X-Ray Evaluation of the Above Knee Socket; A Supplement to Standard Check-out Procedures

Capt. C. James Scanlon, AMSC
Lt. Col. Bob Doctor, AMSC

Patient comfort and functional use of the standard above-knee total contact suction socket prosthesis is dependent upon critical prosthetic alignment and bio-mechanical principles. These alignments and principles have been preached for the past 20 years and the assessment of compliance to these standards have been left to the prosthetist and therapist through their various bench and dynamic prosthetic checkout procedures. The fact, however, that the amputated femur is encased within an opaque socket and not subject to actual visualization left the examiner with no recourse but to assume the stump was functional positioned providing the traditional external standards where complied with.

In 1974 Fitzsimons Army Medical Center in Denver, Colorado began utilizing an X-Ray Evaluation taken under weight bearing conditions to augment the more traditional procedures used to checkout the above knee prosthesis.

Procedure: The procedure followed in this X-ray checkout is as follows: Prior to X-ray, a small solder wire is taped to the superior surface of the posterior brim of the prosthesis and a second wire is taped inside the socket in the center of the medial wall down to the distal end and back up the lateral wall. These wires help visualize the stump-socket interface on the X-ray (Fig 1). The patient then applies the prosthesis.

An anterior - posterior x-ray projection of the patients' pelvis, femurs, and knees is taken utilizing a l4 inch by 36 inch x-ray cassette with a 6 to l grid ratio. The x-ray is taken at a 72 inch tube film distance with the central ray focused at the level of the posterior brim of the prosthesis. The amputee stands facing the machine with his feet spaced 2 inches apart, weight borne equally on both lower extremities, and void of anterior posterior pelvic rotation. (Fig 2)

FINDINGS: Radiographic examination of some 5l amputee patients were performed and were found to be of considerable value in evaluating the following points:

l. Hip Adduction Angle. Ninety-eight percent of the x-rays of a group of amputees who had previously been fitted with the standard above-knee prosthesis demonstrated less than an equal femoral adduction angle on the amputated side and sixty-eight percent of the stumps we in absolute abduction. This deviation from the intended biomechanical optimum was the most common deviation found and nearly impossible to detect by any means other than x-ray examination. Clinically, all did have a significant gluteus medius (compensated Trendelenburg) gait. Figure (3) shows the typical abducted posture of the femur noted on x-ray evaluation as well as the more ideal posture where the femoral adduction angels are equal. Based upon this study we found that very few of the prosthesis built according to standard alignment criteria achieve the desired hip adduction posture and that the actual degree of adduction of the femur

Figure 2

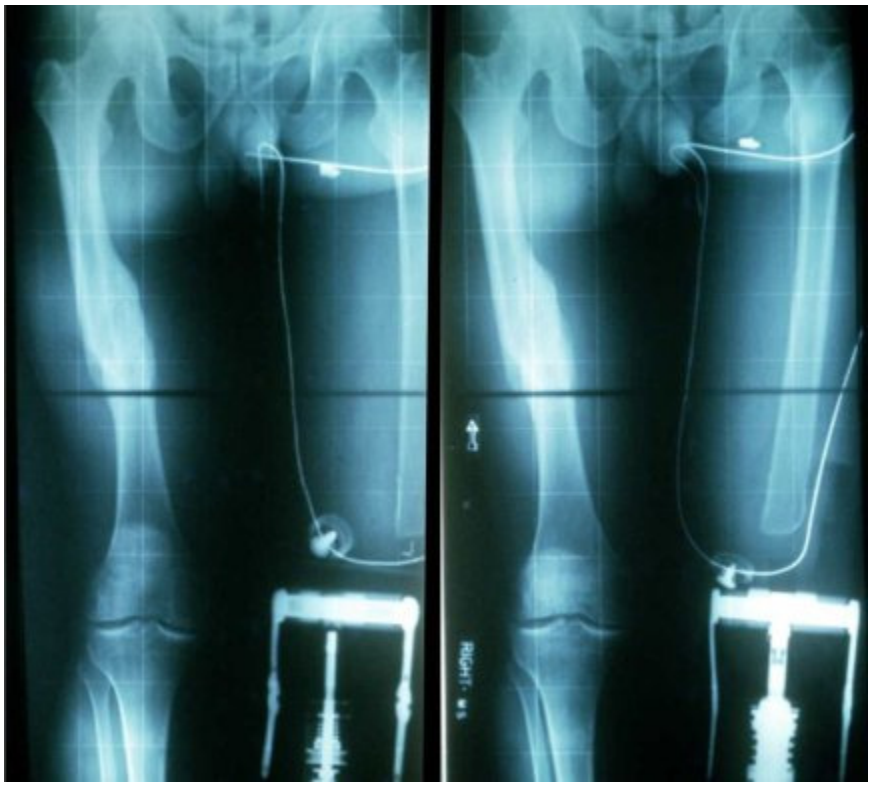

Figure 3

within the socket cannot be determined by the angle of the lateral wall of the prosthesis itself.

