3. Materials and methods

Between January 2000 and May 2004, 140 horses of different sexes, ages and breeds admitted to the equine clinic at the Free University, Berlin and underwent fluoroscopic guided phalangeal joints surgery.

The animals were divided into the following groups:

Group I: Animals subjected to surgical removal of isolated shadows (radiopaque bodies).

According to the affected joint the animals were divided into the following subgroups:

A- Isolated shadows within the distal interphalangeal (hoof) joint in the region of the extensor process of the third phalanx (28 horses).

B- Isolated shadows within the dorsal aspect of the proximal interphalangeal joint (3 horses)

C- Isolated shadows within the dorsal and the palmar/plantar aspect of the metacarpo/ metatarsophalangeal joint (76 horses).

Group II: Animals subjected to surgical management of subchondral cystic-like lesions.

According to the affected bone, the animals were divided into the following subgroups:

A- Subchondral cystic- like lesions within the distal condyle of the third metacarpus /metatarsus (2 horses).

B- Subchondral cystic- like lesions within the sesamoides (1 horse).

C- Subchondral cystic- like lesions within the distal condyle of the proximal (first) phalanx (1 horse).

D- Subchondral cystic- like lesions within the proximal end of the middle (second) phalanx (1 horse).

E- Subchondral cystic- like lesions within the distal end of the middle (second) phalanx (3 horses).

Group III: Animals subjected to surgical management (internal fixation) of intra-articular fractures.

According to the affected bone, the animals were divided into the following subgroups.

A- Internal fixation of the base of the extensor process of the third phalanx (1 horse).

B- Internal fixation of noncomminuted fractures of the first phalanx (19 horses).

C- Internal fixation of mid-body fractures of the proximal sesamoid bone (1 horse).

D- Internal fixation of the condylar fractures of the third metacarpal/metatarsal bone (4 horses).

For each case, subject details (age, breed and sex) and history were recorded and a complete lameness examination performed. Radiographs of affected joints, based on the lameness examination were taken. Different radiographic projections of each affected joint were used. Fife radiographic projections of each affected metacarpo/metatarsophalangeal joint were obtained, namely the lateromedial, flexed lateromedial, dorsolateral-palmaro/plantaromedial oblique, dorsomedial-palmaro/plantarolateral oblique and the dorsopalmar views. Four radiographic views of each affected proximal interphalangeal joint were obtained, including lateromedial, dorsopalmar/plantar, dosomedial-palmaro/pantarolateral oblique and dorsolateral palmaro/plantaromedial oblique. While the radiographic examination of the distal interphalangeal joint consisted of 2 views: lateromedial and dorsopalmar/plantar.

In some cases real time ultrasonography, using a 7.5 MHz linear probe was performed to determine the size of the isolated shadow. Also Computer Tomography was performed in one case suffered from subchondral bone cyst of the proximal sesamoid bone to confirm the diagnosis.

Synovial fluid analysis, comprising total nucleated cells and erythrocyte counts, differential white blood cell count and total protein was performed on synovial fluid samples collected intra-operatively from all operated joints.

A commercially available mobile fluoroscopy unite or device which also namely C-arm, fluoroscope or image intensifier (Philips BV 212 Release 4)* was used in this study **(Fig. 1)**. The BV 212 comprises:

- A mobile C-arm stand with X-ray generator, medical imaging chain and control panel.
- A mobile viewing station with two monitors, digital image processor and memory, and control panel. Provision is made for the installation of an optional videotape recorder and hard copy unit.

Mechanical joints allow every orientation required for image acquisition during an operation. For obtaining an image a footswitch is pressed and the emitted X-rays are projected through the anatomy onto the image intensifier input plane. The image intensifier unit is a vacuum tube with a phosphor and a metal layer on its slightly cambered input plane. The phosphor layer at first converts the X-rays into visible light of very low intensity that however has sufficient energy to generate free electrons on the metal layer. A strong electric field accelerates these electrons through a common focal point located within the vacuum tube towards an output phosphor layer where they converted into visible light. Since the electrons have gained energy through acceleration the original X-ray image that has been projected onto the input plane is reproduced on the output phosphor in a multiplied intensity. A video camera directed towards this output phosphor captures the image. The intensity detected by the video camera controls the voltage and the current provided to the X-ray emitter and thus the X-ray intensity via a feedback loop. The resulting video signal from the camera is digitally buffered in memory and displayed on a black- and –white monitor. The BV 212 fluoroscope provides a choice of fluoroscopy modes to suit the application. Digital on-line image processing is applied in all modes. This system has a trimode image intensifier with a field of view selectable at 31 cm (normal image), 23 cm (first magnified image) or 17 cm (second or most magnified image). The dose rate was controlled automatically in each operation.

Images can be acquired in either a continuous or single-shot (pulsed) mode. In pulsed mode the X-ray emitter is run for a short period (< 1 second) while the buffer memory holds the acquired image for a static display on the monitor. Continuous mode enables visualisation of the motion in the surgical scene by constant or strobed X-ray exposure and is automatically selected when the system is switched on. Normal continuous mode was used in all the procedures to align the C-arm into the view point required and to monitor motions of surgical instruments during surgical manipulations.

*Philips BV 212 Release 4: Philips medical systems, Nederland BV

3.1. Surgical interference:

***3.1.1. Preoperative preparation**:*

After localisation of the lesions, the patients were subjected to a preoperative physical examination, including haematological analysis, faecal analysis and examination of the respiratory and circulatory systems. The horses were fasted for 12 hours prior to general anaesthesia. After that they were sedated with romifidin (sedivet)* (0, 06-0, 08 mg/kg body weight) intravenously (iv) and levomethadon hydrochloride (L-Polamivet) ** (0.075 mg/kg body weight) iv. General anaesthesia was induced with 15% guaifensin (Myolaxin) *** (80 mg /kg body weight) administered iv within 2 minutes followed by a combination of diazepam (Diazepam-ratiopharm) † (0, 04 mg /kg body weight) and ketamin hydrochloride (Ketavet) †† (2.2 mg/kg body weight) given as an iv bolus. After induction of anaesthesia the horses were positioned in right or left lateral recumbency, depending on the anatomical position of the lesion (the affected limb positioned uppermost when the lesion lateral located and vice versa). After that anaesthesia was maintained with either inhalation gaseous anaesthesia using isofluoran (Iso Flo) ‡ 2.5% vaporized in oxygen 2 L/minute using a semi-closed circle system or iv triple drip mixture of Myolaxin (500ml), Ketavet (30ml) and Sedivet (3ml) which administrated at a rate of approximately 4-6 ml per minute / 500 kg body weight (first 15 minutes about 3 drops per second after that about 1-2 drop/ second) in addition to oxygen insufflations (15 L /minute).

The operated limbs were relied and fixed upon a stand to allow free movement for the C-arm in all directions. In cases of isolated shadows within the region of the extensor process of the 3rd phalanx and the dorsal aspect of the fetlock joint, the foot was extended with a clean rope which is fixed at the operating table edge **(Fig. 2)**. By extending the foot, the extensor process of the third phalanx and the dorso proximal aspect of P1 are readily accessible.

Using a clean # 40 blade the hairs were clipped in the surrounding area of the operated sites. Then the surgical sites were washed with warm water and soft soap, followed by disinfection with alcohol 70% and Povidone- iodine (Braunol) º.

* Sedivet: Boehringer Ingelheim Vetmedica GmbH, 55216 Ingelheim/Rhein,Germany.

**L-Polamivet: Intervet GmbH, Postfach 1130, D-85701 Unterschleißheim,Germany.

*** Myolaxin: Chassot GmbH, 88212 Ravensburg, Germany.

† Diazepam-ratiopharm: Ratiopharm GmbH, Graf-Arco-Str. 3, 89079 Ulm, Germany.

††Ketavet: Pharmacia GmbH, Am Wolfsmantel 46, 91058 Erlangen, Germany.

‡ Iso Flo: Abbott Laboratories Ltd, ME 11 5EL, GB-QUEENBOROUGH KENT.U.S.A.

ºBraunol: B. Braun Melsungen AG, D-34209 Melsungen, Germany

Before the disinfection, the mid-line at the dorsal aspect of the foot proximal to the coronary band was demarcated with a permanent marker **(Fig. 3)**. By detecting the mid line, the extensor process is readily accessible, which located exactly at the mid-line.

All personnel in the operating room wore standard radioprotective aprons on the anterior aspect of the trunk with a 0.3 mm lead equivalence and every one has a portable dosimeter (Film Dosimeter)* which have an established sensitivity range of 0.1 mSv to 1 Sv. Each surgeon wore an additional ring dosimeter. At monthly intervals, the radiation doses were measured for every one in mSv and recorded. The estimated irradiation doses were compared with the legal limits permitted in Germany.

The mobile C-arm device was switched on and all the data considering the patient was entered. After that the device was positioned in the position, which allows free movement in all directions required for image acquisition during the operation and allow the operator to work without any interference with the surgical or the viewing fields. A preoperative image was obtained **(Fig. 4)**. Keeping the image intensifier or imaging assembly as close to the patient as possible minimizes the overall distance between the focal spot and image receptor.

The surgical sites were draped with sterile surgical towels fixed in place with towel clips. In addition the C-arm and spring bow, X-ray tank and image intensifier were covered with sterile covers (reusable sterilisable cover set).

3.1.2. *Operative technique:*

3.1.2.1 Fluoroscopic guided extirpation of isolated shadows within the joints:

3.1.2.1.1 *Distal interphalangeal joint.*

Isolated shadows in the area of the extensor process were firstly localised under fluoroscopic control with the aid of a hypodermic needle **(Fig 5)** to determine the exact site of instrument portal. After that the joint punctured from the dorsal aspect 1 to 1.5 cm proximal to the coronary band and 1.5 cm paramedial (abaxial) to the extensor process with a 1.5 inch 20-guage surgical needle and a synovial sample was taken for examination. A three-way stopcock was attached to the needle and the joint was distended with about 20 ml of sterile

* Film Dosimeter: AGFA-GEVAERT N.V. B-2640, Horstel. Belgium.

isotonic polyionic Ringer's solution (Ringer B. Braun) * through an automatic arthro pump** till bulging of the skin over the joint was seen **(Fig. 6)**. An about 1 cm stab skin incision was placed 0.5 to 1cm proximal to the coronary band through the skin, common digital extensor tendon and joint capsule (through the anterior mid-line) using a 15 # scalpel and under fluoroscopic control the isolated shadow was palpated with an arthroscopic probe to determine if it was free movable or fixed. Free isolated shadows were grasped, rotated and removed easily by using a suitable Ferris-Smith intervertebral cup rongeur***or a suitable closed curette **(Fig. 7)**. Adhered (fixed) or metaplastic shadows were firstly dissected and pried from its tendinous attachments with a curved round elevator, osteotom or sharply dissected with a scalpel. In some cases with large isolated shadows, the skin incisions were enlarged to accommodate the size of the shadow and the isolated shadows were removed by using a Crocodile forceps. After fragment extirpation the joint was flushed with a sterile Ringer's solution (1-2 L) through an egress cannula (4.5 mm) which was placed in the instrument portal to remove both loose soft tissue and remaining small fragments. Finally a postoperative control image was taken to ensure that the isolated shadow was removed completely **(Fig. 8)**.

The skin incision was closed with 1 or 2 interrupted vertical mattress sutures **(Fig. 9)** using 3-0 poly-glactin 910 (Vicryl) [§] and the sutures covered with Povidone -iodine ointment (VET-SEPT) [‡]and elastic adhesive bandage (Elastoplast) [†]bandage was applied.

3.1.2.1.2 *Proximal interphalangal joint.*

Isolated shadows in the dorsal aspect of the joint were firstly localised under fluoroscopic control with the aid of a hypodermic needle to determine the exact site of instrument portal.

A 2.5 cm 18- gauge needle was placed into the dorsal pouch of the proximal interphalangeal joint and a synovial sample was collected for examination. The joint was distended by the same manner described previously in the hoof joint with about 15-20 ml sterile isotonic polyionic Ringer's solution. Distension of the joint defined the limits of the dorsal joint pouch. After distension of the joint, a 1 cm stab incision was made just lateral to the common

*Ringer B. Braun: B.Braun Medical AG, CH-6020 Emmenbrücke, Germany.
**Arthro pump: Karl Storz GmbH & Co, Mittelstraße 8, post fach 230 D-7200, Tuttingen, Germany.
*** Rongeur: Dr. Fritz Molketestraße 41, 18532, Tuttingen, Germany.

[§]Vicryl: Ethicon GmbH &CO. KG. Robert-Koch-Straße 1.D-22851, Norderstedt, Germany
[‡]VET-SEPT: A. Albrecht, Vet-med. Erzeugnisse, 88326, Aulendorf.

[†]Elasoplast: BSN medical S.A.S., F-72320 Vibraye, France.

digital extensor tendon through the skin and joint capsule over the dorsal aspect of the joint with a # 15 scalpel blade and under fluoroscopic control the isolated shadow was palpated with an arthroscopic probe or hypodermic needle to determine the nature of its attachment to the parent bone (free movable or fixed). Totally free isolated shadows were grasped and removed easily by using a suitable Ferris-Smith intervertebral cup rongeur or biopsy cutting forceps. Adhered (fixed) shadows were firstly dissected and pried from its osseous attachments with a curved round elevator **(Fig. 10)**, osteotom or sharply dissected with a scalpel. In some cases with large isolated shadows, the skin incisions were enlarged to accommodate the size of the shadow and they were grasped and removed by using a Crocodile forceps. After fragment extirpation the joint was flushed with a sterile Ringer's solution (1-2 L) through an egress cannula (4.5 mm) which was placed in the instrument portal to remove both loose soft tissue and remaining small fragments. A postoperative control image was taken to ensure that the isolated shadow was removed completely **(Fig. 11)**.

The skin incision was closed with 1 or 2 interrupted vertical mattress sutures using 3-0 poly-glactin 910 (Vicryl) and the sutures covered with Povidone -iodine ointment (VET-SEPT) and elastoplast bandage was applied.

3.1.2.1.3. ***Metacarpo/metatarsophalangeal joint.***

Isolated shadows either in the dorsal or the palmar/plantar aspect of the joint were firstly localised under fluoroscopic control with the aid of a hypodermic needle to determine the exact site of instrument portal **(Figs. 12 &13)**. A 2.5 cm 18- gauge needle was placed either into the dorsal pouch of the joint or the palmar/plantar pouch (between the base of the sesamoid bone and the eminence of P1) and a synovial sample was taken for laboratory analysis **(Fig. 14)**. The joint was distended by the same manner described previously in the hoof joint with about 30 ml sterile Ringer's solutions **(Fig. 15)**. Adequate distension can be recognized easily with bulging of the joint capsule on either side of the CDET. The out pouching of the distended joint is more prominent lateral to the CDET than it is medial to it. Under fluoroscopic guide a 5 to 8 mm stab incision was made in the centre of the bulge over the isolated shadow (just lateral or medial to the common digital extensor tendon in case of dorsal isolated shadows) through the skin and joint capsule with a # 15 scalpel blade **(Figs. 16 &17)** and under fluoroscopic control the isolated shadow was palpated with an arthroscopic probe or hypodermic needle to determine the nature of its attachment to the parent bone (free

movable or fixed). The surgical manipulations to remove the fragment were dependent upon the result of probing. Totally free isolated shadows were grasped and removed easily by using a suitable Ferris-Smith intervertebral cup rongeur or biopsy cutting forceps **(Figs. 18, 19 , 20)**, meanwhile all isolated shadows with any significant attachment, a curved round elevator or osteotome was used to pry the isolated shadows off the bone **(Fig. 21)**. The elevator was also used to break down capsular attachments to the dorsal aspect of the fragment. In some cases with large isolated shadows, the skin incisions were enlarged to accommodate the size of the shadow and they were grasped and removed by using a Crocodile forceps. After fragment extirpation the joint was flushed with a sterile Ringer's solution (1-2 L) through an egress cannula (4.5 mm) which was placed in the instrument portal to remove both loose soft tissue and remaining small fragments **(Fig. 22)**. Complete removal of the fragment was verified through a final intra-operative fluoroscopic image.

The skin incision was closed with 1 or 2 interrupted vertical mattress sutures **(Fig. 23)** using 3-0 poly- glactin 910 (Vicryl). The surures covered with Povidone-iodine ointment (VET-SEPT).

In some cases with large fragments in which the initial incision was enlarged the articular capsule was closed firstly with interrupted sutures using the same suture material and a heavy half -limb bandage was applied.

