CASE REPORT

The tell-tale thigh

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SUMMARY

A body of a 91-year-old donor underwent whole-body CT scanning before being transferred for use in an anatomical dissection course. Metallic objects were detected in the thigh muscles, extensive bone abnormalities were found in the left femur and the diaphysis of the left femur was 50% wider than that of the right diaphysis. History revealed that the body donor had been seriously wounded at the end of World War II by a rocket explosion. His multiple fractures and lesions had not been surgically treated either in an Austrian military hospital or in a French prisoner of war camp. The patient suffered for almost 70 years from this violation of the Geneva Conventions. In the light of current armed conflicts, the present case is an example of how one injustice can result in severe, lifelong medical consequences. It also shows that the history behind a wounded thigh can have an enormous impact on teaching ethics to today's medical students.

CASE PRESENTATION

A man aged 91 at time of his death was, in accordance with his will, embalmed and his body donated to our medical faculty for use in the anatomical dissection course. As a part of our teaching concept, whole-body CT and MRI scanning is performed on every other donated body in order to teach radiological anatomy using images of the same bodies that are dissected.¹ During routine CT scanning of this 91-year-old donor body, various small metallic objects (later identified as shrapnel fragments) were detected in the right gracilis muscle and the left gluteus maximus muscle. On CT scanning, extensive bone abnormalities were also found in the left proximal femoral bone and the greater and lesser trochanters (figures 1 and 2).

To obtain a better view of the extent of the changes, three-dimensional (3D) reconstruction of the CT images was performed. The 3D reconstruction (figure 2) shows massive bone remodelling as well as differences in trabecular and cortical architecture in the left compared to the right proximal femur. Two shrapnel fragments can also be seen above the left femoral shaft and in the right adductor muscles (green arrows in figure 2). The metallic fragments seen on CT imaging were located and removed during the dissection course. The proximal left femur was largely connected with the surrounding soft tissue and muscles. Twelve weeks of warm water and enzymatic maceration of both lower limbs allowed comparison of the bones. The diameter of the left femoral diaphysis was 50% wider than that of the right femoral diaphysis. Additionally, the trabecular and cortical architecture was distinctively

Figure 1 Anteroposterior view of the hip joints and the proximal femoral bones. Extensive bone abnormalities can be seen in the left proximal femoral bone and the greater and lesser trochanters.

altered and the left lesser trochanter was completely destroyed (figure 3).

A history obtained from the widow and daughter of the donor revealed he had been seriously wounded on the Eastern Front at the end of World War II, probably by a nearby rocket explosion. The soldier had been taken to an Austrian military hospital, which was shortly afterwards captured by Allied troops. Thereafter, the wounded man became a prisoner of war in France. In 1948, 3 years after the end of World War II, he was released from the prisoner of war camp. The multiple fractures had not been surgically treated in either the Austrian military hospital or the French prisoner of war

Figure 2 CT with three-dimensional reconstruction (anteroposterior view) of the hip joints and the proximal femoral bones. Green arrows indicate shrapnel fragments.

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Figure 3 The wider diameter and distinctively altered trabecular and cortical architecture of left compared to the non-affected right femoral bone can be seen after bone maceration.

camp. Furthermore, the lesions caused by the shrapnel were insufficiently treated: there was no surgical removal of the fragments, there was poor wound care and no antibiotic therapy. This is a violation of the Geneva Conventions of 1864, 1906 and 1929. As a consequence of these untreated war wounds, the donor experienced pain and stiffness in his left leg for the rest of his life and several times sought surgical intervention due to shrapnel fragment infection. Unfortunately, neither his wife or daughter could remember the exact numbers and dates of his hospitalisations. The surgical interventions were mostly futile and ended twice in septicæmia. The mobility of the patient was limited for the rest of his life as he had to use a walking aid, even for very short distances at home.

GLOBAL HEALTH PROBLEM LIST

- ▶ Very few contemporary witnesses of war injuries from World War II are still alive.
- ▶ War wounds, both treated and untreated, can result in unforeseen lifelong consequences for an individual.
- ▶ Wounded civilians and soldiers of all races, colours, religions and gender must be treated quickly and with the best available care.