2. Lateral Wall Support. Lack of adequate support as well as unequal distribution of weight along the lateral wall of the prosthesis was another point easily discernible via x-ray and not so by other means. Figure (4) depicts a bulging lateral wall offering little lateral support and a better fitting prosthesis that provides good lateral stability and equal weight distribution.

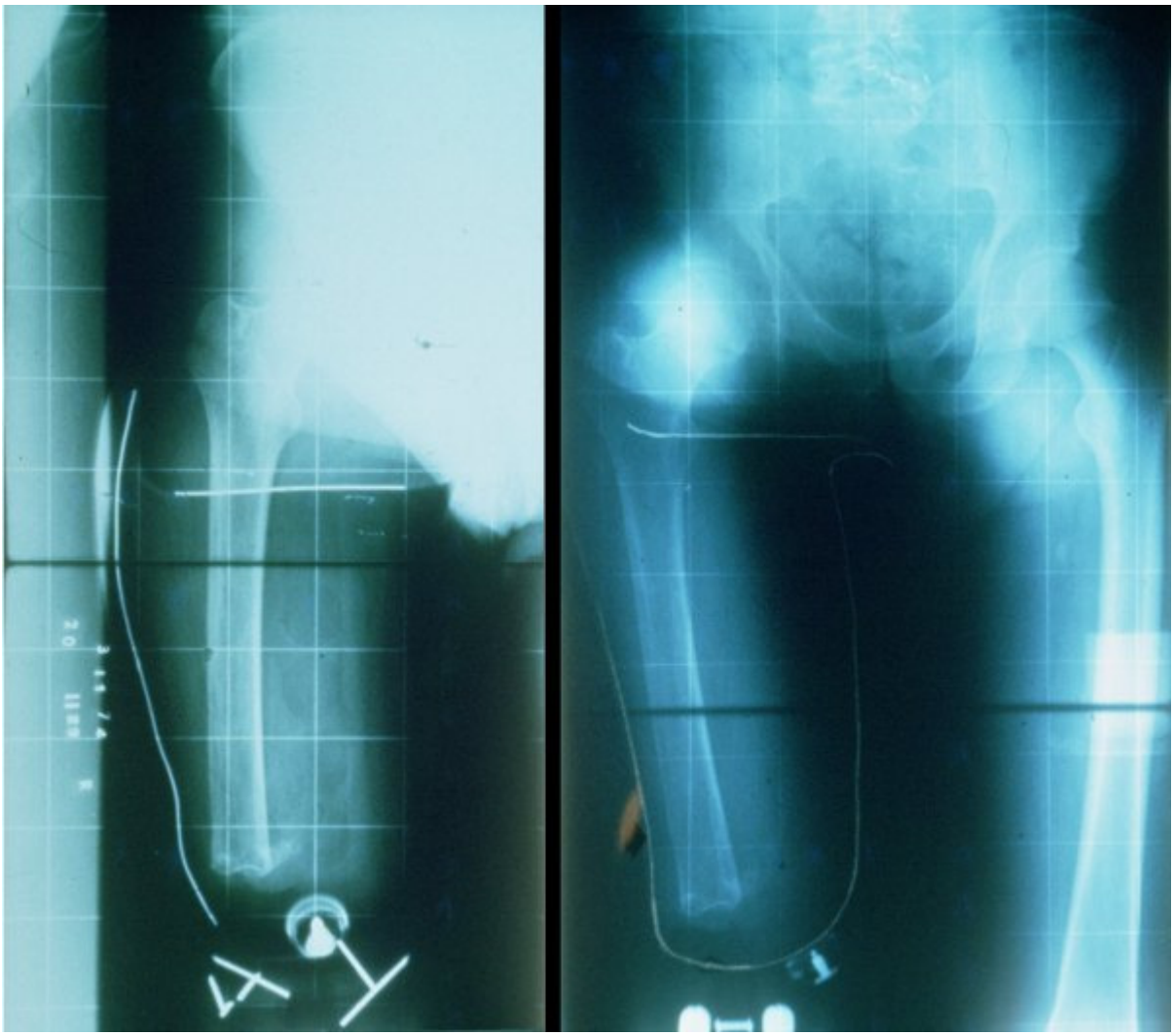

Figure 4

3. Pressure Points. Figure (5) demonstrates how readily pressure points at the distal stump can