In some cases A combination of arthroscopy and fluoroscopy techniques were used **(Fig. 24)** to improve the localisation of the isolated shadows and to promote a good prognosis. An additional arthroscopic portal was located on the dorsal or the palmar/planter pouch of the joint and an 8-mm skin incision was made. The arthroscopic sleeve and sharp trocar then were inserted through the joint capsule, initially perpendicular to the skin and then parallel to the joint surface to avoid damage to the articular cartilage. When the arthroscopic sleeve was inserted so that its tip touched the joint capsule, the trocar was removed and the arthroscop was inserted and arthroscopic examination began. A 4- mm-diameter arthroscope, with a 25° forward oblique viewing angle and the accompanying cannula, sharp trocar and blunt obturator were used for arthroscopic examination.

3.1.2.2 Fluoroscopic guided lag screw fixation for treatment of intra-articular fractures.

Firstly the fracture line under fluoroscopic control with at least 2 images in 2 different projections was determined **(Fig. 25)**. After that the correct position of the first lag screw was determined in the correct distance from the joint surface. Under intra-operative fluoroscopic visualisation or monitoring a stab skin incision with # 15 scalpel blade was made in the appropriate position on the bone as dictated by the fracture configuration and a 4.5-mm diameter bit was used to drill a pilot hole in the proximal fragment using ASIF motorised drill *. A 3.2- mm diameter drill guide was inserted into the drill hole, and a 3.2-mm diameter hole drilled in the distal (far) fragment cortex using a 3.2-mm drill bit **(Fig. 26)**. This step was made under fluoroscopic visualisation to ensure that the drill hole does not extend the opposite cortex. Constant cleaning of the drill bit was essential during the drilling.

Using a depth gauge, the length of the ASIF cortical or cancellous screws ** to be inserted were determined **(Fig. 27)**. The distal 3.2-mm hole was then tapped with a 4.5-mm tap to accept an ASIF screw **(Fig. 28)**.The appropriate length first screw (4.5-mm) was then inserted and fluoroscopic images were taken to check on its position and to ensure that the threaded tip of the screw was not protruding into the opposite collateral ligaments. Once this screw was placed, partial tightening was made using the ASIF hexagonal-head screw driver **(Fig. 29)** and subsequent screws were inserted as dictated by the configuration of the fracture. Tightening was completed and Compression of the two fragments should occur as the screws were tightened **(Fig. 30)**. The joint was punctured with a sterile needle and a synovial fluid sample was taken for evaluation. The skin incisions were closed with interrupted vertical mattress suture using 3-0 Vicryl. A sterile dressing covered with VET-SEPT ointment was placed over the incision. A fibreglass cast (Delta-Lite) *** was then applied, casting the entire foot and extending to the proximal aspect of metacarpus or metatarsus to protect the fracture fixation during recovery from anaesthesia.

In some cases with concurrent hemarthrosis due to the fracture an additional joint lavage was performed with sterile Ringer's solution.

* De Soutter Medical Ltd, River park, Billet Lane, Berkhamsted, Hertfordsheir Hp4 1HL.UK.
** ASIF screws: Synthes GmbH, Am Bergbaumuseaum 31, 44791, Bochum. Germany.
*** Delta-Lite: Johnson & Johnson Medical Ltd., London Road, Bracknell, RG 12 2AT, UK.

3.1.2.3 Fluoroscopic guided surgical management of subchondral cystic lesions.

Under fluoroscopic monitoring subchondral cystic lesions or osseous cyst-like lesions connected with the phalangeal joints were surgically treated through drilling (surgical enucleation) of the cyst using a transcutaneous extra-articular approach and packing or installation the defects with autogenous cancellous bone with the use of special modified Jamshidi-needle*. The equine modified Jamshidi-needle is accommodated to be suitable in use with the osteosynthesis instruments. The needle consists of an outer cannula (cylinder) with a handle which has a separate cover (cap) and an inner needle stylet. The cannula has an outer diameter 4.2-mm, which can pass through a 4.5-mm tap sleeve or drill guide to reach the cyst. The needle shaft is 50 mm long which is long enough to reach the cyst depth.

The complete Jamshidi set for equine consist of **(Fig. 31)**:

- Drill
- 4.5-mm tap sleeve
- 4.5-mm drill bit
- hammer
- Modified Jamshidi-needle (cannula,cover and stylet)

The subchondral cyst was localised **(Fig. 32)** and an extra-articular portal for the drill was selected under fluoroscopic guidance, then a stab incision about 5-mm in size with # 15 scalpel blade was made in the appropriate position on the bone as dictated by the cyst location. A 4.5-mm diameter bit was used to drill the cyst **(Fig. 33)**. At the same time the cancellous bone graft was harvested from the opposite tuber coxae by another separate surgical team. About 5-mm stab incision was made over the tuber coxae and down through the fat pad and subcutaneous tissue to the periosteum of the bone. After that a 4.5 mm drill hole was made through the tuber coxae cortex and the Jamshidi cannula with its seal cap was inserted through the incision and directly advanced towards the underlying bone. After reaching the osseous tissue the cannula was stricken with a hammer through the cortex to collect the cancellous bone cylinder **(Fig. 34)**. The needle was hold with palm and index finger and pulled out while rotating in an attenuating clockwise and counters clockwise movement.

*Manufactured by Schnorrrenberg Chirurgemechanik GmbH. Hauptstr.62, 16352 Schönwalde,Buch.Germany.

The cannula seal cover was replaced with the stylet and was given for another surgical team.

For collection of more cancellous bone cylinders, the needle was stricken in a fan-shaped manner in different directions. The cannula filled with cancellous bone was inserted through the drill sleeve or the drill hole till reach the depth of the cyst and after that the stylet forced down with a hand or with the aid of special forceps to implant the cancellous bone cylinder toward the cyst cavity under fluoroscopic visualisation **(Fig. 35 &36)**. More than one cylinder was needed to fill the cyst cavity according to the size of the defect.

The wound incisions over the joints were closed with a one or two interrupted vertical mattress suture using 3-0 Vicryl. A sterile non adherent dressing covered with VET-SEPT ointment was placed over the incision and a sterile heavy half-limb bandage was applied. The wound incisions over the tuber coxae were closed either with interrupted vertical mattress using a 3-0 Vicryl or with skin staples using skin stapling device and covered with VET-SEPT ointment and a stent bandage or non-adherent dressing pad (Fixomull) **

** Fixomull: BSN medical GmbH &co.KG, D-2277, Hamburg, Germany

3.1.3. *Postoperative care*

3.1.3.1. In case of isolated shadows extirpation.

The bandages were carefully monitored every day and changed until the skin suture removed 10-14 days after surgery.

Postoperative instructions routinely included 2- 4 weeks of box stall confinement with an increasing regimen of daily hand walking for 30-60 minutes beginning 2 weeks after surgery for 6-8 weeks. Riding and more extensive training can start 8 weeks after surgery.

There was no specific recommendation regarding antibiotic, anti-inflammatory or intra-articular medication after surgery. Only in some cases which has accompanied with arthritic changes, hyaluronan was administrated intra-articularly postoperatively.

Postoperative radiographs were obtained to ensure removal of all fragments was mandatory.

3.1.3.2. In case of management of intra-articular fractures.

Casts were removed between one or two weeks after surgery in all horses, depending on the individual case and how the horse tolerated the cast. The limb was maintained in Robert Jonnes bandage for another 4-6 weeks. The sutures were removed 12-14 days after surgery.

A wood wedge or Dallmer hoof shoe with a special wedge was clanged to the hoof. Non-steroidal anti-inflammatory drug was used judiciously during the postoperative period in some cases.

Postoperative management typically consisted of stall confinement for 2 months and controlled exercise (hand walking) for 15-30 minutes initiated 6-8 weeks after surgery.

Free turnout or exercise was not recommended for 6 months and calcium food supplement was recommended.

Postoperative radiographs were made to help monitor healing as well as the degree of DJD.

3.1.3.3. In case of management of subchondral bone cysts.

Postoperative exercise recommendations consisted of 4-8 weeks of stall rest with daily hand walking (up to 30 min/day) and small paddock or pasture turnout by 60-90 days.

Hyaluronan administrated at 4 weeks intervals following surgery (2-3 injections). Based upon clinical and/or radiographic examination performed 3-4 months after surgery, commencement or resumption of athletic training was permitted, or further pasture turnout was recommended.

Figure 1: A mobile C-arm unit with belonging display.

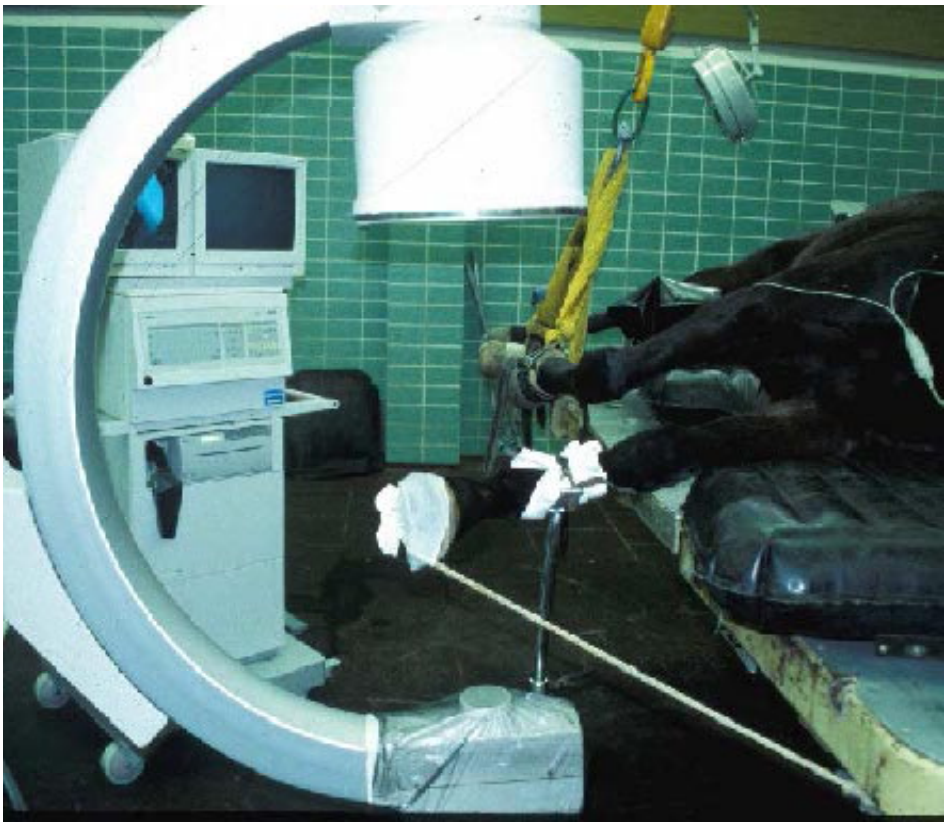

Figure 2: Showing the foot extended with a clean rope which is fixed at operating table edge.

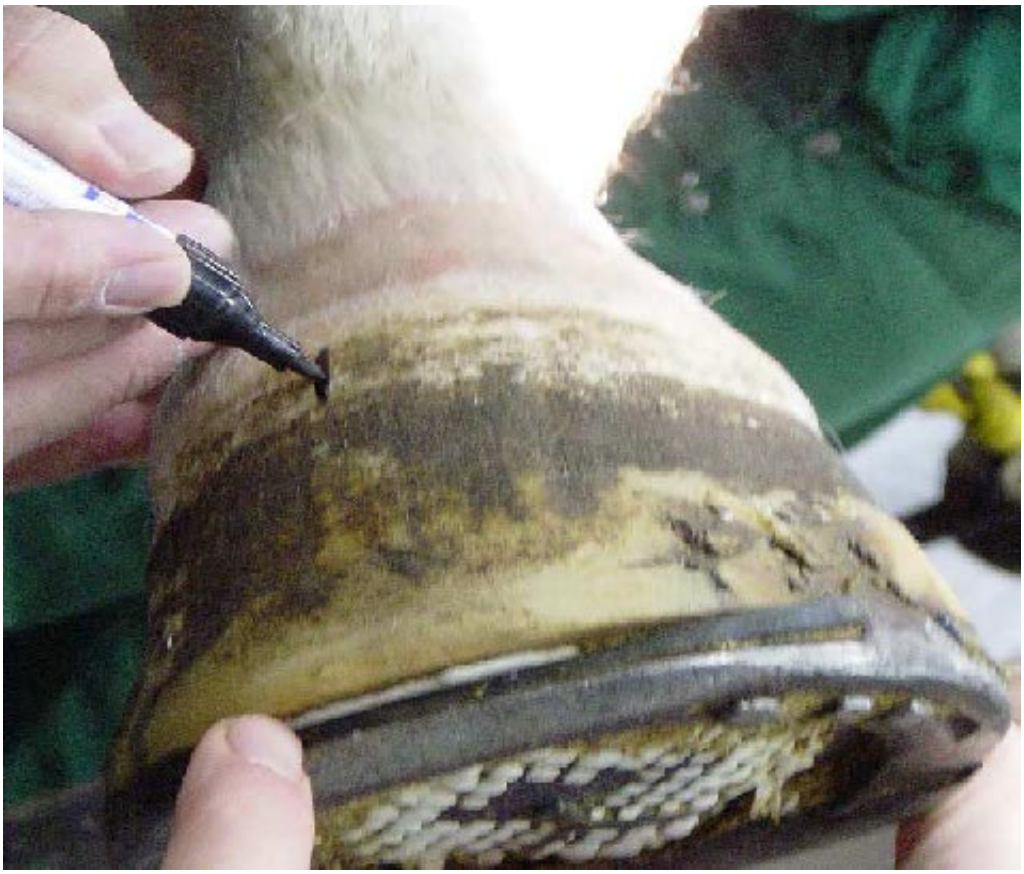

Figure 3: Showing demarcation of the mid-line at the dorsal aspect of the foot proximal to the coronary band.

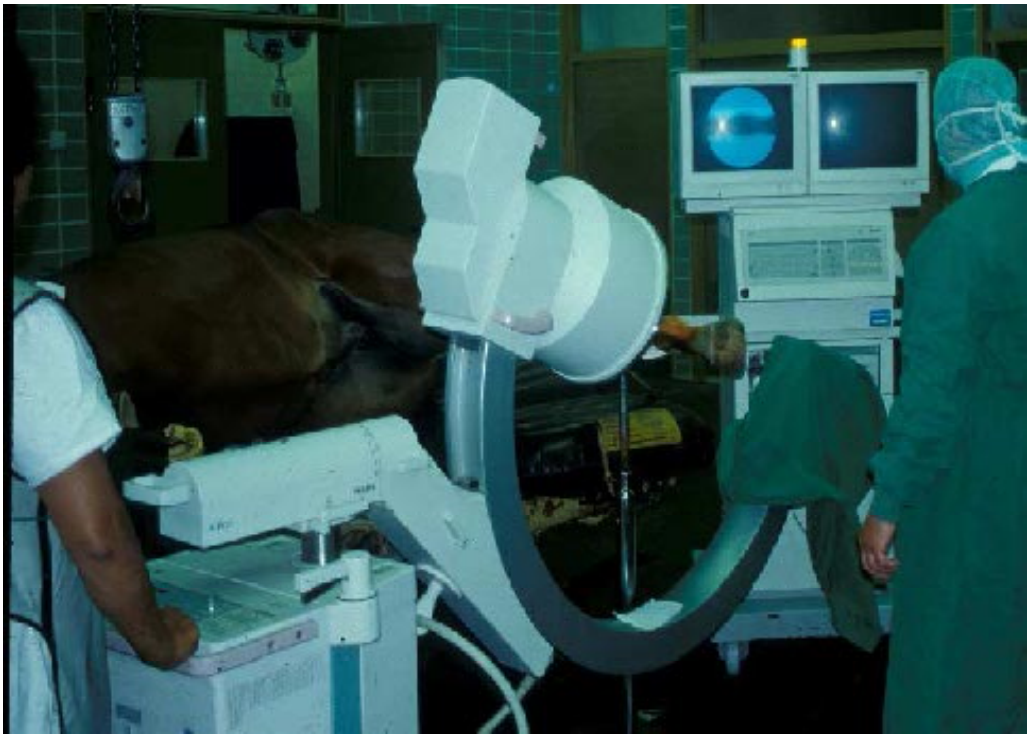

Figure 4: Showing a preoperative positioning of the fluoroscopy unit to obtain a preoperative image.

