for the presence in adults of separate ossicles (the so-called os trigonum) in one or both ankles and for the variety of shapes adopted by them.
4. Contrary to opinions expressed by previous writers, these ossicles may give rise to symptoms.

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REFERENCES


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