Introduction

Today, femoral shaft fractures are medical emergencies which can be easily dealt with. Modern narcotics enable surgeons to reduce the fracture without immense pain to the patient and the fracture can be stabilized by screws or rings if needed. In archaeological contexts, fractures of the femoral shaft are often spectacular, especially when no attempt was made to reduce them. From arch is considered to be one of the three cases of femoral shaft fractures, which had been survived and appeared to be well healed, two from the Bronze Age in Russia and one from the Scythian period in Kazakhstan.

Fractures of the Femur – medical aspects

Fractures of the femur are widely known. Three main areas can be affected by fractures: the femoral neck, the shaft and the distal part of the femur with or without displacement. The site of the fracture is the femoral neck mainly because of the less dense cortical bone that is also easily weakened by osteoporosis. Fractures of the femoral shaft are more common because of the impact of severe bending and torsional forces. Several types of fractures can be outlined: 1. Transverse fractures 2. Short or long oblique or torsion fractures with or without appearance of torsion wedge 3. Comminuted fractures. Typical features of fractures of the femoral shaft are: Shortening, dislocation with flexion, abduction/adduction and external rotation of the proximal fragment. Besides other severe complications, the major is a large amount of blood loss, which can lead to massive haematoma. Myositis ossificans traumatica and secondary arthrosis due to malposition are also frequently described. To date, there is no evidence for a connection between sex and age. The literature shows a probable fall from height as a possible cause. The rarity and the lack of consistency of particular features make the evaluation of this kind of fracture difficult. The main thing all fractures have in common is the positioning. In modern cases the location of the shaft was observed mostly in the middle third. 1 The same is observable in our cases and all cases in palaeoanthropological literature 2, 3, 4, 5, 6, 7, 8, 9, 10, 11. This observation was also confirmed by the study of Ng et al. (2012) 12. In all of the literature, they died in adult age, with healed fractures, acquired at least several years before death. In Case 3 of our cases and the two mature cases from the literature the exact dating of the fracture is not possible because of long-term survival of all of the palaeopathological cases in contrast to modern cases there is a tendency towards the younger age and no second peak in same age could be confirmed.

Age distribution for acquiring femoral fractures: Studies of modern cases indicate two age related peaks for acquiring fractures: in the early years 15-24 and over 75%. This observation can also be confirmed by the study of Ng et al. (2012) 12. In all of these cases and in six of eight individuals, they died in adult age, with healed fractures, acquired at least several years before death. In Case 3 of our cases and the two mature cases from the literature the exact dating of the fracture is not possible because of long-term survival of all of the palaeopathological cases in contrast to modern cases there is a tendency towards the younger age and no second peak in same age could be confirmed.

Sex distribution concerning femoral fractures: The study of modern cases by Ng et al. (2012) 12 showed a connection between sex and age of people with femur fractures: males had a first trauma at the mean age of 31.2 years, in females fractures appeared at the age of 59.7 years. In our three cases and in seven cases in the literature, there is no evidence for a connection between sex and age. Causes: In the recent younger group displaying fractures the cause was mostly found to be due to high energy impacts (e.g. motorvehicle accidents), as well as falls from heights or direct trauma. In the cases of the older group low energy impacts were already found to be sufficient to break the shaft. 11 In only one case in the literature, was a probable fall from height mentioned as a possible cause. In our three cases, falls from height and direct force are possible sources of trauma. The question of the impact of horse riding and the accompanied dangers of falling or being kicked by a horse must be considered but cannot be confirmed. In modern cases, polytraumata have been found in up to 95% of fractures which provides the severe forces leading to this particular fracture. In all of our cases, additional fractures (craniol, patella and talus fractures) are present. One femur displayed an oblique fracture, two most probably a comminuted fracture, leading to the assumption that the kind of trauma was indirect in one and direct in two cases. Healing and Complications: In all of our cases and in 13 of 14 cases in the literature, the fractures are well healed (in one case only partly healed). In modern medically treated fractures non-union appeared in 14.7%. In all of the palaeopathological cases malunion emerged, most likely due to the lack of reduction, whereas malunion was found in only 8% of the modern cases. Osteomyelitis has been discovered in 1% of the modern treated cases and in one of the 14 palaeopathological cases in the literature, 8, 12, 13. This is mostly due to being simple and not compound. 12 In modern cases secondary arthrosis seems to have only minor effects. 12 In two of our cases severe arthrosis was present, due to malposition and shortening of the fractured femur. Most probably, in palaeo-pathological cases, arthrosis as a complication was quite common but is only mentioned in one case. However, Myositis ossificans traumatica is mentioned as a complication in four cases in the palaeopathological literature and occurs in two of our three cases. Although the fractures were survived for a long time, in one case a Myositis ossificans traumatica could be proved by histology. The fact that the liver of ancient cases and less detailed information in the publications of modern and ancient samples makes it difficult to come to more detailed conclusions. None the less, most of the observations made in the modern samples can be seen in the ancient samples as well. Today complications like mal- or non-union are rare but still to be found even with medical intervention.

Discussion

**Histological observations**

Histology was undertaken to get a better idea of the origin of the newly formed structure. Histological findings were compared with the radiological results. In modern patients, it is possible to diagnose between subperiosteal haematoma, myositis ossificans traumatica or phlegmon. The borders between old and new bone structures are not distinct due to the long period of healing. It fits with the findings of Shaposhnikov et al. 14 (2012). The comparison between subperiosteal haematomas and infectious bone changes on the anterior tibia. Histomorphological features as an aid for accurate diagnosis. Int J Osteoarcheol 20(2), pp. 227-239

**Methods**

Three cases of femur fractures, two from the Bronze Age in Russia and one from the Scythian period in Kazakhstan were investigated (see table). For the sex and age estimation of the individuals the method outlined in Bukst 15 and Ubelaker 16 was used. X-Ray was conducted using Fastron and CT-Scans were conducted with the DICOM-reader© software. For analysis of the X-Ray and CT-Scans, the recommendations of Roberts (1988) 17 were used for orientation. For description of the fractures the features of the LARA (length, apposition, rotation, angulation) method as proposed by Lovell (1997) 18 was used. For light microscopic analyses thin-ground sections were prepared by the technique described by Schultz and Brandt 19, 20.