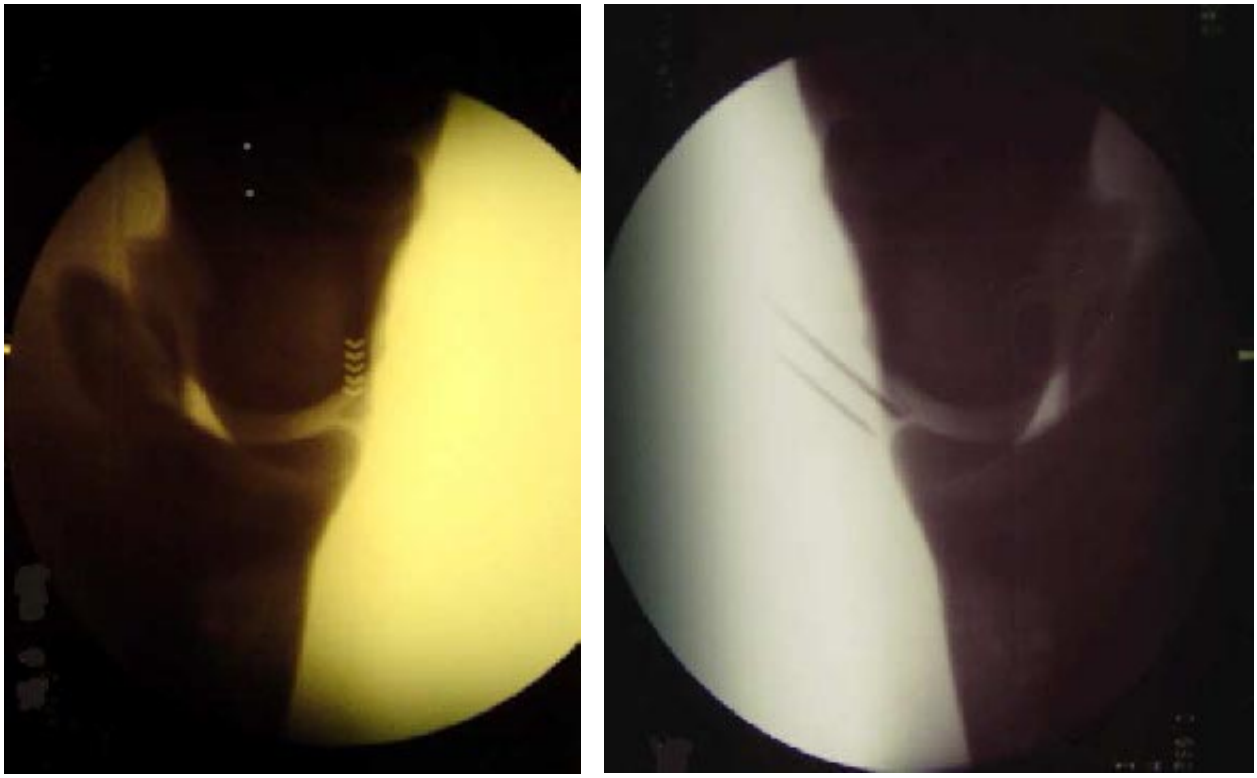

Figure 5: Showing the fluoroscopic guided localisation of isolated shadow in the area of the extensor process of the third phalanx.

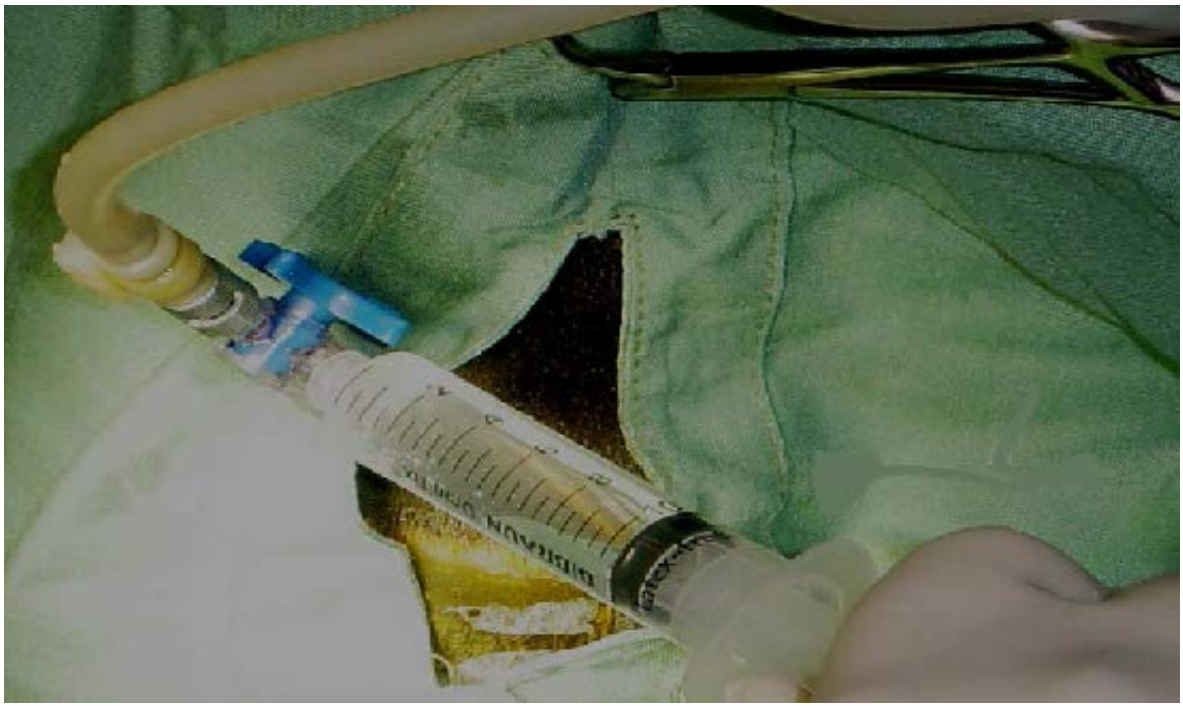

Figure 6: Hoof joint distension through a three-way stopcock.

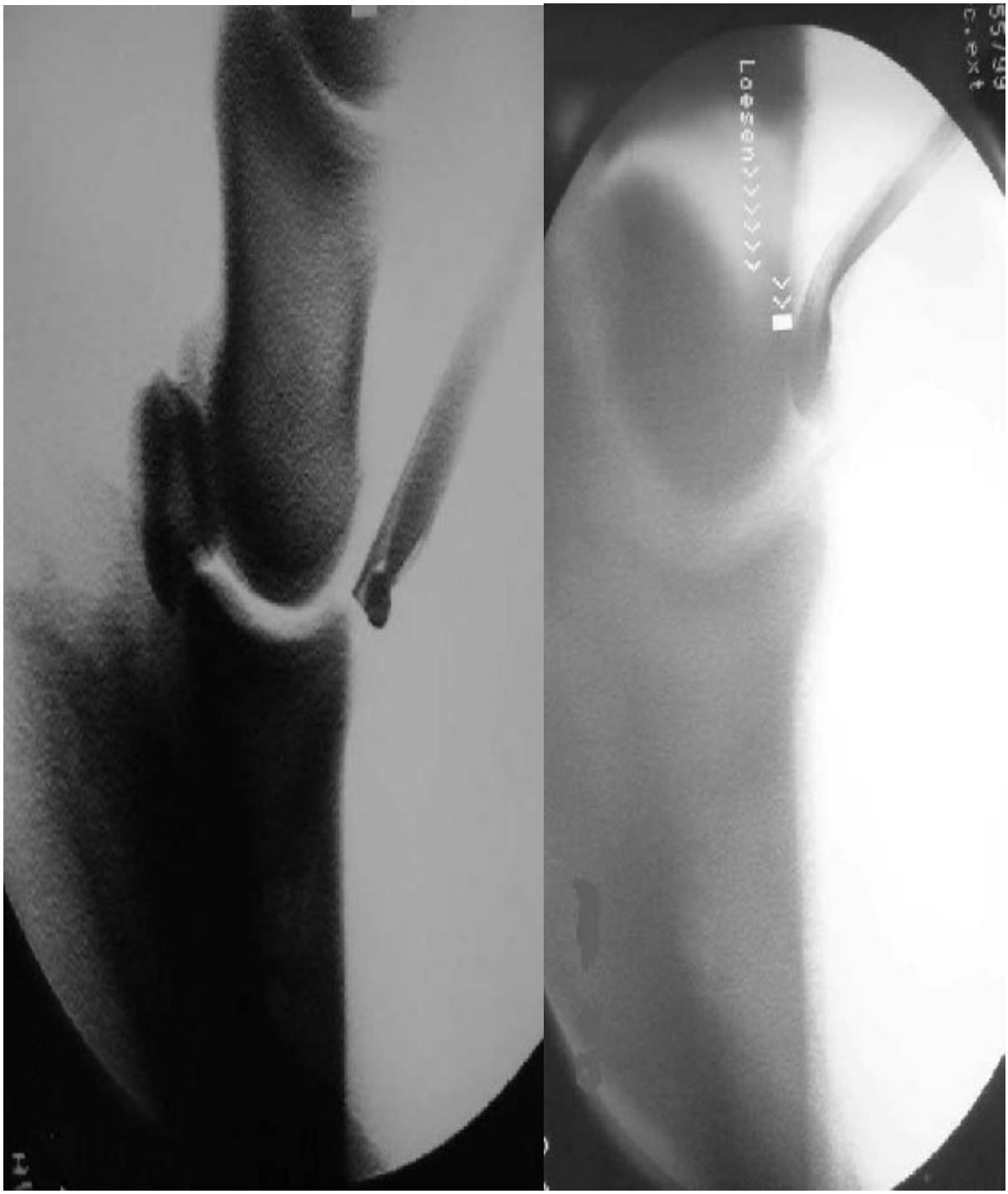

Figure 7: Fluoroscopic guided extirpation of isolated shadows from the region of the extensor process of the third phalanx using a rongeur or a closed curette.

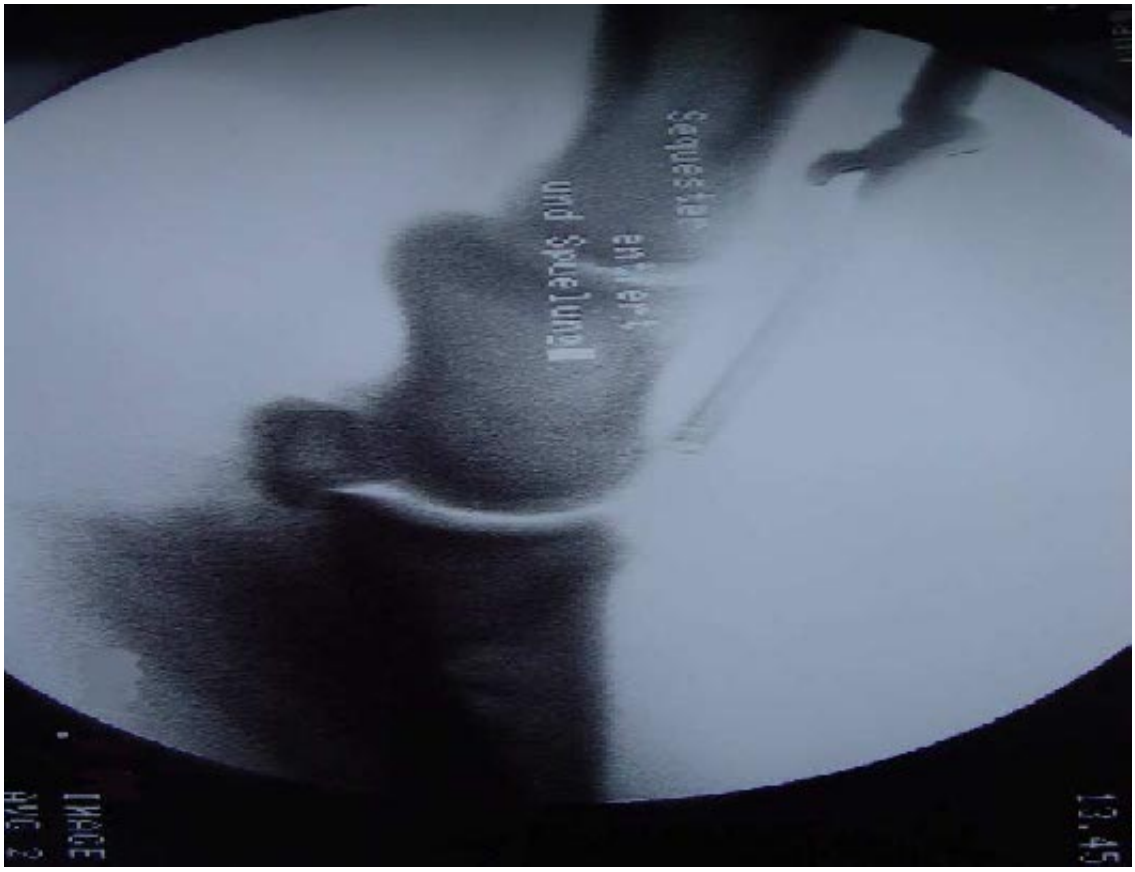

Figure 8: Postoperative control image showing complete removal of the isolated shadow and hoof joint flushing through an egress cannula (4.5 mm).

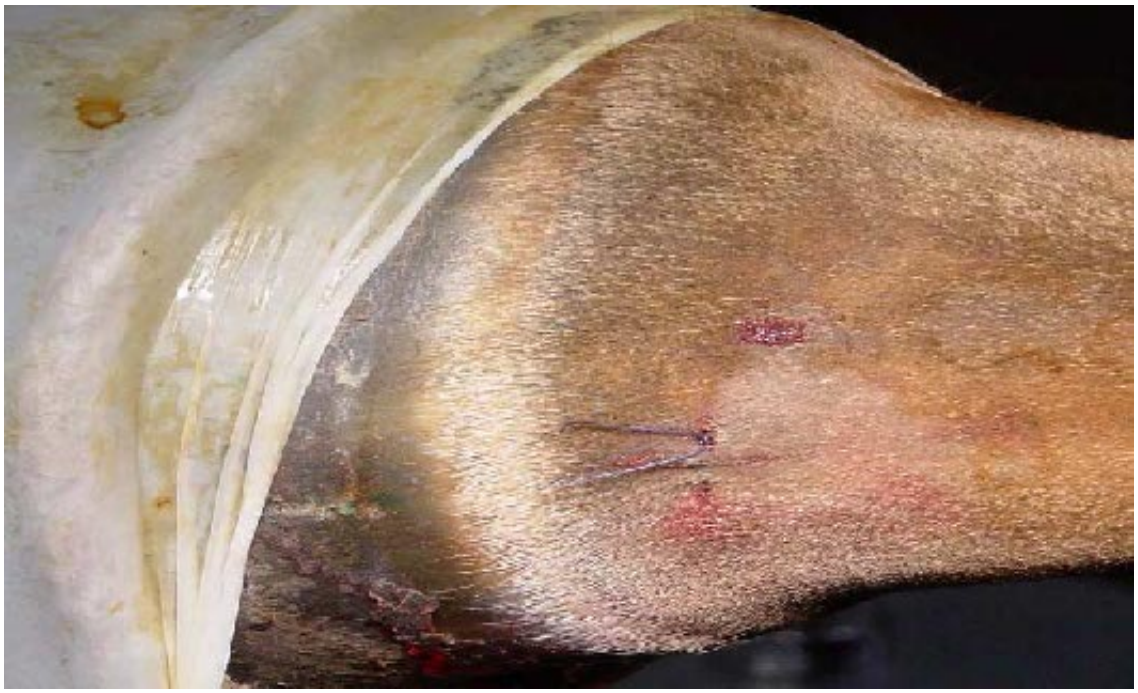

Figure 9: Closure of the stab skin incision with 1 interrupted vertical mattress suture.