GLOBAL HEALTH PROBLEM ANALYSIS

History of bone fracture treatment

The treatment of bone fractures has advanced greatly during the last 150 years. Although by the first half of the 20th century conservative methods were still standard for the treatment for most fractures, in the late 19th century pioneers such as Groves,² Langenbeck,³ Lambotte⁴ and Gluck⁵ began to develop and establish better methods of surgical fracture care, using ivory pins and bone chips for fixation and laying the foundations of intramedullary fracture treatment. Their techniques were promoted and improved by the German surgeons Oskar Müller-Meernach⁶ and especially Gerhard Küntscher.^{7 8} In the 1930s these surgeons made significant discoveries in the field of bone mechanics, which made it possible to correlate the fracture patterns of single fractures with defined loads and their spikes, and compare callus formation and fracture healing disorders with poor tensile stresses in the fracture area.⁹ On the basis of his findings, Küntscher developed an intramedullary nail for long human bones and applied it with great success. Better understanding and increasing surgical experience allowed him to improve this technique to a standard still applied today.¹⁰

Several decades before the development of these surgical devices, there had been improvements in extramedullary surgical approaches. The first bone screw apparatus with metal screws was introduced by Joseph François Malgaigne and laid the basis for the introduction of external fixation. The developments by Alfred Schanz, Jean Paul Lamare and Gustav Riedel were also important.¹¹ From 1925 to 1930 they independently described the importance of Kirschner wires implanted at particular angles. In 1937, Otto Stader introduced a fixation rail, which was used in World War II by the USA and Canada. However, immediate surgical intervention may be hindered by limited facilities in the conflict area. Although surgery was performed in World War II and in current military conflicts, for example, Afghanistan, it has been shown that initial careful wound debridement is the most important factor for patient outcome.¹²

Surgical treatment of war wounds and impact of Geneva Conventions

The developments mentioned above represented major advancements in the treatment of fractures, were frequently employed to treat the large numbers of severely wounded in both world wars and resulted in better rehabilitation and decreased long-term disability. However, although the benefits of these treatments had already been recognised by World War II (1939–1945), we here describe a case of multiple untreated explosion wounds and fractures.

Death rates and causes during wars differ greatly from those in peace time.¹³ In times of war healthcare resources, political affiliations and people's locations hugely influence the probability of survival and quality of life. Until the middle of the 19th century, more people died from infectious disease and poor supplies during armed conflicts than from direct force of arms, the Crimean War (1853–1856) and the battle of Solferino (1859) being striking examples.¹⁴ The misery and horror of those conflicts led to the foundation of the International Committee for Relief to the Wounded in 1863 which in 1876 became the International Committee of the Red Cross. One of its founders was Henri Dunant, a Swiss social activist, a witness of the battle of Solferino and the first recipient of the Nobel Peace Prize. The first Geneva Convention in 1864 was based on Dunant's ideas and established today's general idea of humanitarian law. The first treaty and later revisions (1899, 1906, 1907, 1929, 1949) included an explicit commitment by the contracting parties to treat wounded soldiers and civilians as well as other persons in need of protection "under all circumstances humanely, without any adverse distinction founded on race, colour, religion or faith, sex, birth or wealth, or any other similar criteria".^{15 16}

A breach of the Geneva Convention and its lifelong medical consequences

The case described here clearly constitutes a breach of the Geneva Conventions by Austrian and French doctors. Our donor had untreated wounds and multiple fractures. Due to extensive callus formation, the mechanical stability of the femur did not greatly affect his everyday life. However, he experienced recurrent infections due to the shrapnel fragments, which could have been prevented by prompt surgical removal shortly after injury. Those fragments led to septicæmia which on two occasions required treatment in an intensive care unit. It is over 75 years since beginning of World War II, and very few people from this time are still alive, reducing the possibility for young doctors to learn from individual patients like our body donor. In light of the current wars, the treatment of wounded soldiers and civilians must conform to the Declaration of Helsinki. The

presented case highlights how untreated war wounds can result in lifelong physical consequences and how, even after death, a wounded thigh and the story behind it can inform young physicians about the cruelties of war and their obligation to treat people regardless of race, religion and gender.

Learning points

- ▶ Although the severely wounded soldier survived without treatment, he experienced pain and stiffness for the rest of his life.
- ▶ A donated body can be used to teach medical students about both anatomy and an entire medical record through dissecting the body of their first patient.
- ▶ Implementation of the Geneva Convention must be demanded by governments and NGOs whenever civilians and soldiers are wounded.

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Contributors HK designed the study. JS dissected the donated body, removed the shrapnel fragments and took the case history from the donor's family. JS took pictures of the femoral bones. DS performed the CT scanning and the 3D reconstruction. HS evaluated the bone abnormalities. JS and HK wrote the manuscript. All authors critically revised and approved the final manuscript.

Competing interests None declared.

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