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EXAMINATION OF THE VASCULAR DISTURBANCE OF THE FEMORAL HEAD FOLLOWING INTRACAPSULAR FRACTURE OF THE HIP

A Preliminary Report Using a New Isotope Complex

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Post-traumatic necrosis of the femoral head following a medial neck fracture has long been a challenge to investigators. Many theories have been put forward and several methods have been tried in an effort to predict the viability of the head following such a fracture. Hitherto none of the methods used have been sufficiently easy or rapid and reliable enough for clinical application.

Recently Subramanian et al. (1972) published a preliminary report using 99mTc-labelled polyphosphate as a skeletal imaging agent. The deposition of the 99mTc stannous polyphosphate in the bone is primarily a function of the bone blood flow as well as of the clearance of the isotope complex. Therefore a decreased radioactivity would be anticipated in the caput region if vascularization is impaired, e.g. after certain fractures of the femoral neck.

The purpose of the present investigation was to examine whether this new isotope complex may be used to study the vascular supply of the femoral head.

METHODS

99mTc stannous polyphosphate was supplied by Nyegaard & Co A/S, Oslo, or obtained from New England Nuclear Corporation (Code NRP-158). The 99Mo/99mTc generators (30–50 mCi) were obtained from Institutt for Atomenergi, Kjeller, Norway (Code TeCS). The isotope agent was prepared according to the instructions (Code NRP-158). A dose of 8–10 mCi was given intravenously immediately after preparation of the agent. Photoscintigraphy was performed, 3–4 hours after

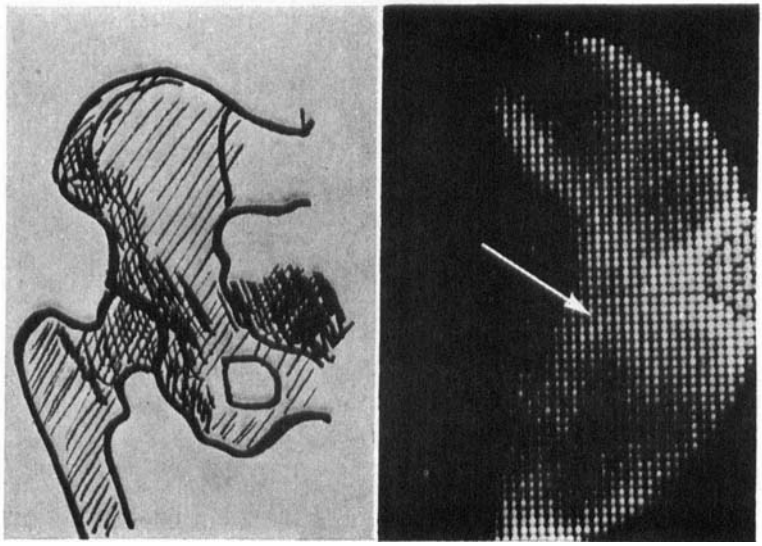

Figure 1. Drawing of a normal pelvis and hip. Scattered areas show increased radioactivity over the bony parts. To the right a photoscintigram of a normal non-traumatized right hip.

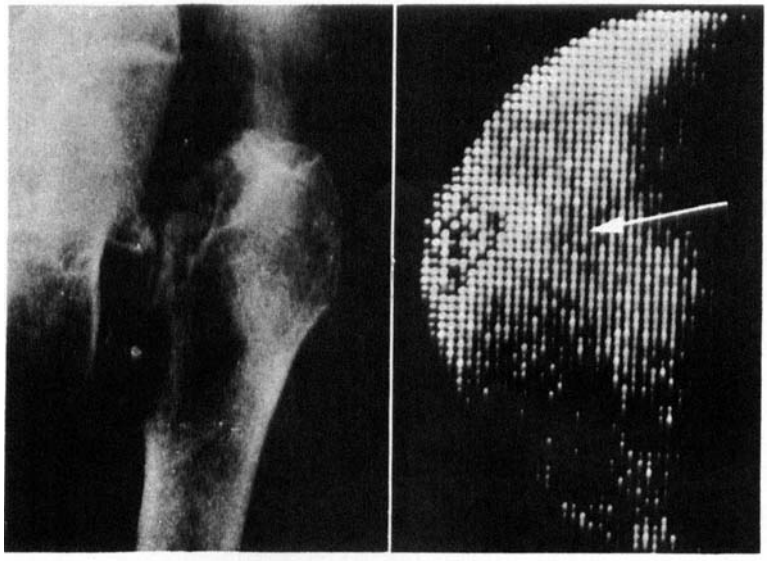

Figure 2. Intracapsular neck fracture with moderate dislocation. The scintigram shows normal and uniform radioactivity over the femoral head region.