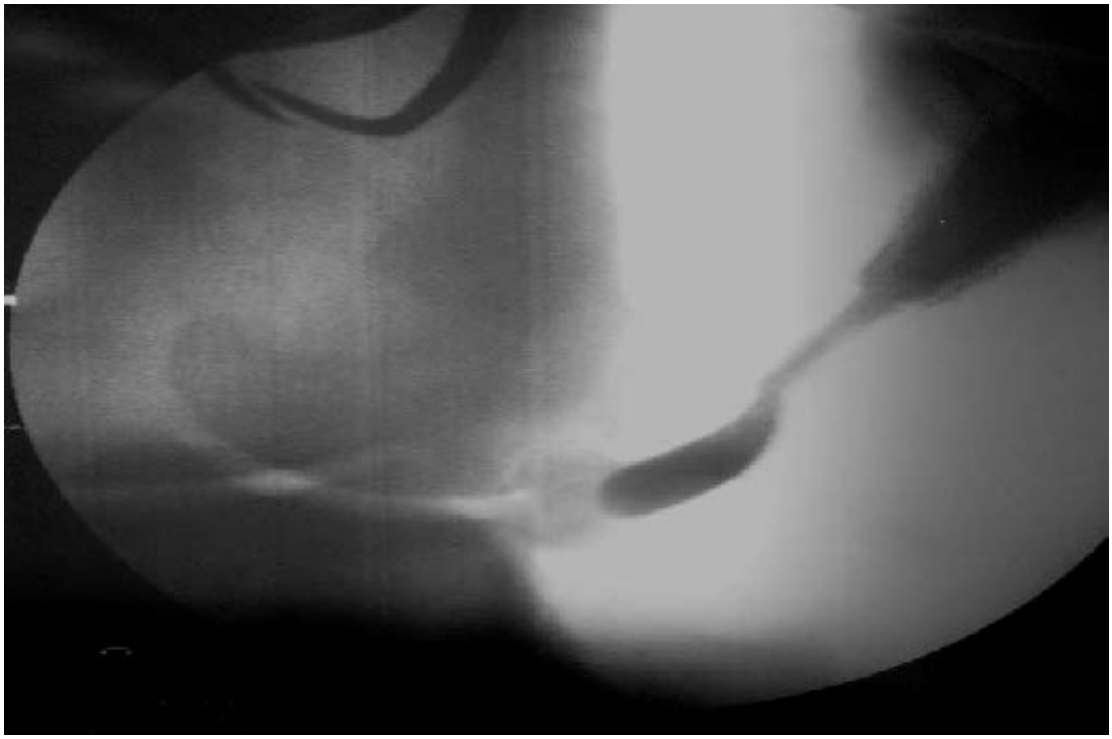

Figure 10: Fluoroscopic image of the proximal interphalangeal joint showing the prying process of a closely attached radiopaque body to the dorsoproximal margin of P2.

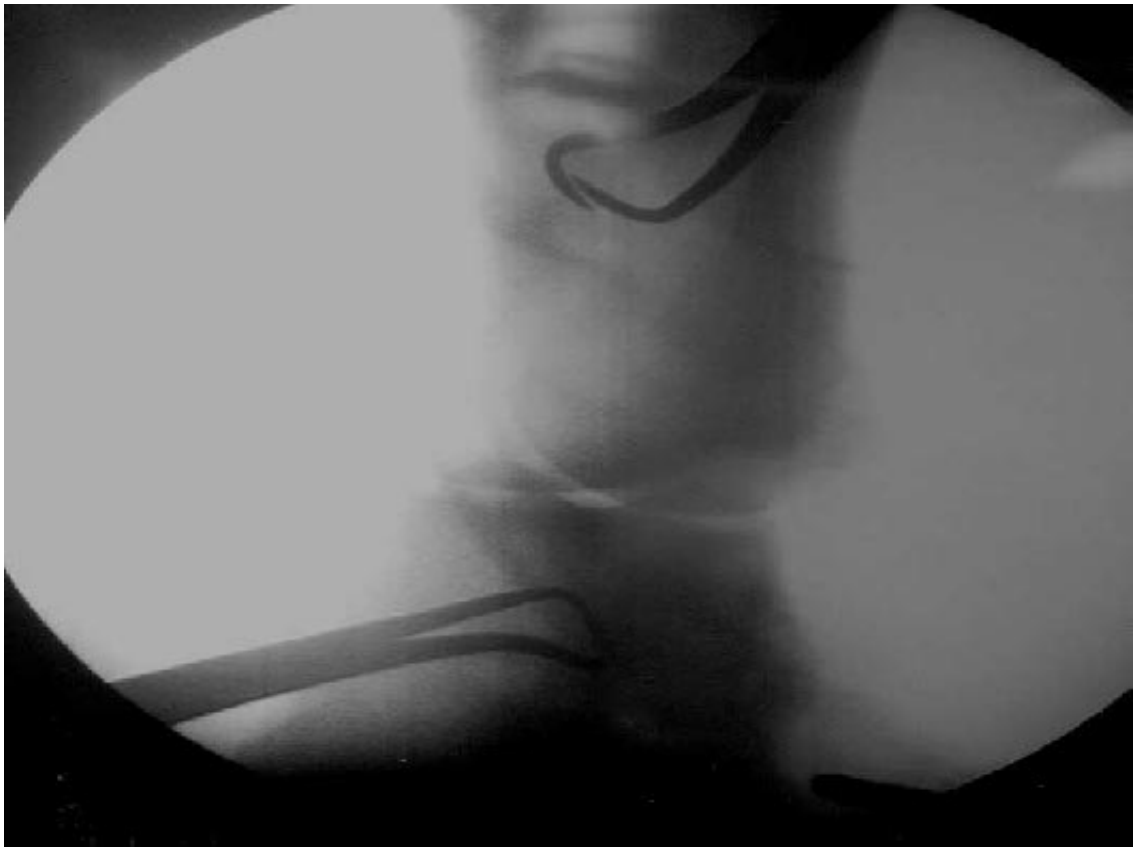

Figure 11: postoperative final fluoroscopic image of the proximal interphalangeal joint showing that the radiopaque body was completely removed.

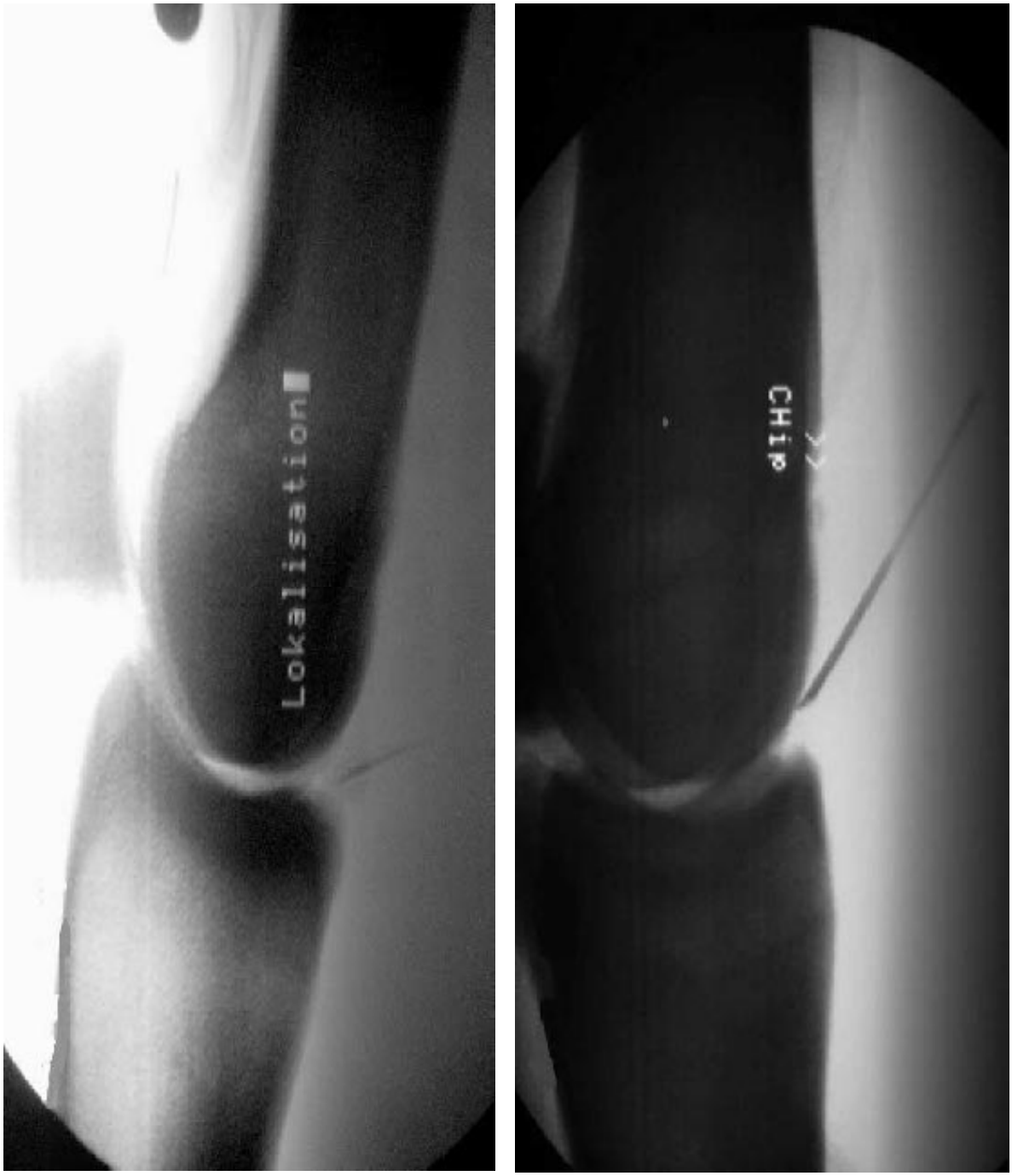

Figure 12: Showing the fluoroscopic guided localisation of isolated shadows in the dorsal aspect of the fetlock joint.

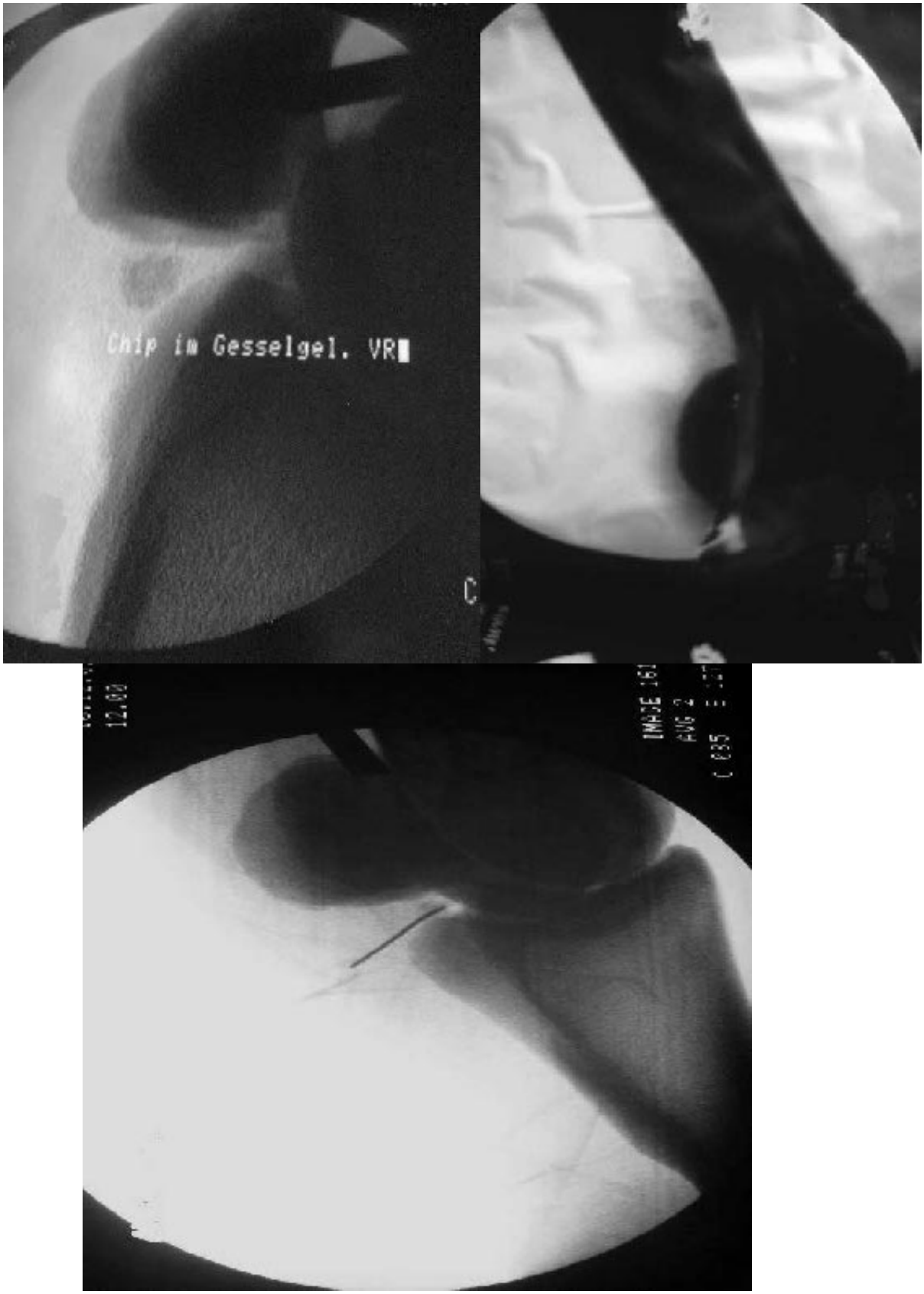

Figure 13: Showing the fluoroscopic guided localisation of different isolated shadows in the vicinity of the palmar/plantar aspect of fetlock joint.

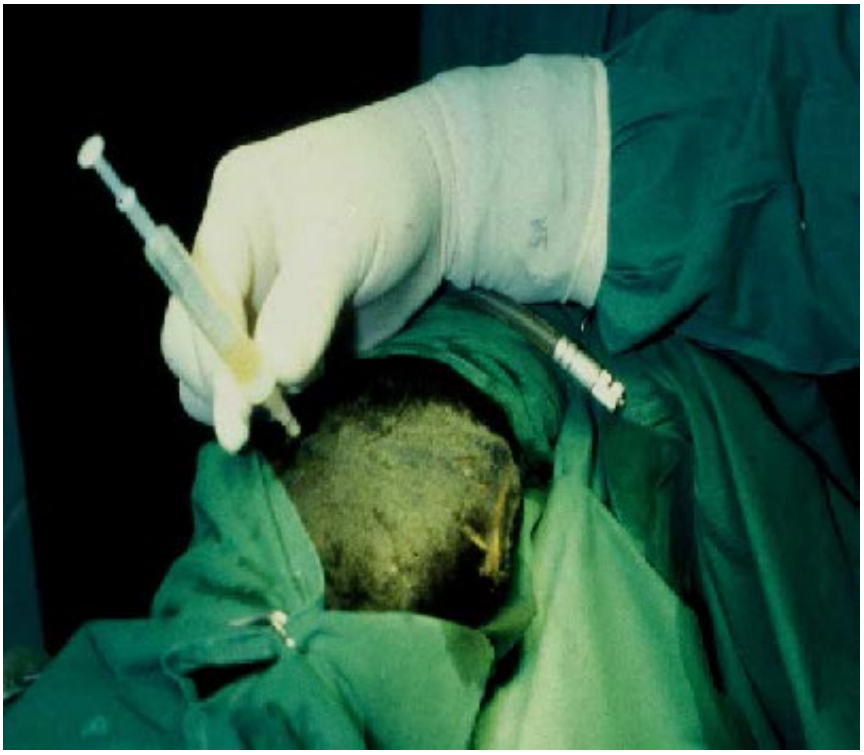

Figure 14: Synovial fluid collection from the dorsal pouch of the fetlock joint.