be diagnosed thru the use of an x-ray. This patients' antalgic gait was relieved by correcting this mal-alignment.

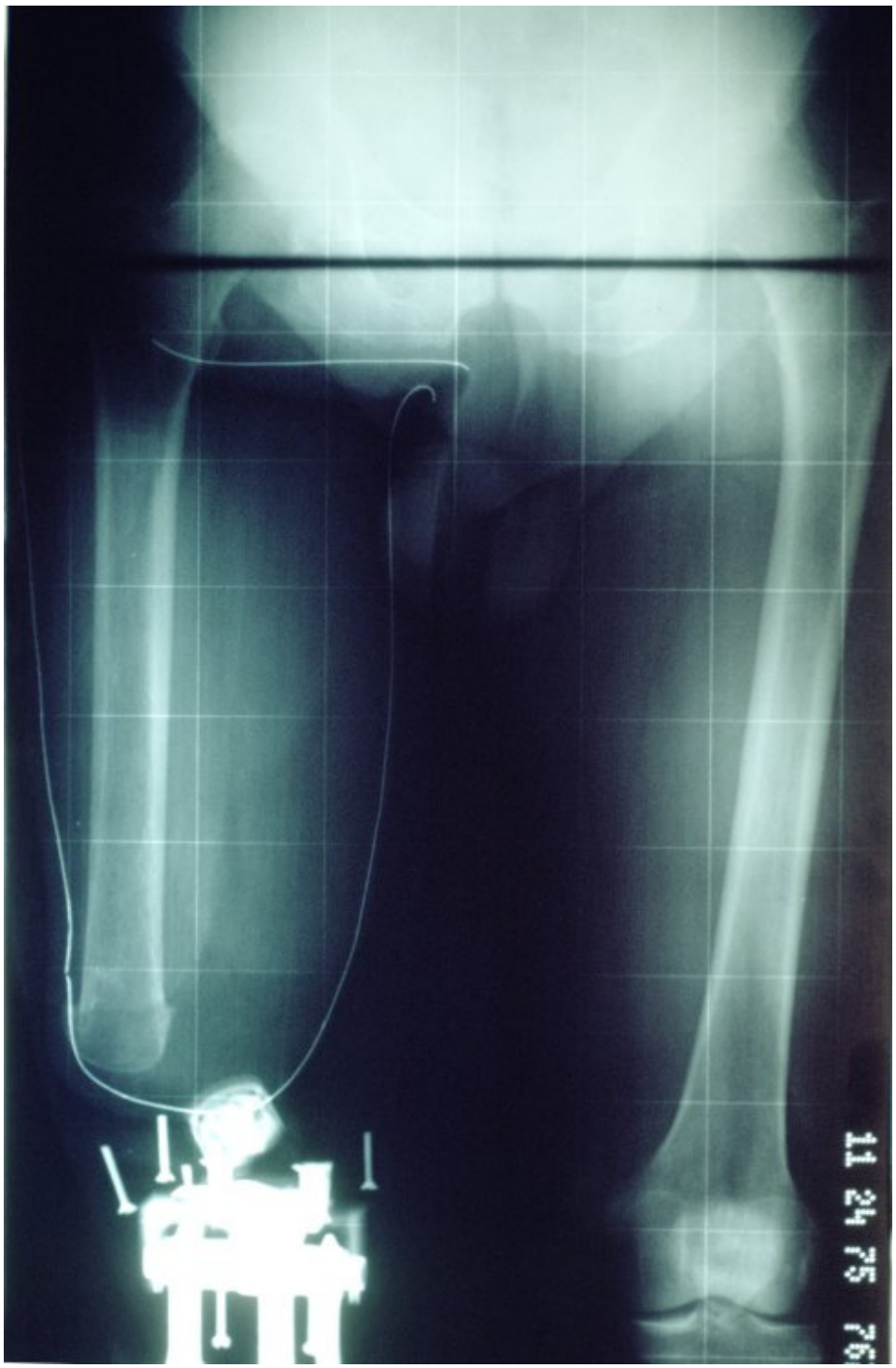

Figure 5

4. Leg Length Discrepancy. Utilizing such boney landmarks as the heads of the femur or the iliac crests aids in detecting leg length discrepancies provided you are assured the patient is bearing weight equally on both legs at the time of the x-ray exam. The grid lines in figure (6) are horizontal to the floor - Note the height difference at the femoral heads.