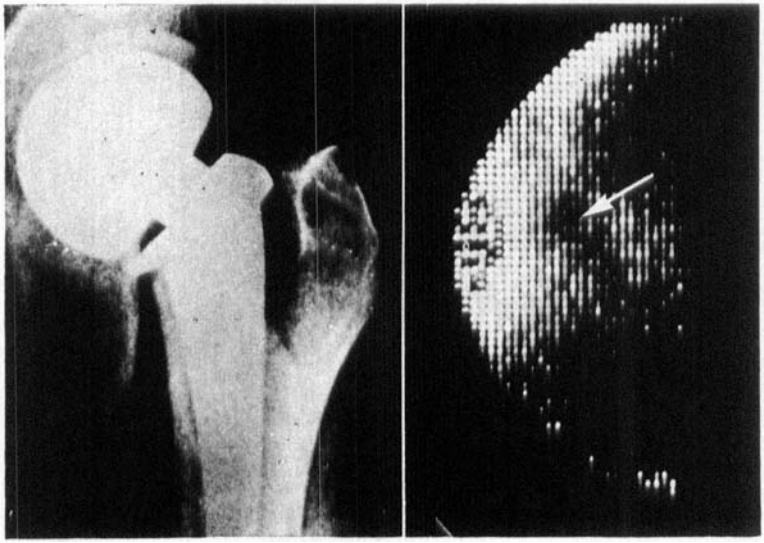

Figure 3. The same patient as shown in Figure 2 after application of a Christiansen endoprosthesis. Reduced radioactivity over the head of the prosthesis.

administration of the dose, using a gamma camera (Nuclear Chicago, Pho-Gamma III) fitted with a parallel hole collimator (4000 holes). The urinary bladder was emptied immediately before the scintigraphy.

MATERIAL

16 patients were investigated; 15 had fractures, 14 of them having fractures through the upper end of the femur. Most were females over 70 years. The isotope examination was in most cases performed before reduction and nailing. Both the fractured and the non-traumatized hip were examined in every patient.

The administration of the isotope and the scintigraphy were entirely discomfort-free from the point of view of the patient. The scintigraphy of both hips was run for approximately 20 minutes and the result printed as a photographic picture.

RESULTS

Some of the findings are shown and described in Figures 1–7.

Figure 7 shows the result in a one-year-old medial fracture of the left hip, which had been nailed, primarily, in a fairly good position. The fracture failed to heal, the nail became loose and was therefore removed. The X-ray fifteen months after the trauma shows necrosis of the caput and a pseudarthrosis in the collum femoris. The isotope

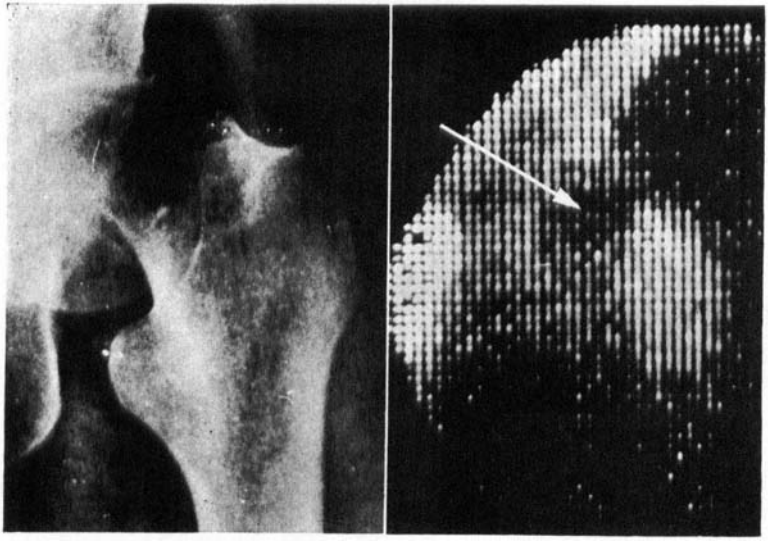

Figure 4. A medial neck fracture, heavily dislocated with reduced radioactivity over the femoral head region.

scintigraphy indicates an increased radioactivity in a zone around the caput femoris, but in the middle of this region the radioactivity seems to be reduced.