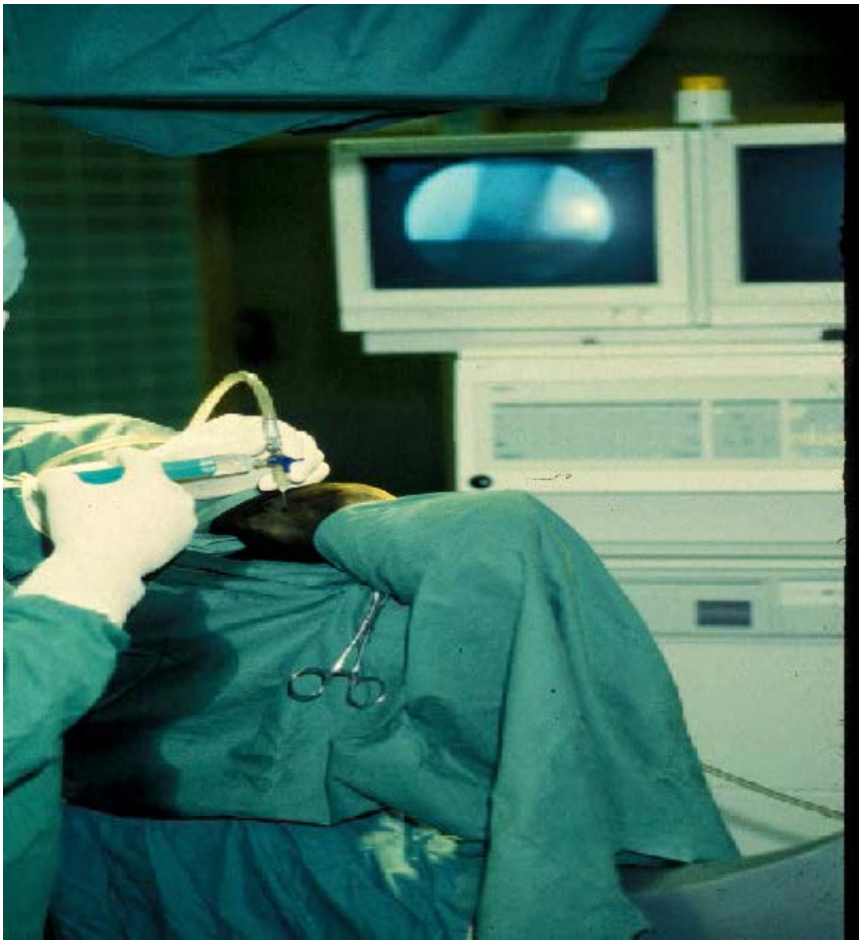

Figure 15: Fetlock joint distension through a three-way stopcock.

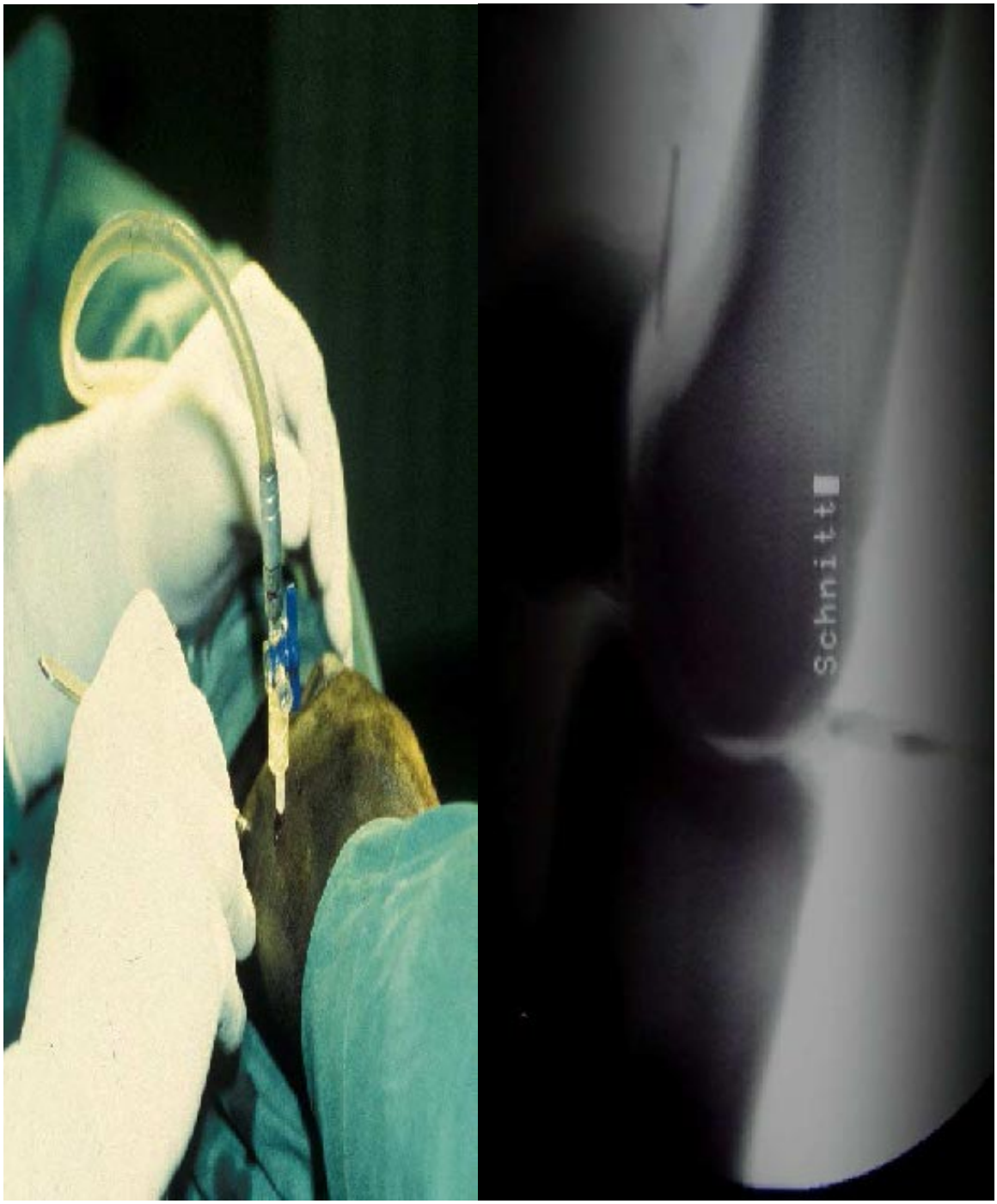

Figure 16: Showing fluoroscopic guided stab incision in the centre of the bulged joint capsule over the isolated shadow.

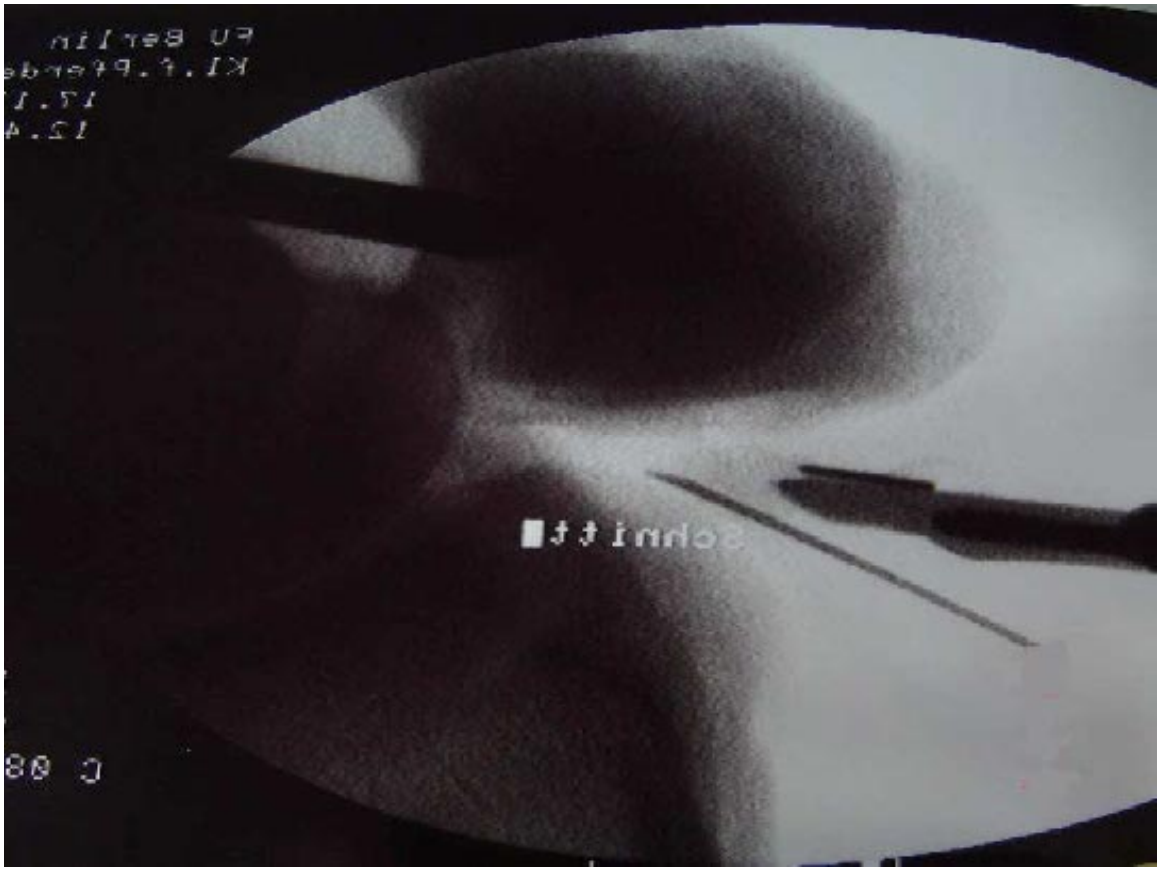

Figure 17: Showing fluoroscopic guided stab incision over an isolated shadow in the region of the palmar aspect of the fetlock joint.

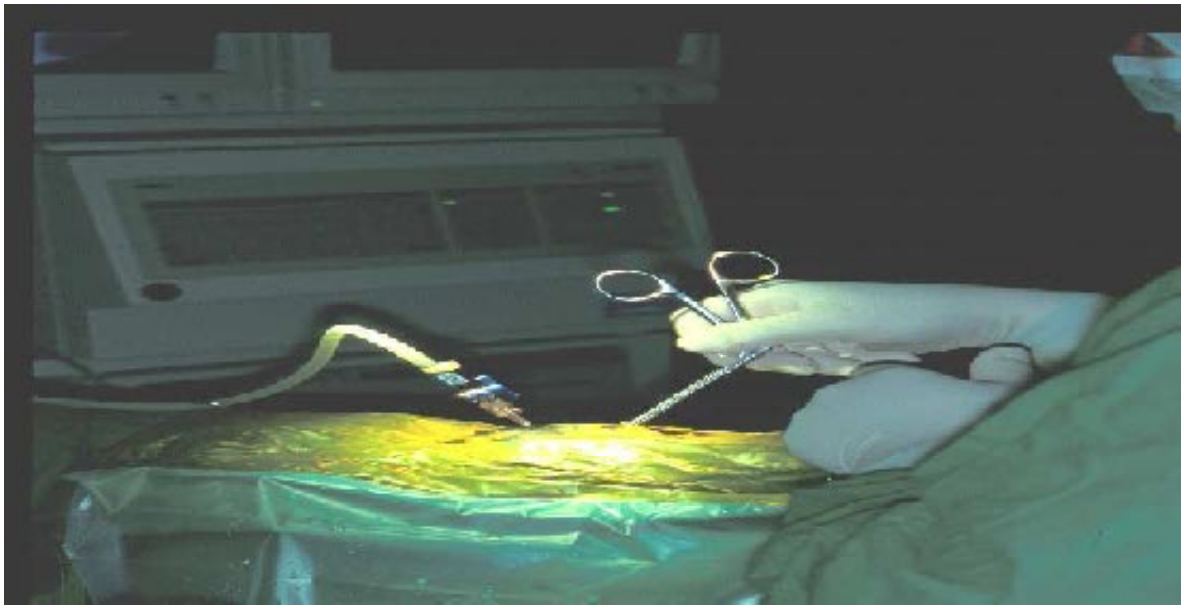

Figure 18: showing fluoroscopic guided surgical removal of isolated shadow from the dorsal aspect of the fetlock joint using a curved rongeur.

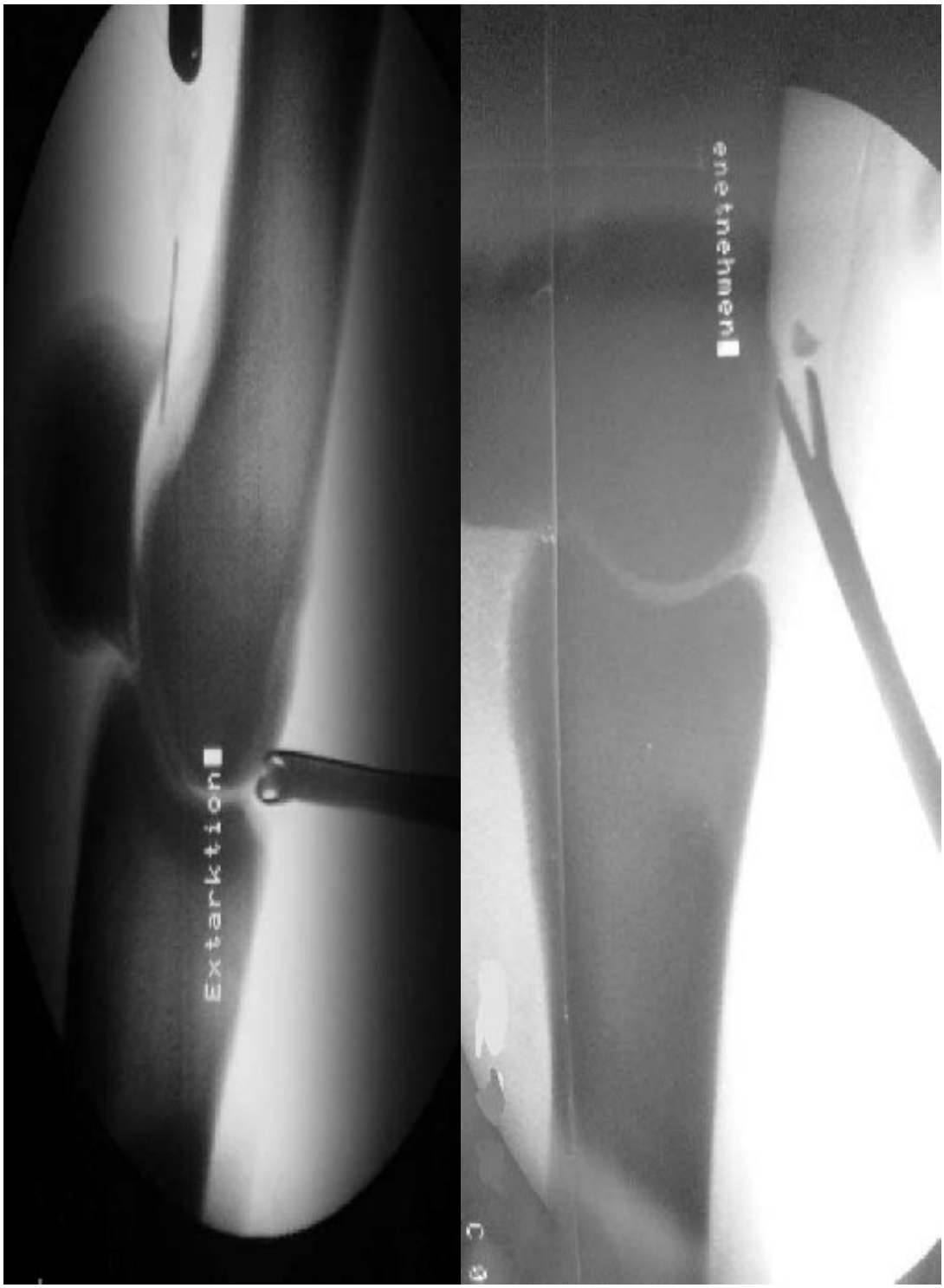

Figure 19: Fluoroscopic images showing the removal of isolated shadows from the proximal aspect of the fetlock joint.