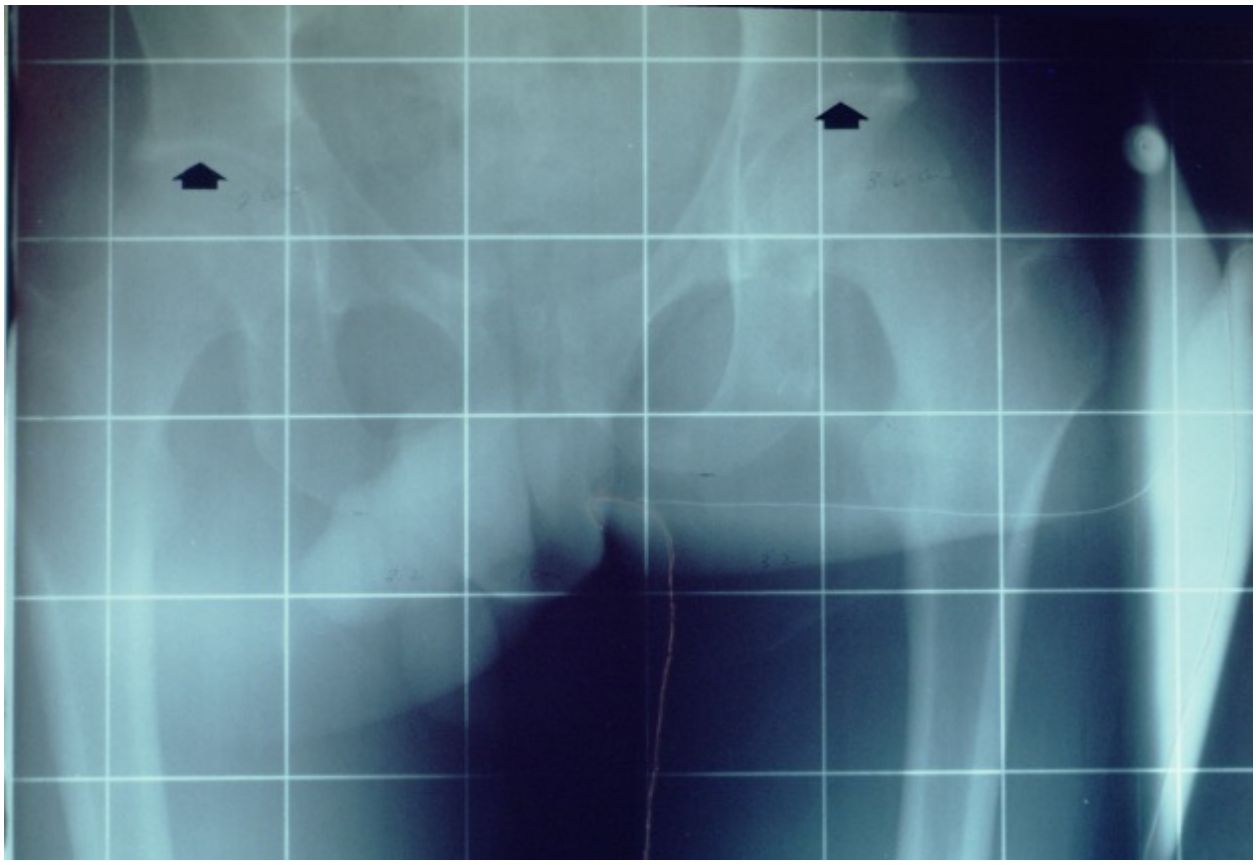

Figure 6

5. Ischial Seat. The actual position of the Ischial tuberosity on the posterior brim of the prosthesis is yet another difficult point to pin point clinically. The usual standard is for the tuberosity of the ischium to rest directly on a level posterior brim approximately one inch from the medial wall as noted in Figure (7). Figure (8) shows a variety of different deviations found thru x-ray examination.

