Scand J Rehab Med 18: 23–27, 1986

OBJECTIVE ANALYSIS OF WALKING IN A PATIENT WITH ANKYLOSING SPONDYLITIS AND BILATERAL HIP AND KNEE FUSION

A Case Report

Takanobu Matsunaga, Takashi Nakata and Andrew C. W. Wong

From the Department of Orthopaedic Surgery, Gifu University School of Medicine, Gifu, Japan

A fifty-two-year-old man with no known past medical history developed ankylosing spondylitis at the age of 21. Ankylosing rigidity of the entire spine and both knee and hip joints developed with these four extremity joints immobilized at 90 degrees flexion position.

The patient was subjected to the following operations over a period of 6 years:

1) interposition arthroplasty in both hips;
2) corrective osteotomy of the supracondylar region of both thighs;
3) correction of flexion ankylosis in the right hip;
4) supracondylar wedge osteotomy of the left femur;
5) subtrochanteric osteotomy of the right femur.

After this series of operations he received physiotherapy. He was able to walk with crutches and even unaided walking was possible at a later stage. Total hip or knee replacement was not performed in this patient as he did not request this.

The right hip was fused at 50 degrees flexion, 40 degrees abduction and 60 degrees external rotation. The left hip was immobilized at 30 degrees flexion, 5 degrees adduction and neutral rotation. The right and left knees were held at 30 degrees and 50 degrees flexion respectively (Fig. 1). The cervical spine was held and fused at 45 degrees flexion position and there was slight degree of flexion in the thoracic and lumbar spine with a typical bamboo spine.

Radiographs of both ankle joints revealed slight arthrotic changes; however, the patient did not complain of any symptoms. Function of the foot distal to the ankles was completely normal. There was slight restriction of shoulder elevation.

Activities of daily living included the use of simple tools and capability of getting out of bed without any aid.

Gait analysis was done with a 16 mm cine camera, a colour printer for foot print, a device for measurement of the centre of gravity of the body, a twelve-channel electromyograph recorder and a film motion analyser.

Results. Cadence was measured 84.5 per minute which is only 70–80% of normal. Walking speed was 8.5 metres per minute which is 15% of normal. The gait was non-symmetrical, and step duration longer for a short step length. Stance phase of the right lower limb was 76% which is significantly increased. The characteristical features of the walking pattern included external rotation of the frontal half of each foot during the latter half of the stance phase (Fig. 2). This gait pattern resulted from fusion of both hips and knees. Hip flexion and extension, abduction as well as knee flexion and extension of both sides were absent in this patient, and in order to proceed forward with these non-functioning joints the patient had to externally rotate the upper body on the weight-bearing limb which served as an axis for rotation.

Surface electrodes were applied to record the muscular activities of rectus femoris, biceps femoris, gastrocnemius and the anterior tibialis. Activation of the gastrocnemius started when touching the ground during the earlier half of the stance phase. In the latter half of the stance phase the anterior tibialis was highly activated. The need of stabilizing the ankle and foot joints when externally rotating the body on the weight-bearing limb was responsible for this activation.

Another point of interest was that despite total fusion of both hips and knees for more than twenty years, rhythmic movement of the rectus femoris and the biceps femoris still persisted (Fig. 4).

Discussion. Normal locomotion is determined by six determinants: pelvic rotation, pelvic tilt, knee and hip flexion, knee and ankle interaction, and lateral pelvic displacement. With the loss of e.g. one determinant of which that at the knee is the most costly, compensation can be made reasonably effective. Loss of two determinants makes effective compensation impossible and the cost of locomotion in terms of energy is increased threefold. For this patient forward movement was possible despite he had mobility only of the bilateral ankle joints and foot.

The characteristics of the pathological gait in this patient were as follows:

1) Reduction in step length because of bilateral fusion of hips and knee which influenced and decelerated the walking speed.

2) Due to flexion and extension of both hips and knees being absent the normal walking pattern, in which the falling and falling-prevention mechanism work repetitively, was completely absent. This was substituted by external rotation of the body on the weight-bearing limb and at the same time the opposite lower limb proceeded forward.