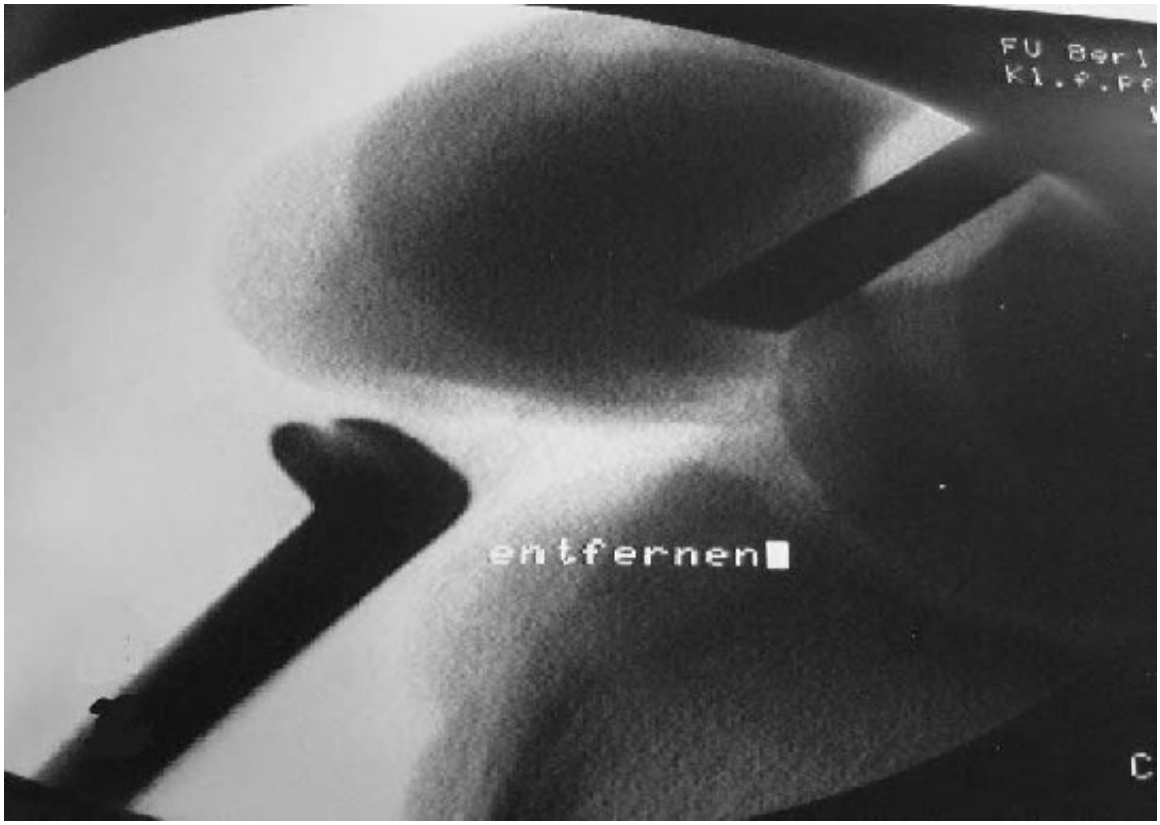

Figure 20: Fluoroscopic images showing the removal of isolated shadows from the plantar aspect of the fetlock joint.

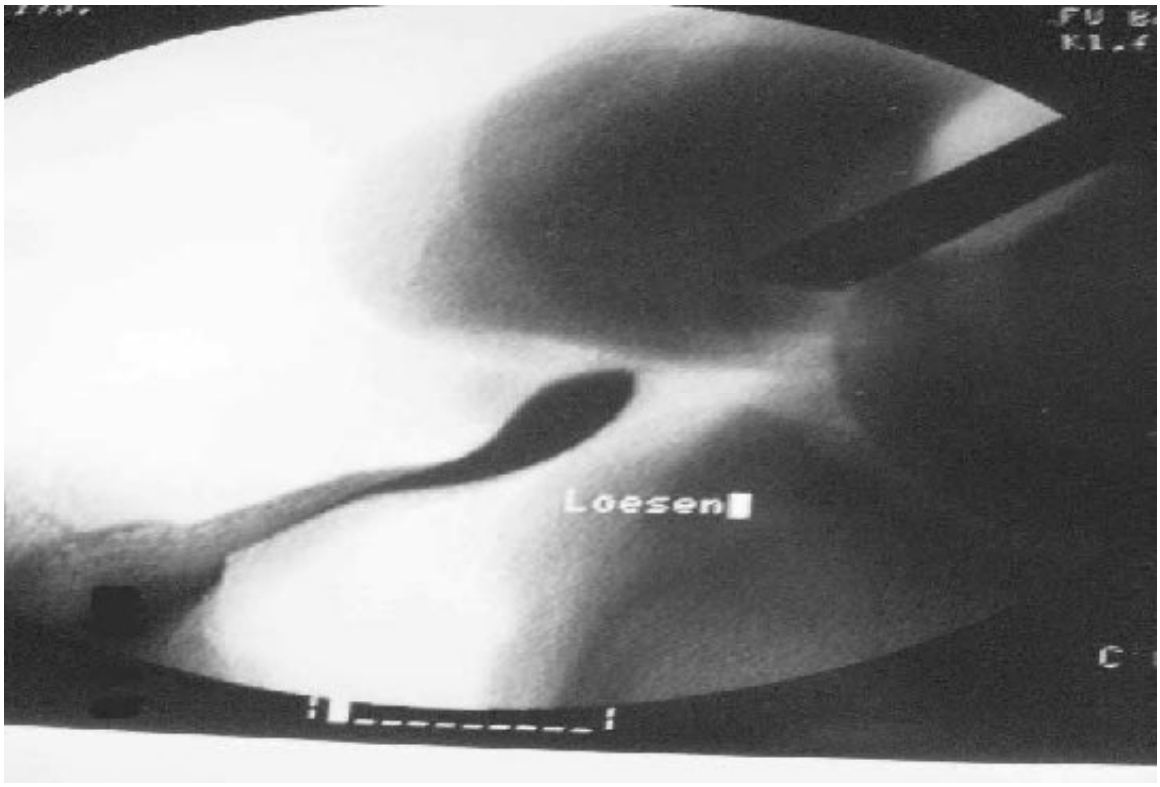

Figure 21: Fluoroscopic image of the bfetlock joint showing the prying process of a closely attached radiopaque body to the plantar aspect of the fetlock joint.

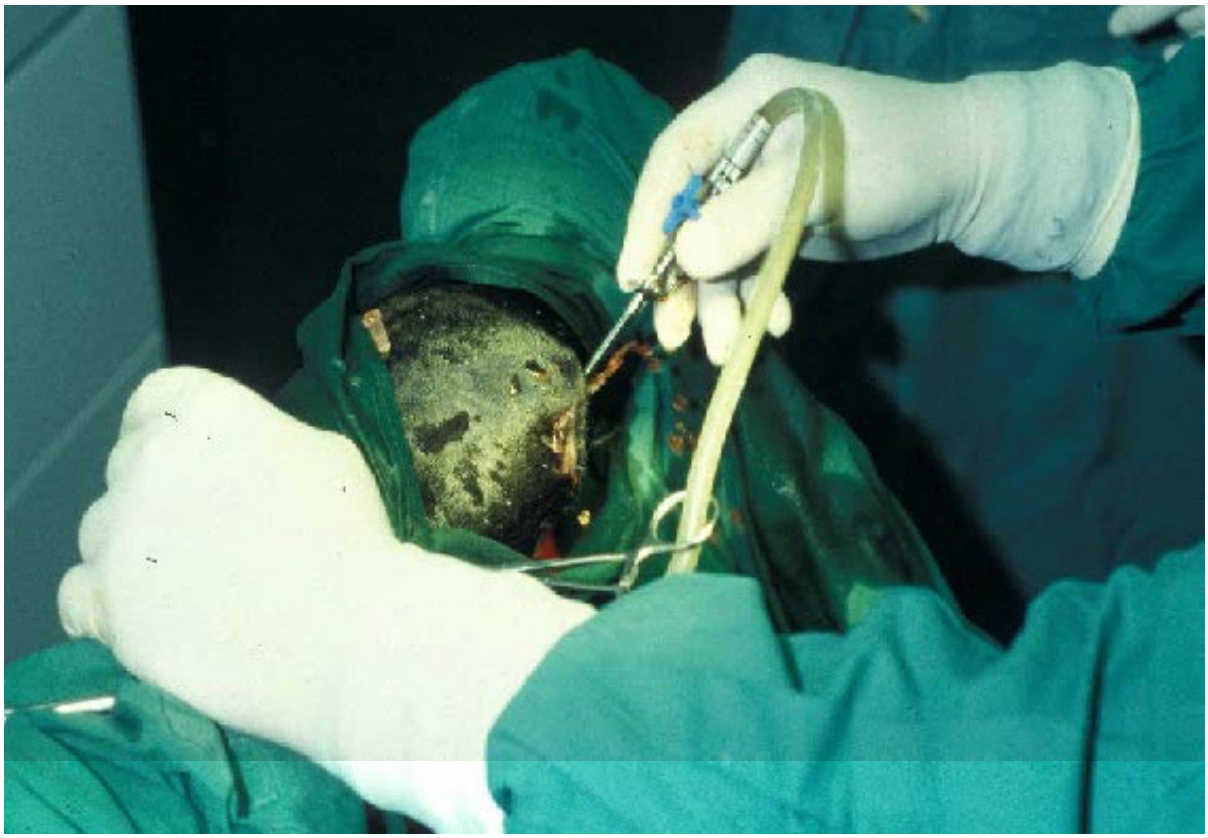

Figure 22: Postoperative fetlock joint flushing through an egress cannula (4.5 mm).

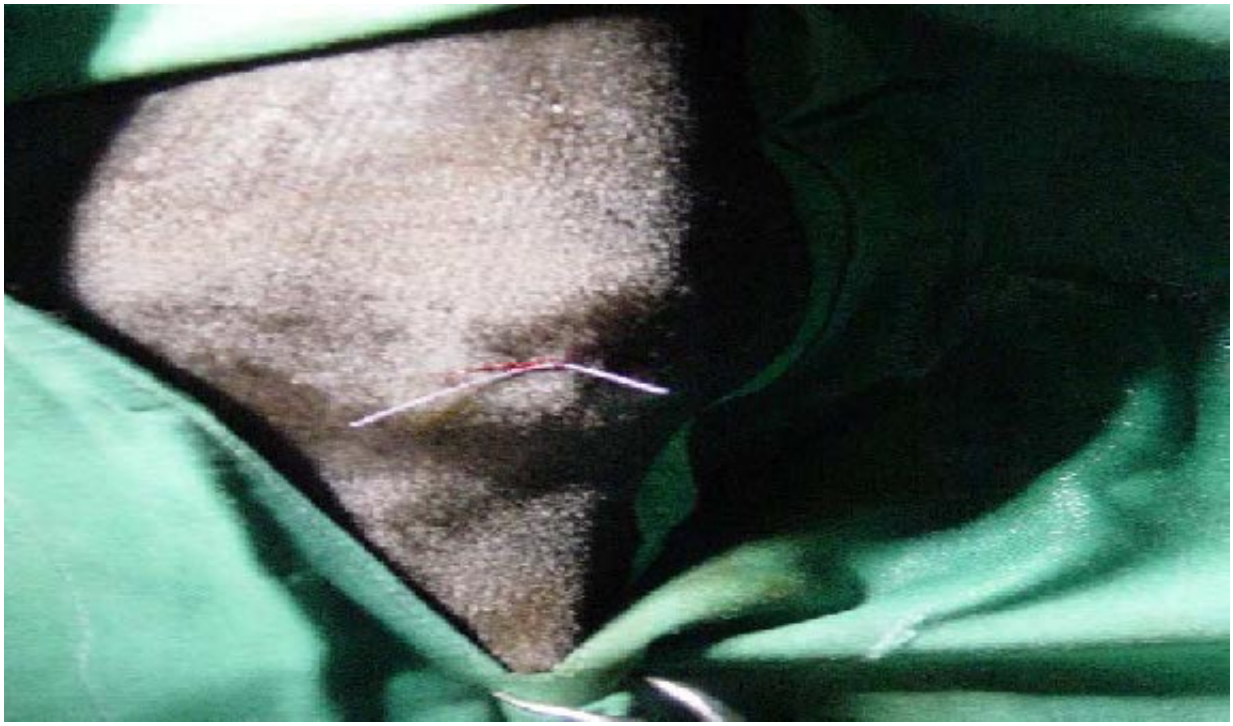

Figure 23: Closure of the stab skin incision with 1 interrupted vertical mattress suture.

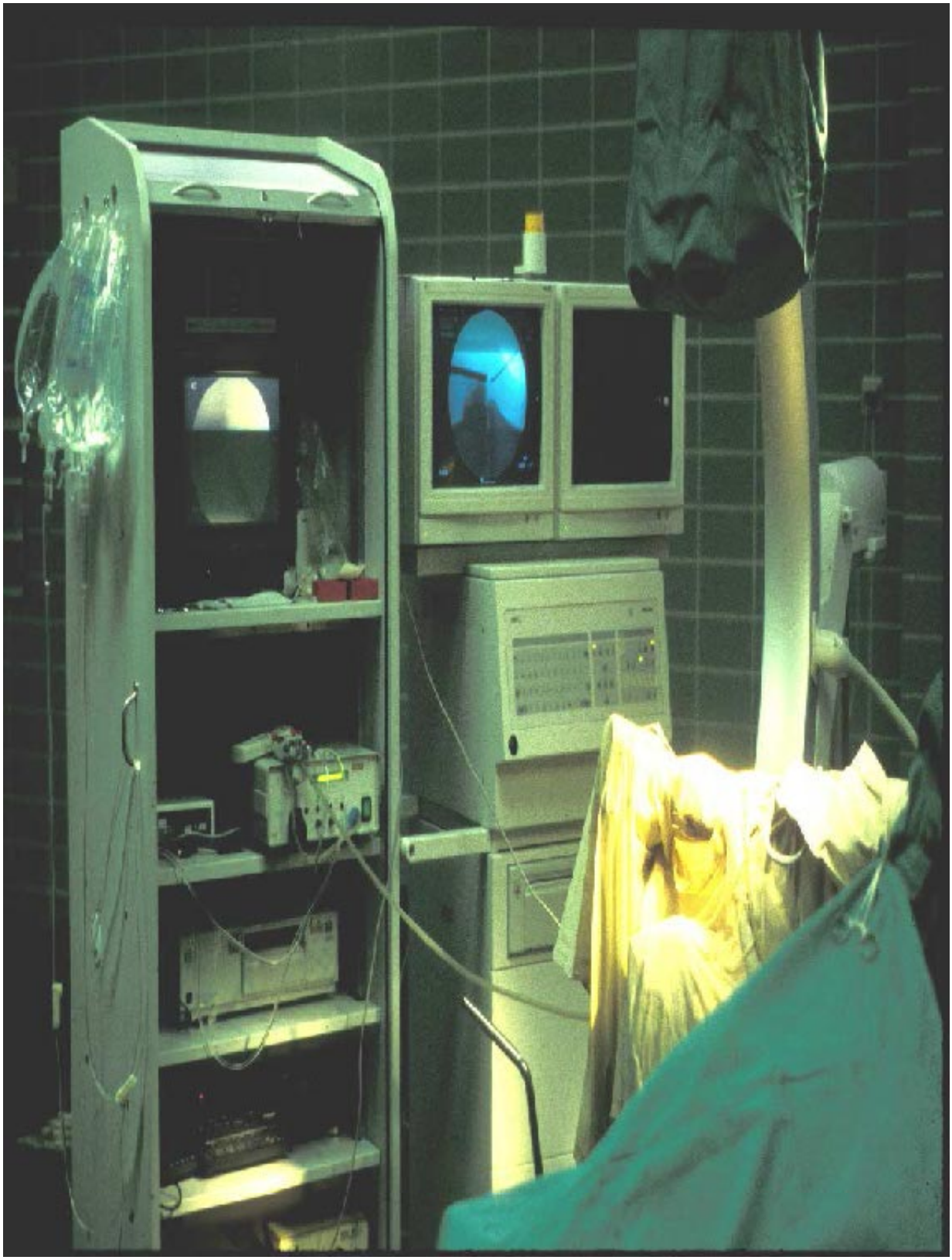

Figure 24: A combination of both fluoroscopy and arthroscopy techniques.