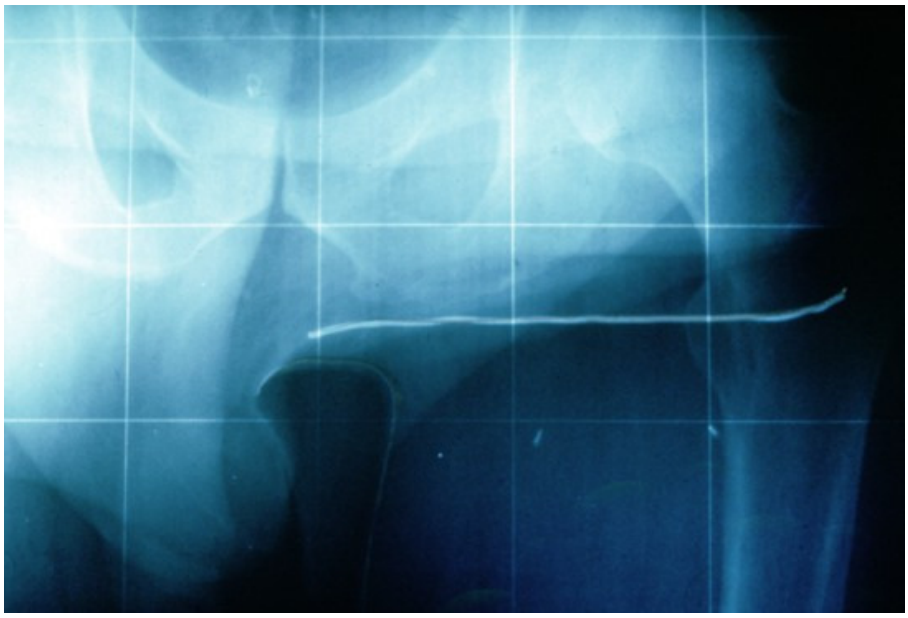

Figure 7

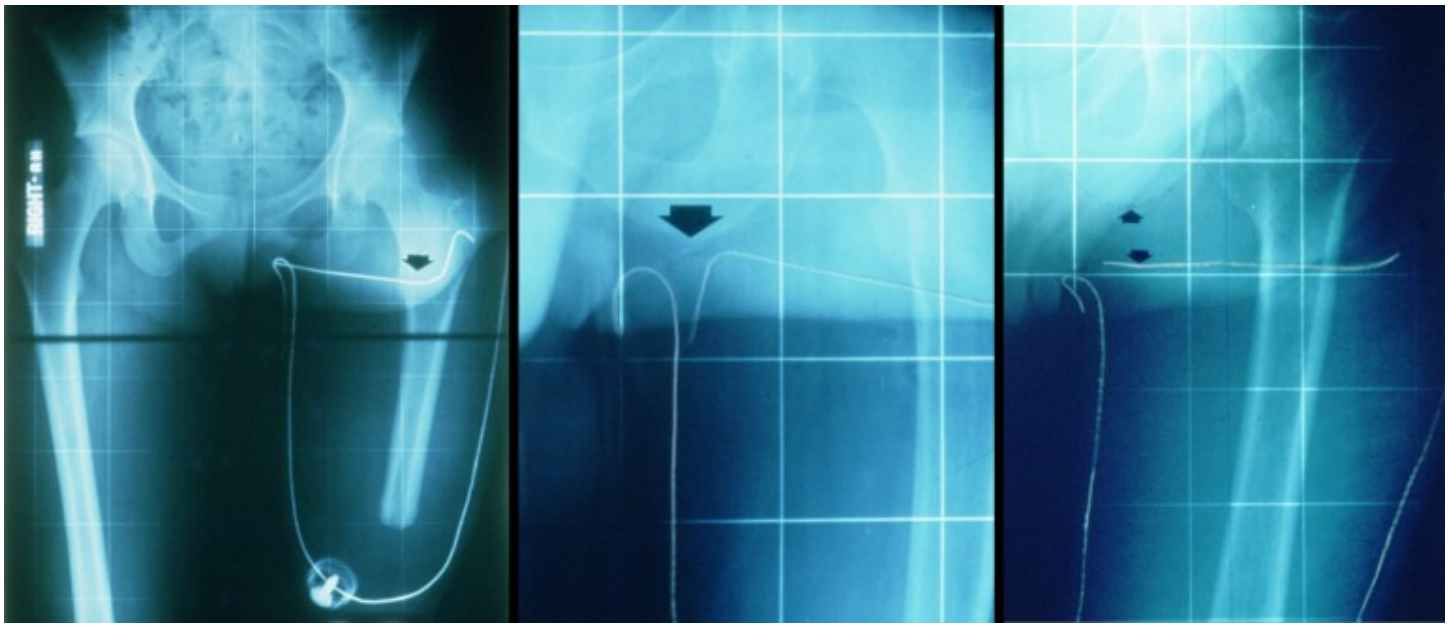

Figure 8

6. Total Contact. Current design concepts require total contact of the stump with the socket. Lack of total contact on x-ray is evidenced by a darkened dead air space as depicted distally in Figure (9).