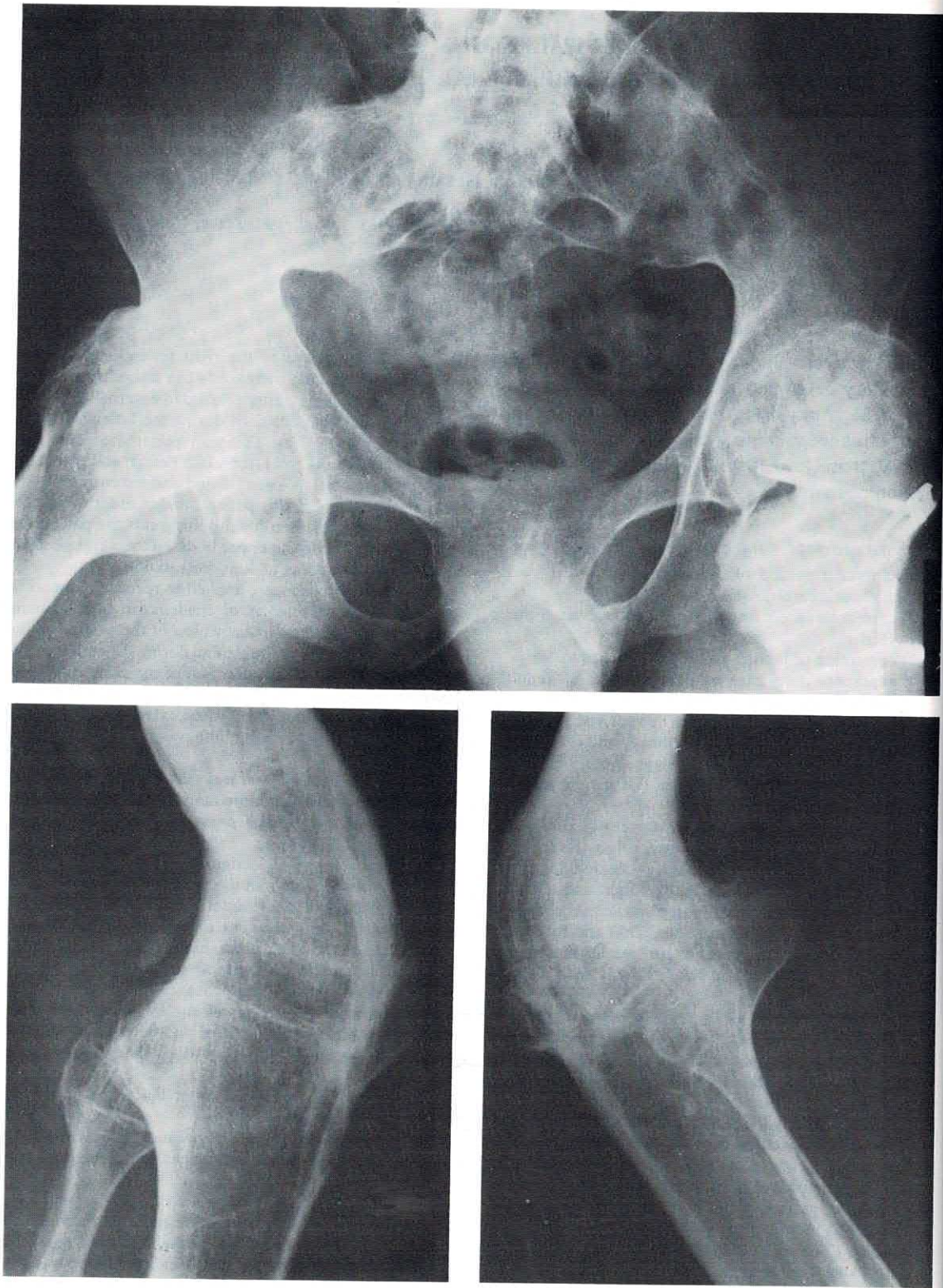

Fig. 1. Radiographs of fused hip and knee joints.