Several other intracapsular hip fractures have been examined. Some show reduced radioactivity, others have normal radioactivity over the femoral head region. Lateral neck and inter- or pertrochanteric fractures all showed normal radioactivity over the region of the femoral head on the photoscintigrams. Trauma to the hip without fracture also revealed normal photoscintigrams. Isotope examination of the non-traumatized hip showed in all cases uniform and normal radioactivity over the caput region.

DISCUSSION

Technetium-99m is a short-lived (half-life 6 h), low energy (140keV) isotope without primary beta emission. The radiation to the total body with the standard diagnostic test compares favourably with that of other nuclides used for bone scintigraphy, e.g. ^{18}F and several strontium nuclides. The agent can be easily prepared locally, and the procedure is without discomfort to the patient. The rapid and high rate

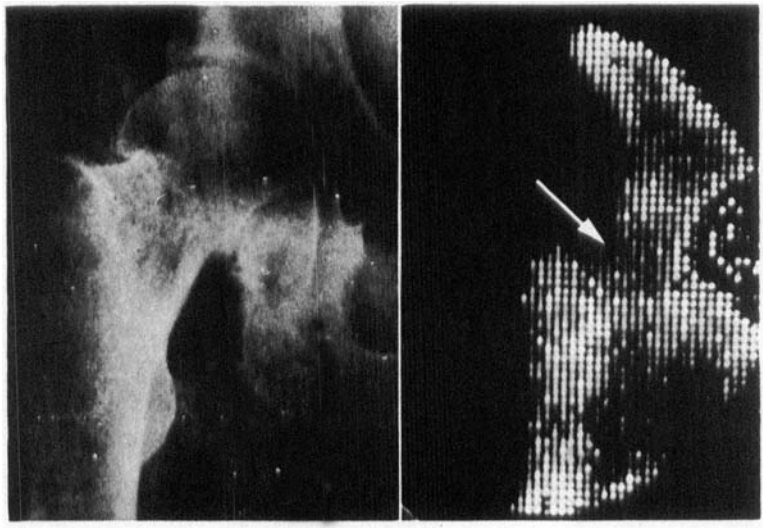

Figure 5. An impacted neck fracture with reduced radioactivity over the femoral head region.

of clearance from the blood and deposition in the bone make it very useful for this particular purpose.

Almost all of the isotope is cleared from the body by the urine. Disturbing radioactivity will after a while be collected in the bladder as one can see in several of the photoscintigrams presented. It is therefore important to empty the bladder immediately before the scintigraphy is performed.

If the patients moved about a great deal during the 4 hours which elapsed between injection of the isotope and the scintigraphy, photograms were obtained in which the bony parts were barely visible. This might be due to enhanced clearing of the isotope from the bony parts with the increased regional blood flow during exercise.

It has been shown previously, by various methods, that the development of capital necrosis is caused by interrupted vascular supply to the femoral head. It seems obvious that the vascular supply is more often disturbed in medial and heavily dislocated fractures because of the vascular pattern of the femoral head and neck. Repositioning tends to improve the circulation, but often the femoral head seems to remain deprived of its vascular supply in spite of correct repositioning and nailing.