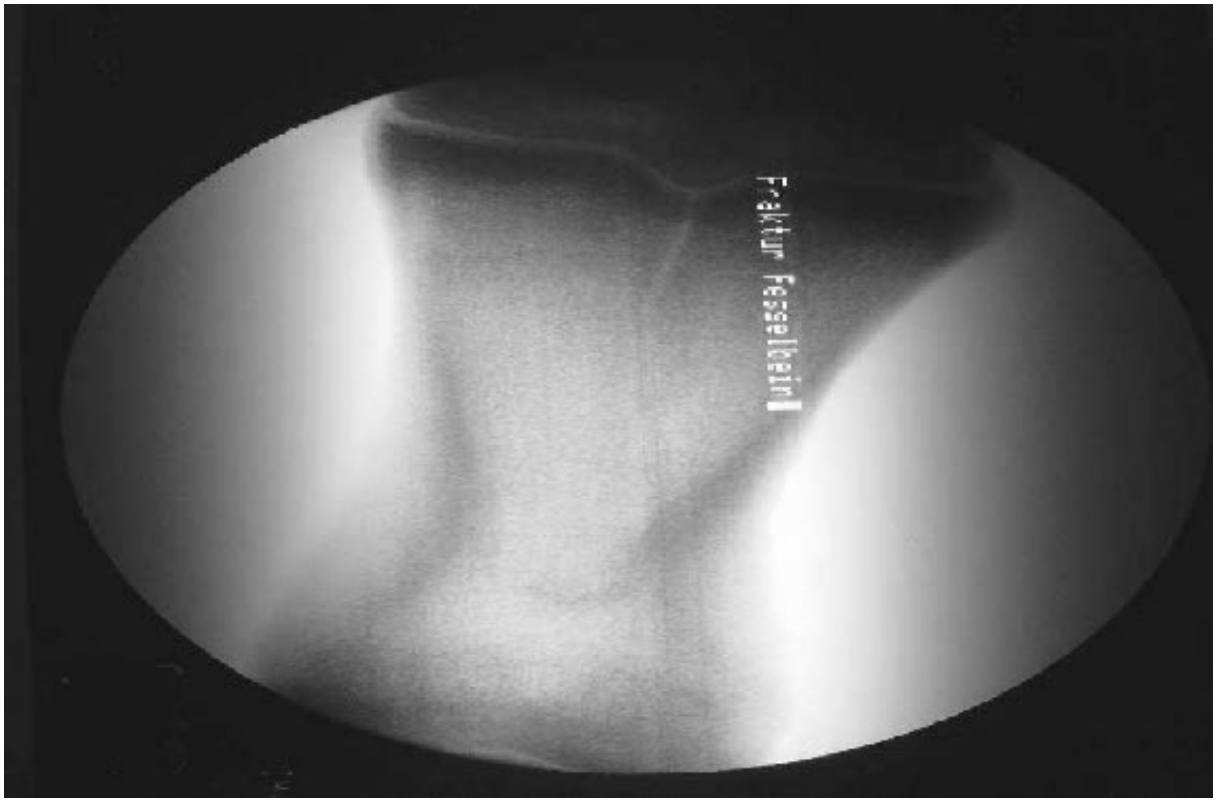

Figure 25: Fluororoscopic image localise a longitudinal fracture of the proximal phalanx.

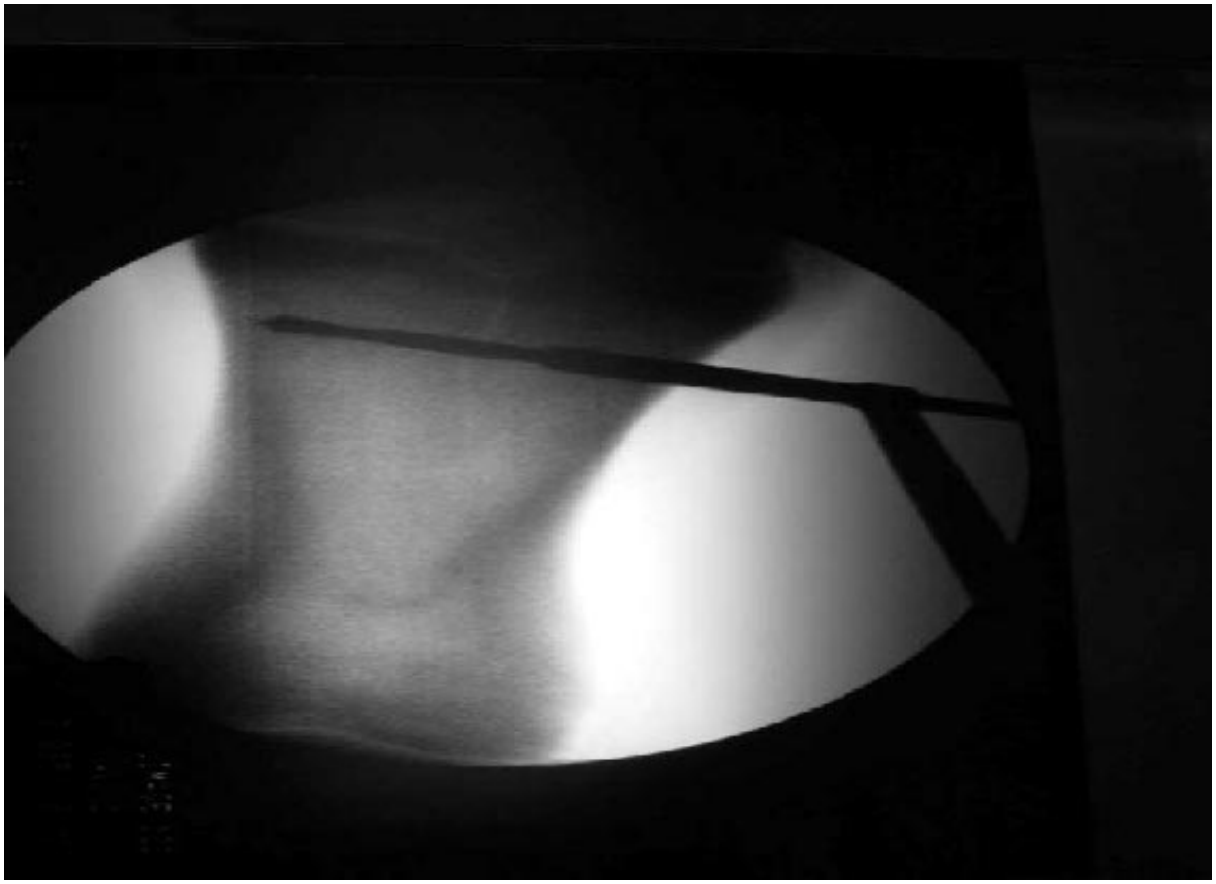

Figure 26: Fluoroscopic guided drilling of the far cortex of P1 using a 3.2 mm drill bit.

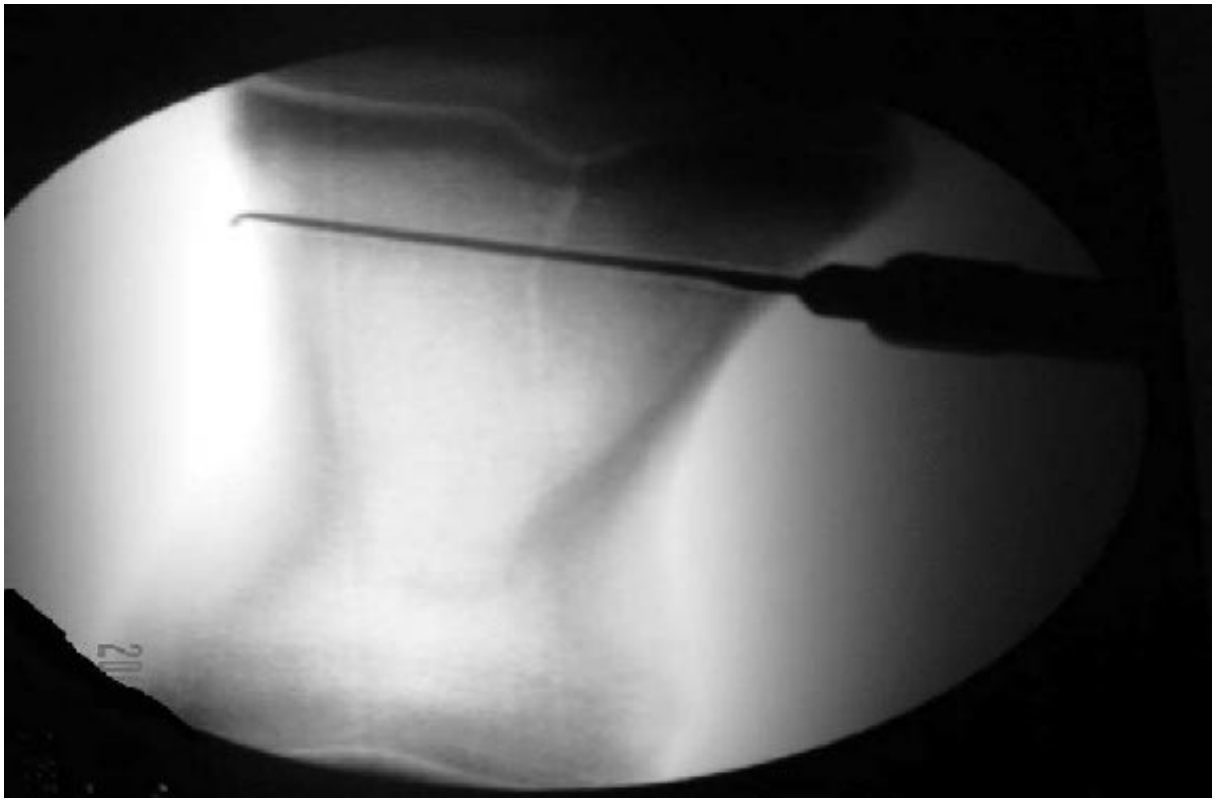

Figure 27: Measurement of the of the ASIF screw to be inserted using a depth gauge.

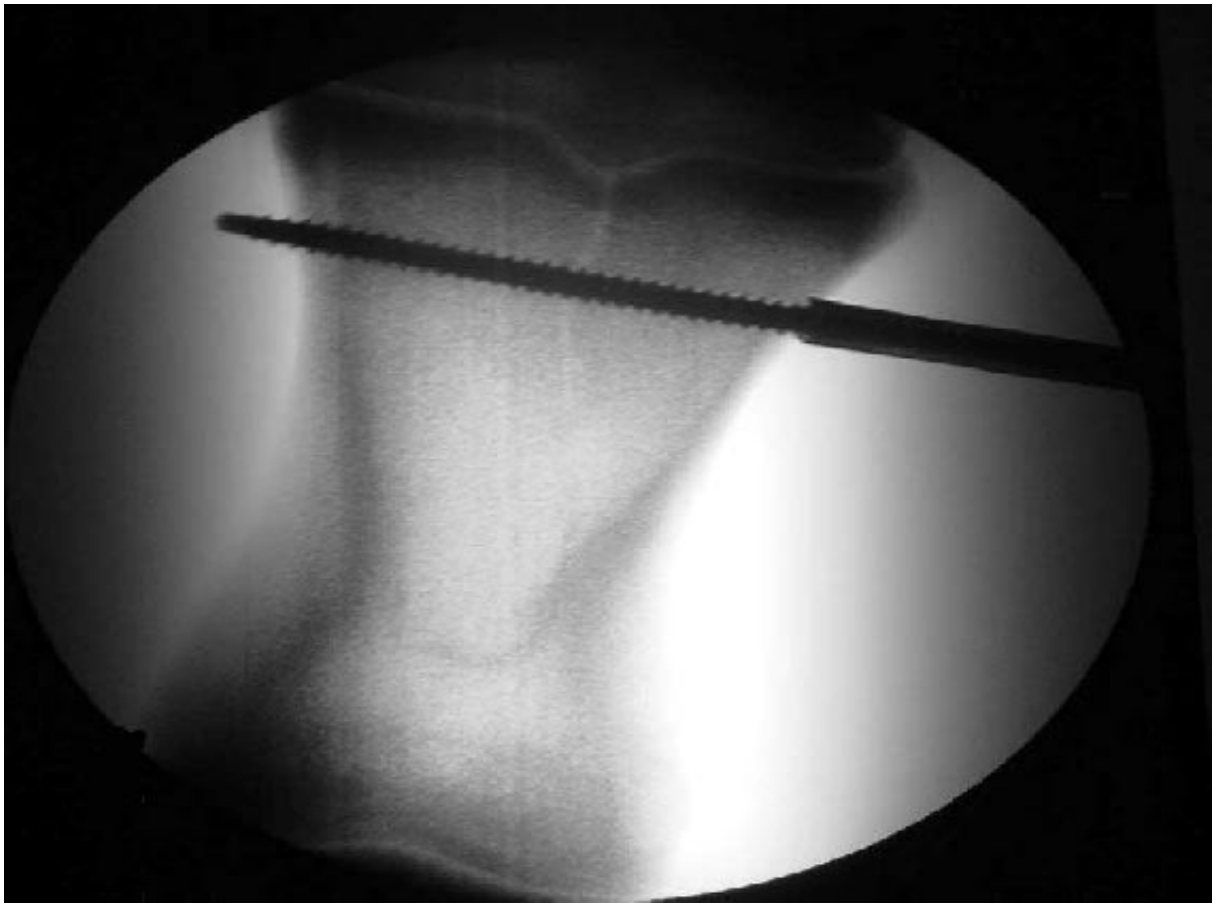

Figure 28: Tapping the distal 3.2 mm hole with a 4.5 mm tap.

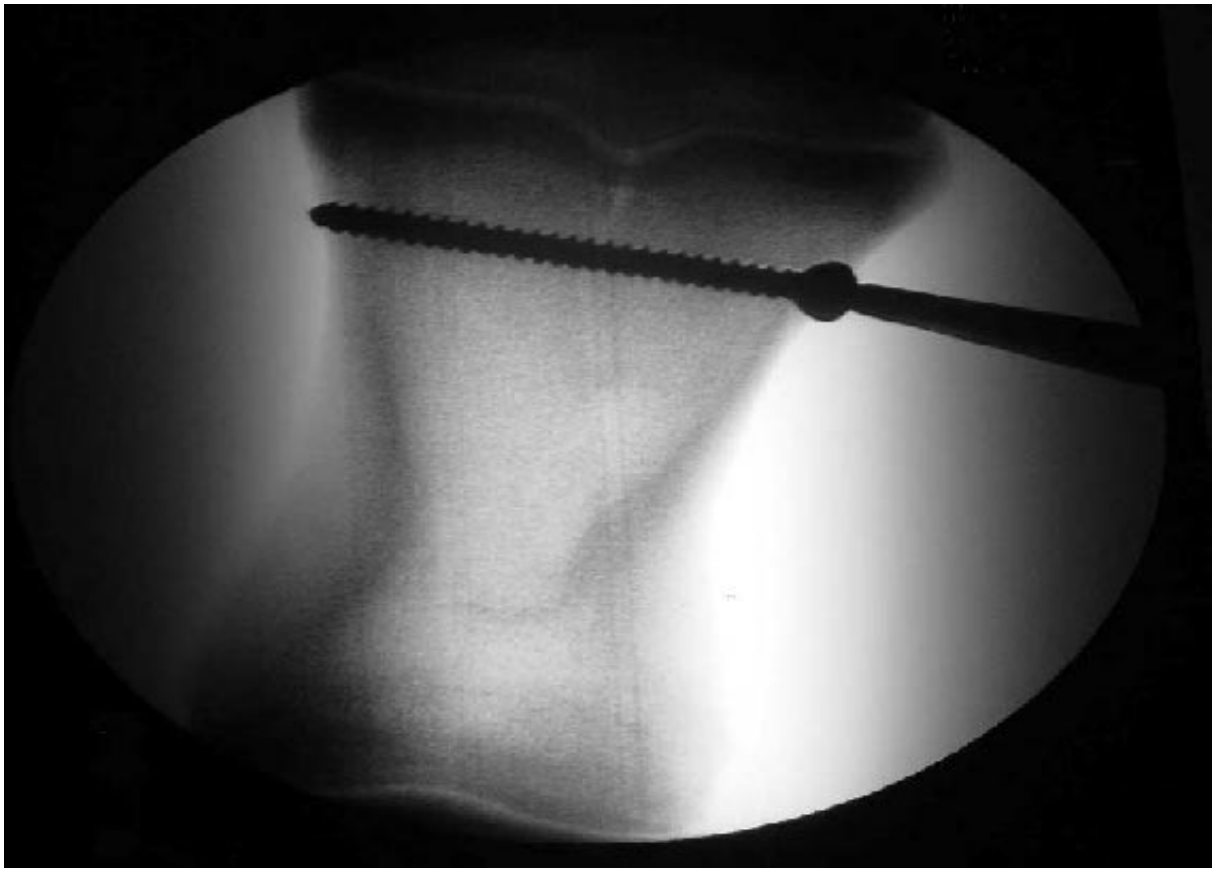

Figure 29: Partial tightening the screw using the ASIF Hexagonal-head screw.