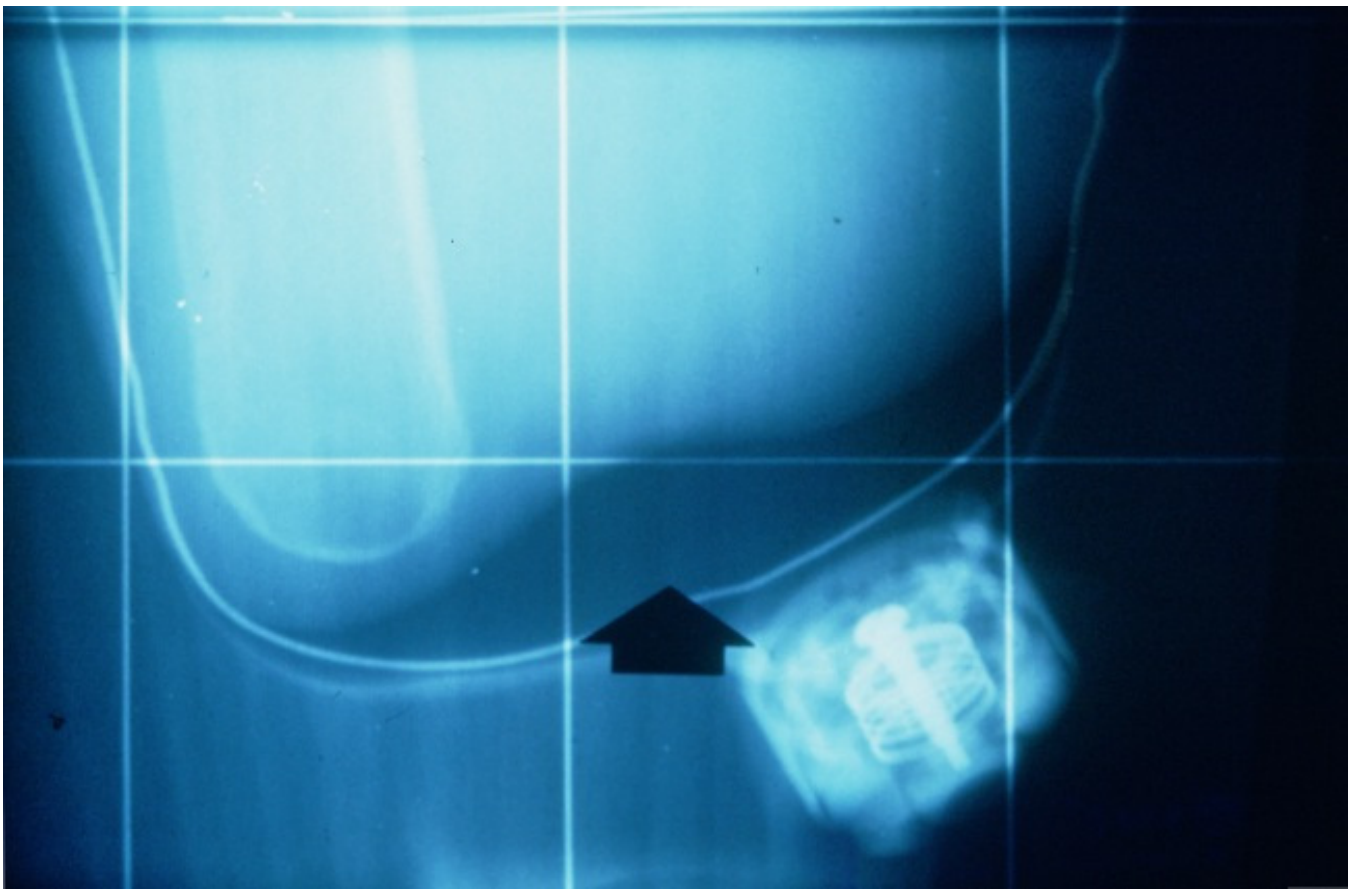

Figure 9

SUMMARY: While several other points were noted on x-ray examination as deviations from traditional alignment criteria, the above six points were found to be the most common. Figure (10) is an x-ray of a patient and his prosthesis that was aligned by conventional criteria. Note the uneven Ischial seat, the abducted posture of the femur, and the tilted knee bolt. The x-ray of the new prosthesis Figure (11) modified as the result of the previous x-ray evaluation demonstrates how improved socket support and mediolateral alignment can be achieved. Note the level seat, the adducted femur, and the level knee bolt.