Capital necrosis after neck fractures may develop in as many as

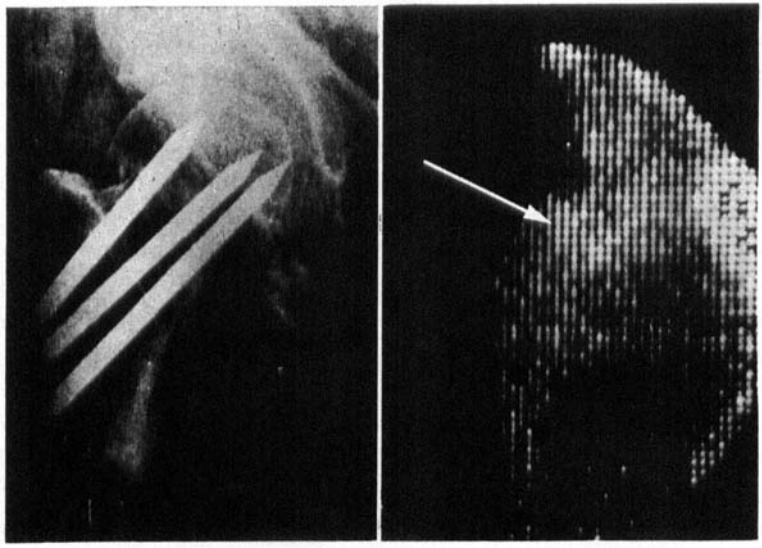

Figure 6. A nailed impacted intracapsular fracture of the femoral neck with increased radioactivity 10 weeks postoperatively.

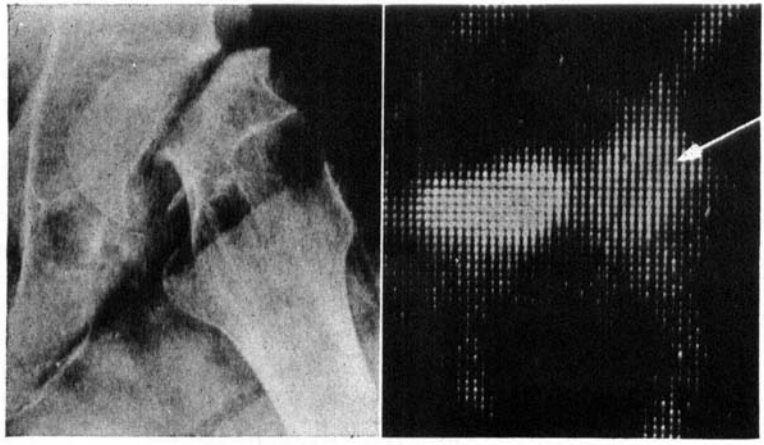

Figure 7. One-year-old fracture of the left femoral neck, with necrosis of the femoral head and pseudarthrosis. Reduced radioactivity centrally in the femoral head region.

30–40 per cent of the patients. The necrosis which develops over several years may be of great discomfort to the patient, and the treatment of these patients often necessitates several, long-lasting hospital stays. It would therefore be a great advantage if it were possible to

predict which of the hip fractures would lead to necrosis. It would be a considerable improvement if these patients could initially be given the treatment which is ultimately necessary e.g. fitting with an endoprosthesis.

The 99mTc-polyphosphate complex has the advantage that its localization in the bony parts seems to depend mainly on the vascularization. The method described using this isotope and a gamma camera gives a visualized answer in about 20 minutes. It is our impression that the photoscintigrams give a picture of the nutrition of the femoral head which corresponds well to the degree of vascular disturbance after a fracture.

Whether or not this method permits prediction of a later development of an avascular necrosis of the femoral head is still an unanswered question. To solve this problem it is necessary to follow a series of patients with isotope scintigrams, X-rays and clinical examinations for at least 2 or 3 years. However, the isotope technique presented seems to be a rapid, easy and promising method worthy of further investigation.

SUMMARY

A preliminary report is given of the findings with 99mTc-labelled polyphosphate as an isotope method to determine the vascular supply of the caput femoris following fractures of the femoral neck.

It seems to be a rapid and easy method for visualizing the bony parts. Whether or not reduced radioactivity of the femoral head region indicates later development of avascular necrosis of the caput is a question which still remains to be answered. However, the method seems to be promising.

REFERENCES

Subramanian, G., McAfee, J. G., Bell, E. G., Blair, R. J., O'Mara, R. E. & Ralston, P. H. (1972) 99mTc-labeled polyphosphate as a skeletal imaging agent. *Radiology* **102**, 701–704.

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