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Amputee stump radiology

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Abstract

In patients with stump problems, radiological examination of the stump is desirable. To get a maximum of information, the X-ray technique has to be adapted to the qualities of the stump which are different from the corresponding part of a normal limb. Special techniques permit further diagnosis.

Introduction

In many respects, radiology of the amputation stump is different in technique, indication and interpretation compared with X-ray examination of a corresponding part of the intact extremity. Thus, in standard and other X-rays made with the same criteria usually applied to a normal limb, results are often very disappointing. The purpose of this paper is to present the particular aspects of the amputation stump from the point of view of X-ray examination to obtain a maximum of diagnostic information with a minimum of exposure to radiation.

Tissue qualities

The tissues of the stump differ from the normal limb in two respects. Firstly the general diameter is usually less than normal. If not, there might be swelling caused by oedema or haematoma, both presenting rather a slight obstacle to X-rays compared to muscles and bones. Secondly, the density of the bony tissues is always less compared with the normal limb. There is normally presence of osteoporosis in some degree, usually due to old age, inactivity or both. The only exception is the bone immediately after amputation on a young, otherwise healthy patient. Finally, the radiological density of the stump considerably decreases from proximal to distal direction.

For diagnostic evaluation, the interpretation of the soft tissues in a stump is just as important as bone and joints. In addition to that, we are interested in the proximal and the distal part of the stump as well (Fig. 1). A peculiarity of stump radiology is examination with the patient wearing his prosthesis. On these pictures, the inner wall of the sockets should become visible. the densities of the prosthetic components (wood, laminated plastics, metal) are different; if possible, metal parts of the prosthesis should not overlap stump tissues important for diagnosis.

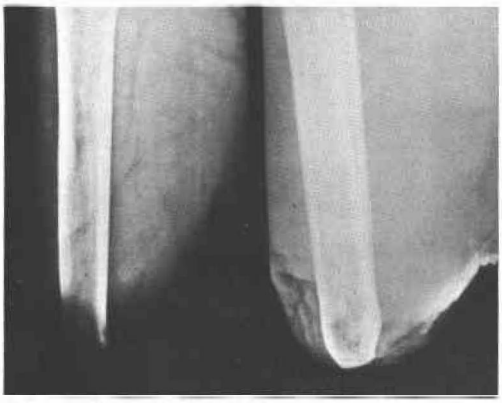

Fig. 1. Two X-rays of the same above-knee stump. Left, standard exposure for the femur, over-exposed tip of the femur. Soft tissues only partially visible. Right, low contrast technique shows the whole of the femur and also the soft tissues. The quality of the soft tissues covering the bone and a skin ulceration on the medial side become visible.

Technology

Since soft tissues, bones and even prosthetic components should be visible on the X-ray film, low contrast techniques, even in standard exposures, are necessary using a system of films and screens with low gradation, high kilovoltage and a wedge shaped aluminium filter.

If one is interested only in details, direct magnification technique with a focus less than 0·3mm controlled by television gives an optimum of sharpness and contrast. If emphasis is put on the soft tissues, we recommend the exposure with low kilovolts as used in mammography.

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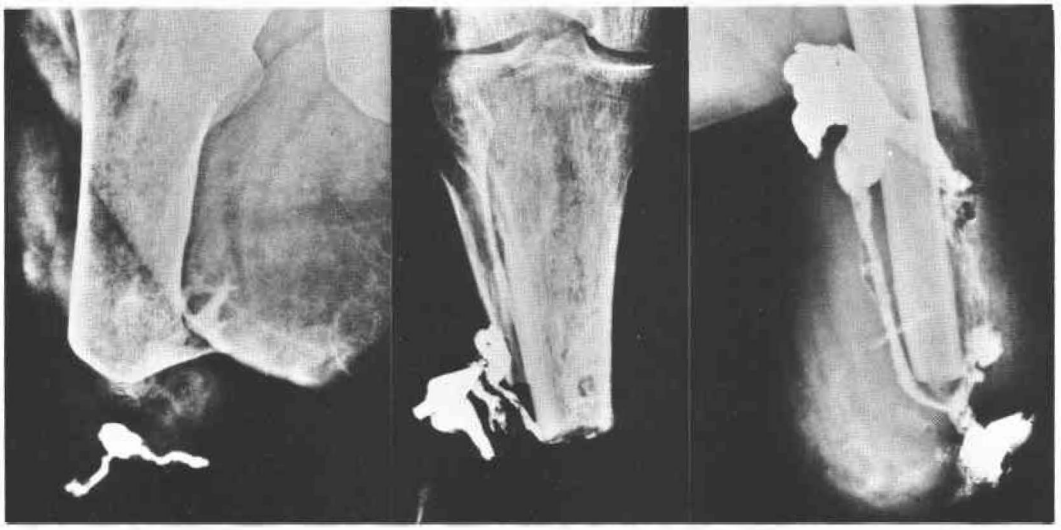

Fig. 2. Three examples of fistulography. Left, bursa on a short above-knee stump filled with contrast liquid. Middle, lateral fistula on a below-knee stump. The cone marks the orifice of the fistula which unexpectedly does not reach the tip of the fibula but the end of the tibia. Right, fistula on an above-elbow stump caused by electric burns. Fistula following the stump of the radial and ulnar nerve filling a cavity in the axilla.

For further diagnosis, special techniques such as xeroradiography (Otto & Wellauer, 1977), tomography, arteriography and fistulography might be indicated.

In arteriography, we recommend the Seldinger technique which inserts the catheter into the femoral artery of the opposite side to prevent any damage to the stump arteries which are usually already impaired.

In fistulography, we inject a water soluble contrast liquid under pressure using a cone shaped bulb instead of a needle (Fig. 2). This technique is simple and does not require other than standard X-ray equipment.