The use of an x-ray evaluation of the above knee prosthesis was found to be a valuable supplement to standard checkout procedures and has proven to be an objective guide toward achieving optimal fit and mediolateral alignment for the above knee amputee. Such an evaluation has not replaced more traditional checkout procedures, but rather, has been used as yet another tool to provide objective information as an aid in achieving optimum alignment and patient function.

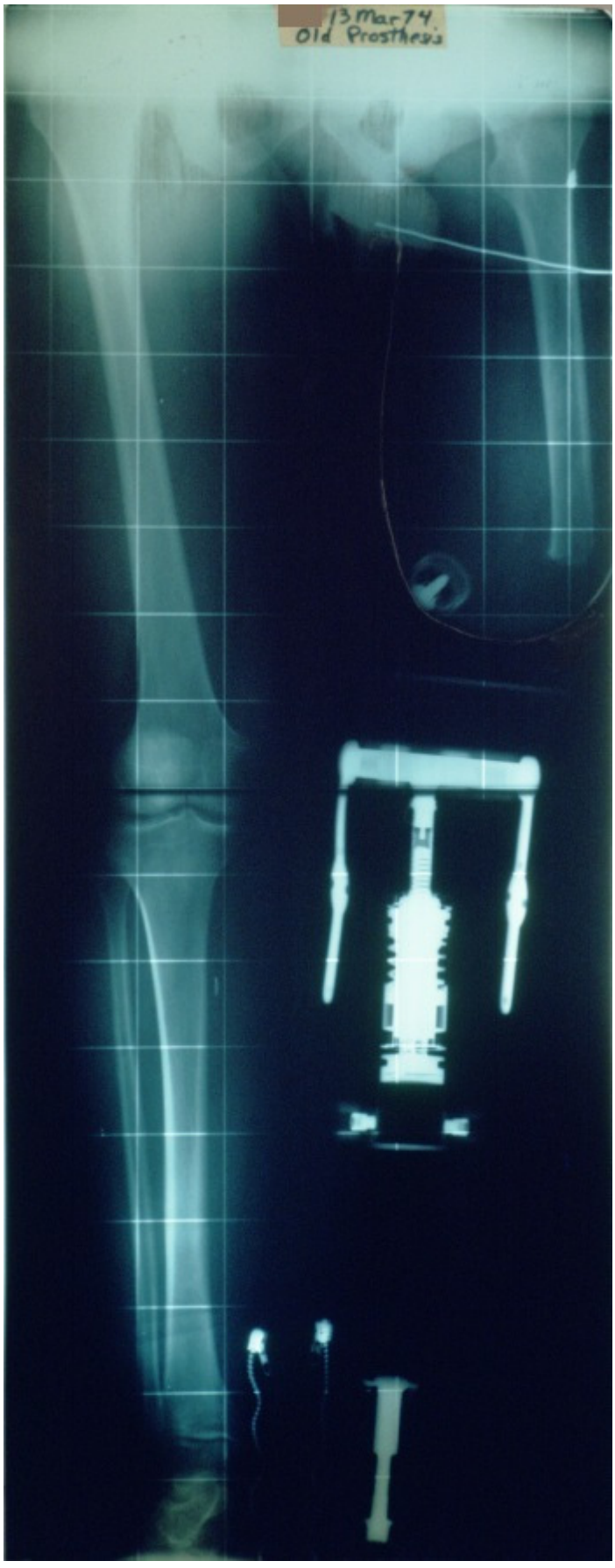

Figure 10

Figure 11