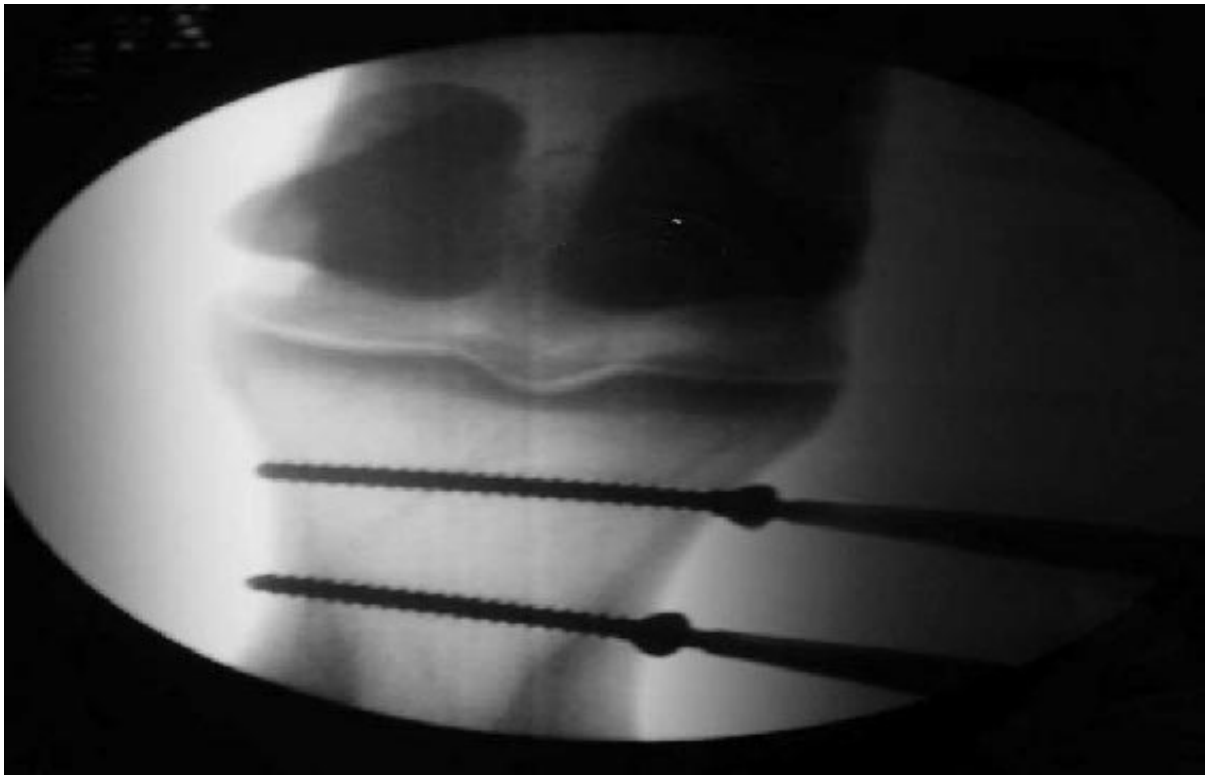

Figure 30: Complete tightening of all screws to obtain compression of the fracture fragments.

Figure 31: Showing the complete Jamshidi set for collection of cancellous bone graft.

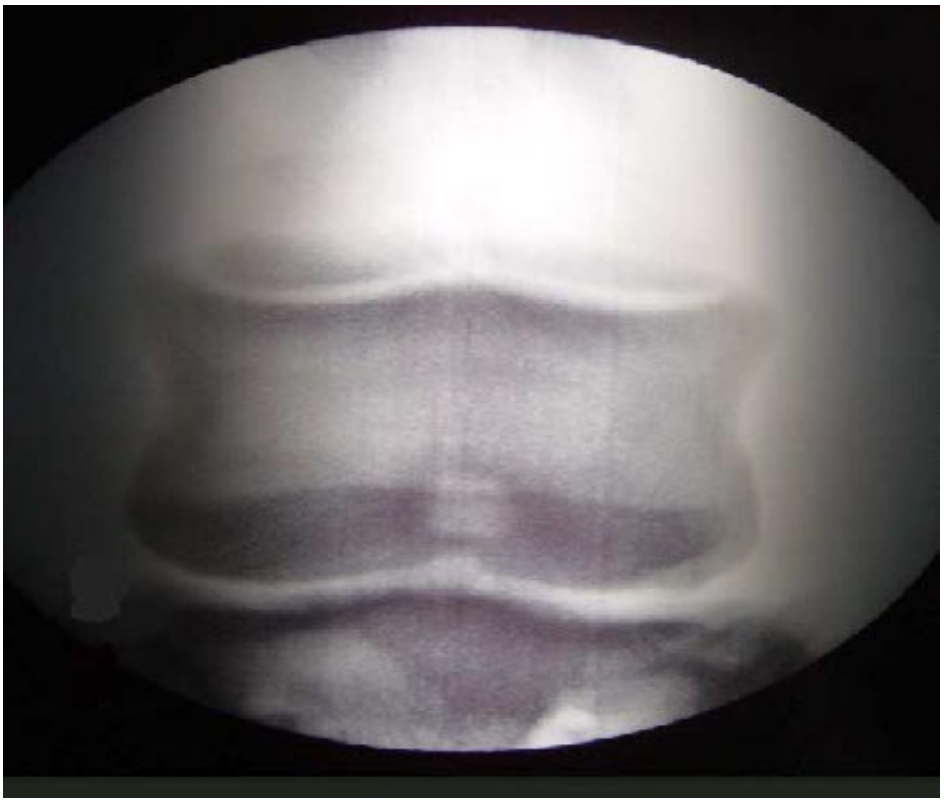

Figure 32: Fluoroscopic guided localisation of cyst-like lesion at the distal end of the second phalanx.

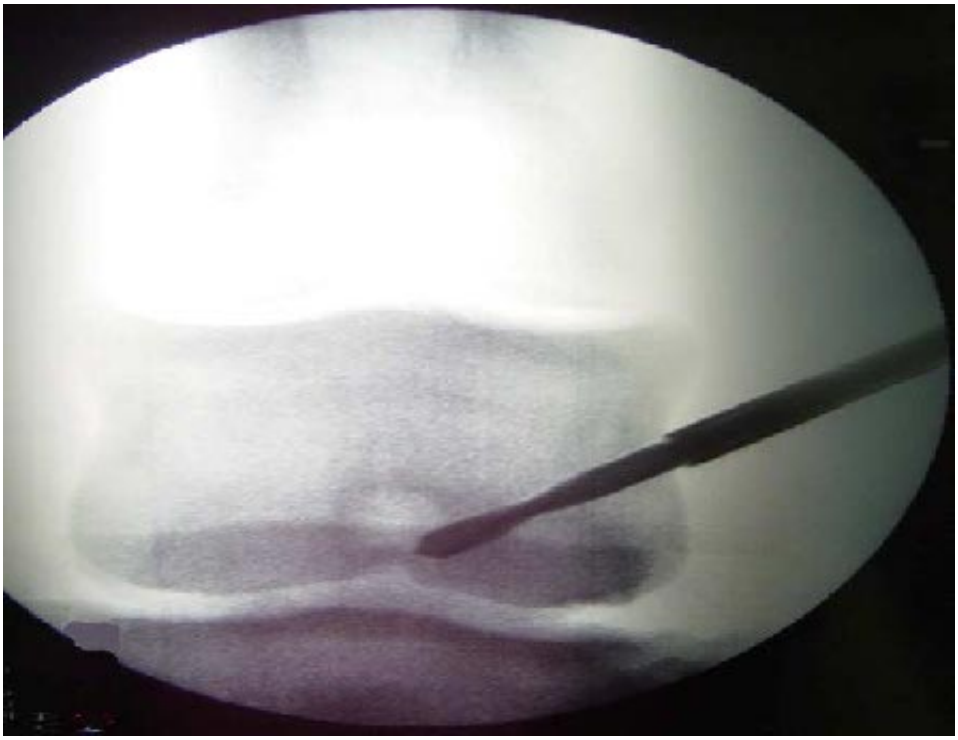

Figure 33: Fluoroscopic guided drilling of a cyst-like lesion with 4.5 mm drill

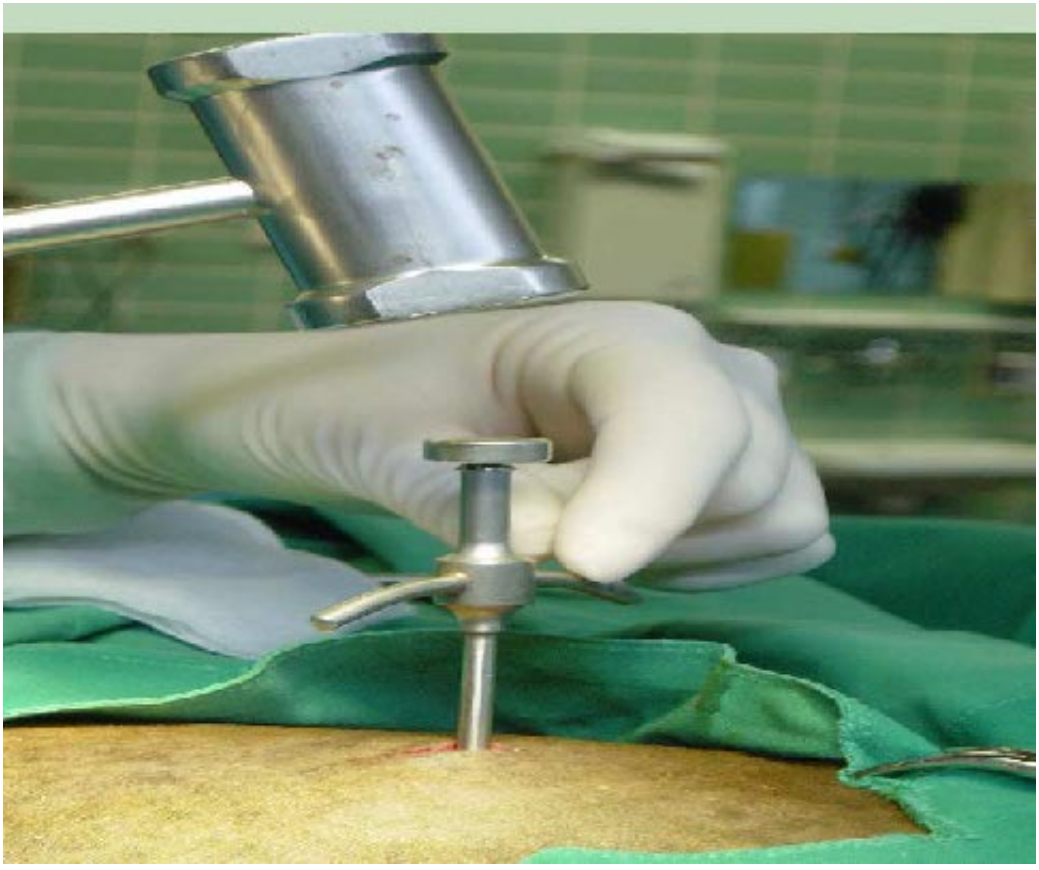

Figure 34: Harvesting of cancellous bone graft from the tuber coxae with the aid of the equine modified Jamshidi-needle

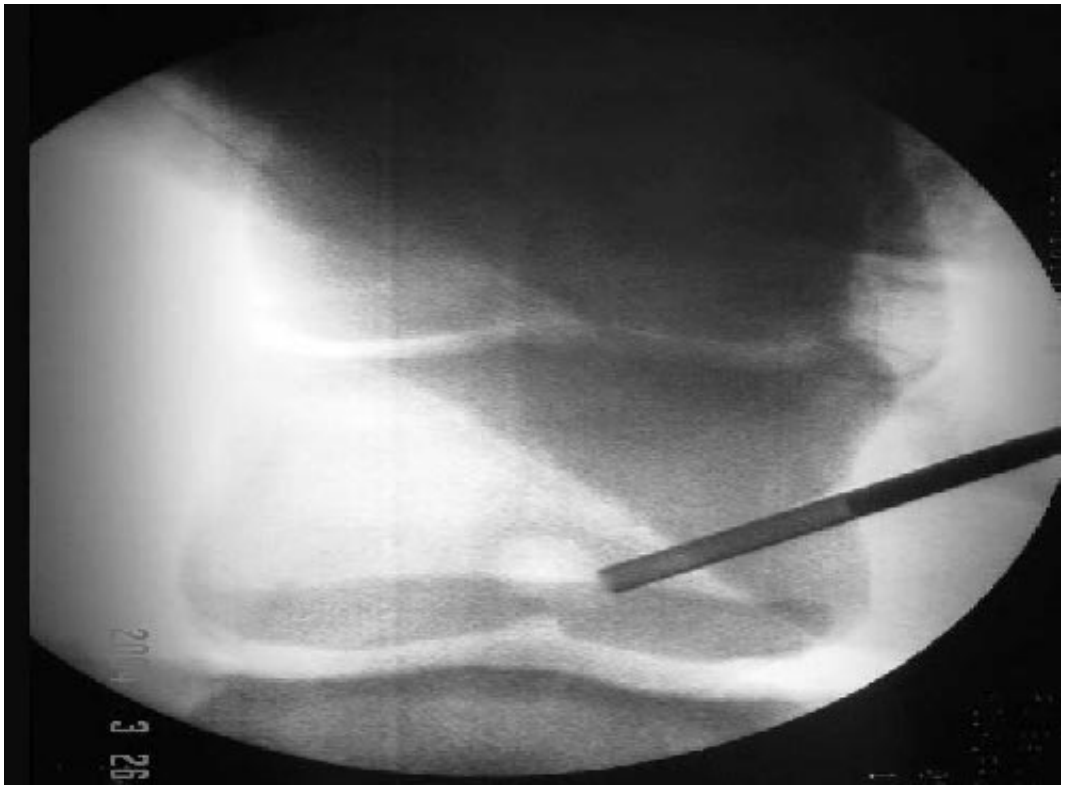

Figure 35: Fluoroscopic guided packing of the cyst-like defect with the cancellous bone graft cylinder.

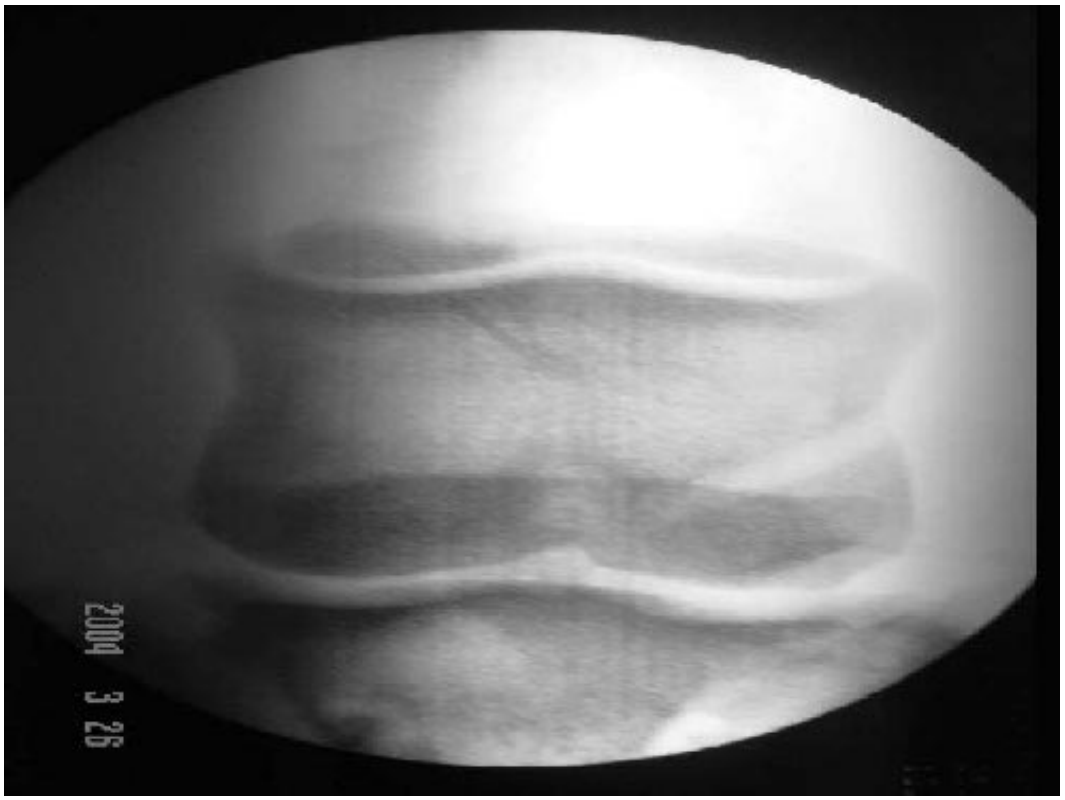

Figure 36: The cyst-like defect completely filled with cancellous bone graft.