Diagnostics

At the time of amputation, most patients already present a marked osteoporosis of the cortical and cancellous bone. After amputation, all patients present some degree of osteoporosis even if they are regularly wearing a prosthesis. If the stump presents and bearing qualities and the patient is adequately fitted with a prosthesis, the degree of osteoporosis is less important. Since osteoporosis in stumps is often very marked and irregular, it might be confused with Sudeck dystrophy. This diagnosis can never be based on X-ray examination only.

Every amputation stump also shows a certain muscle atrophy. In unilateral amputation, this atrophy is exaggerated since there is regularly a compensatory hypertrophy of the opposite side. Stump atrophy is more important if the patient is unable to activate his stump or if the prosthetic fitting immobilizes more muscles than necessary. Thus, stump atrophy of the thigh in below-knee amputees is much more important in patients wearing a prosthesis with thigh cuff than in those fitted with a total contact below-knee prosthesis.

In patients amputated before the end of growth, differences in size of bones and joints are present. Depending on the epiphyseal growth lines which had to be sacrificed at amputation, the stump will also present bony over- or undergrowth. The younger the age of the patient at the time of amputation the more important these growth effects will be in some cases and might necessitate stump corrections (Baumgartner 1979).

Atrophy not only occurs in bone and muscles of the stump, but also in the arteries and veins. As for instance in leg paralysis following poliomyelitis, less cells are to be provided with blood and for the remaining tissues there is less activity and thus less energy consumption. Consequently nature automatically diminishes the diameter of the blood vessels (Fig. 3). With the patient getting old, arteriosclerotic changes and external pressures from prostheses often cause early arterial obliteration. In patients with

peripheral vascular disease, calcium deposits even in smaller arteries are visible on standard X-rays.

Fig. 3. Arteriogram of a 60 years old patient who underwent an above-knee amputation 30 years ago. The contrast liquid is injected by a femoral catheter at the opposite side. Considerable narrowing of the diameter of the left iliac arteries. Obliteration of the femoral artery. Osteoporosis of left femur and left half of the pelvis.

Radiological examination is particularly important in diagnosis of the problems which frequently occur at the stump end. The bony stump has to be carefully rounded at the operation. If the stump has two or more bones such as in below-knee or midfoot amputations the relation in length between these bones is very important. Overlength of one bone might cause troubles. Secondary changes of bone configuration at the end of the stump are very frequent and often cause problems. Growth or chronic external pressure by the prosthesis can result in the bone becoming slim like a pencil and thus perforate the soft tissues and give rise to chronic infection. Often there is a large bursa filled with calcium deposit between the soft tissues and the bone.

More often, the standard X-ray shows evidence of bony overgrowth from a minimal spur to a huge exostosis.

If there is acute or chronic osteomyelitis, erosions and sequestrations may be present. In addition to standard radiograms, fistulography and tomograms might be indicated (Figs., 2 & 4).

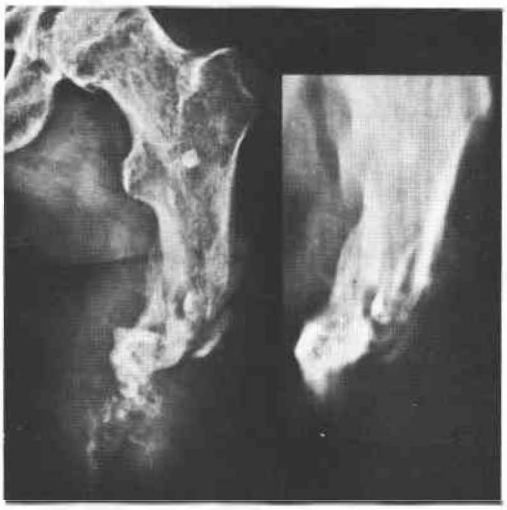

Fig. 4. Traumatic above-knee amputation with chronic osteomyelitis. The tomogram (right) provides better evidence of the size and site of sequestrations.

On standard X-rays, the contours of the stump, the position of the muscles and of the major vessels and nerves as well should be visible. We are looking for the degree of muscle atrophy and eventual retraction of muscles. On the radiogram in the sagittal plane, the stump of the major nerves might become visible, particularly if a neuroma is present (Fig. 5). Foreign bodies must be identified even if they are not as opaque as metal. Sutures in stumps more often cause granuloma and fistulae as in current orthopaedic surgery.

Trauma of the stump might cause fractures and more frequently a large haematoma at its end. In amputations for malignancies, we must look for metastases (Fig. 6). If they are not visible on standard x-rays, arteriography and scinitgraphy give further information.

Radiological examination of the stump within the prosthesis should not be a routine procedure. In difficult stump conditions, however it can be helpful in achieving a prosthetic fitting with a total contact socket. In leg amputees, radiograms with and without load provide evidence of the sometimes surprising differences in the position of the stump in the prosthesis.

Conclusions

In stump problems, radiological examination is of great help in diagnosis. To evaluate the

Fig. 5. Lateral view of an above-knee stump. The dorsal side (left) shows poor soft tissue covering. The sciatic nerve is clearly visible forming a bulb-shaped neuroma at 3cm from the tip of the femur.

evolution of a stump, a standard examination in the frontal and sagittal plane should be performed immediately after surgery to document the result of the operation and for comparison in case stump problems might occur later on. More sophisticated X-ray techniques are indicated in particular conditions where stump corrections have to be discussed. Radiological examination also can be helpful in improving prosthetic fitting of difficult stumps.

Fig. 6. Below-knee amputation due to malignant tumour of the calcaneus and talus (left). One year after amputation, the patient complained of increasing stump pains. The X-ray gives evidence of two metastases in the fibula.

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