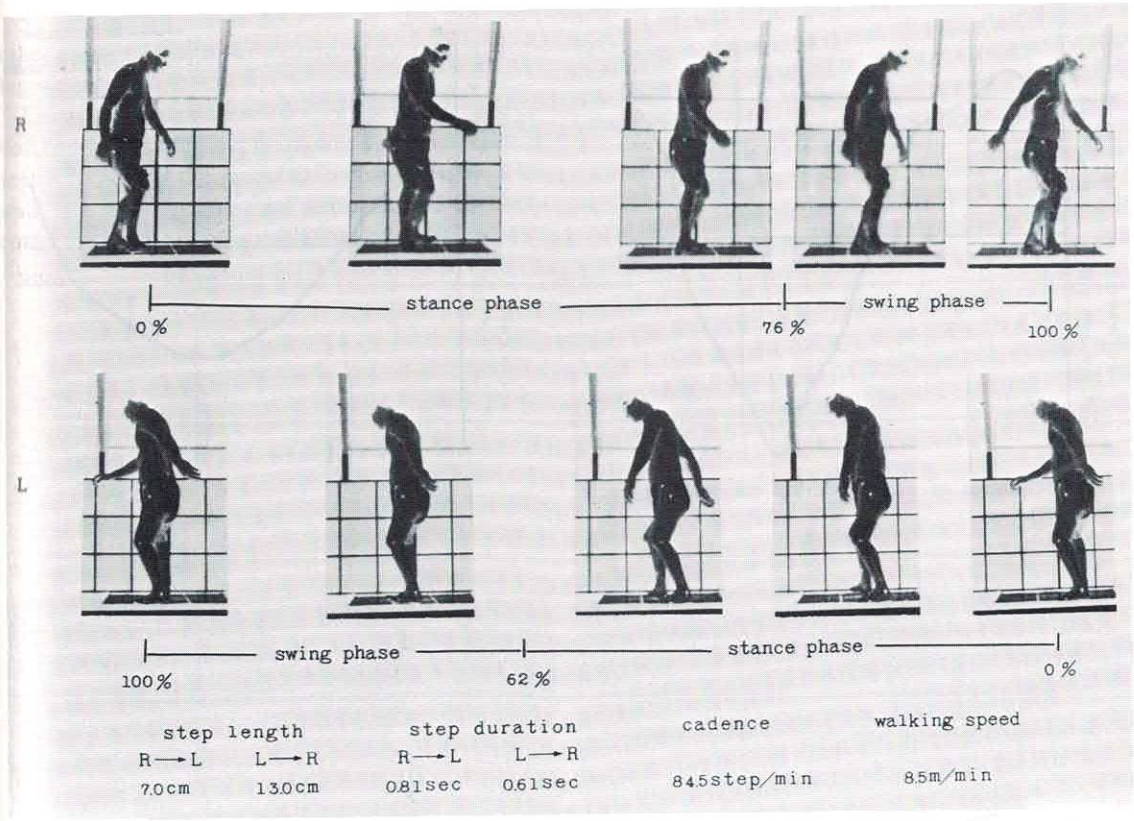

Fig. 2. Gait analysis of the patient.

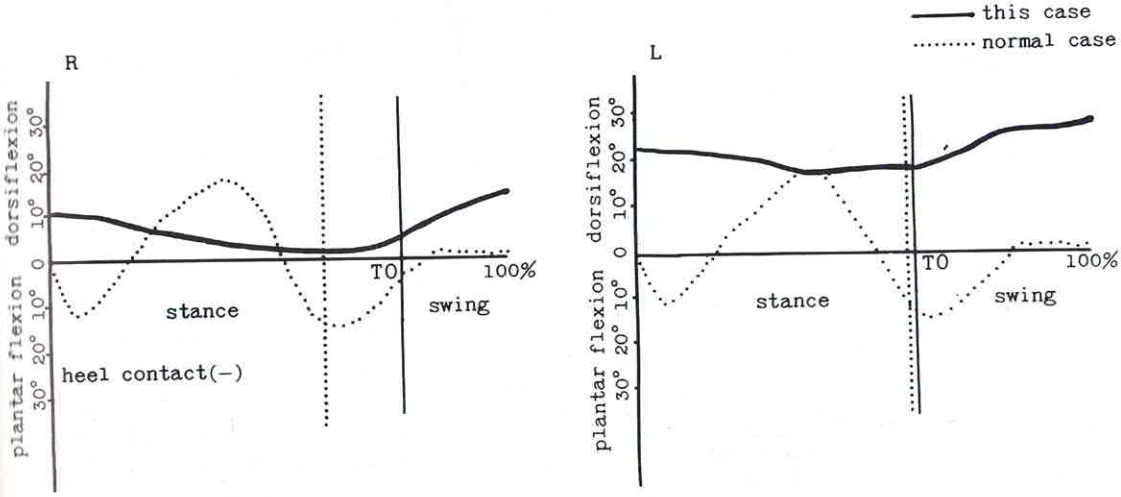

Fig. 3 A. Range of motion during one walking cycle (ankle).

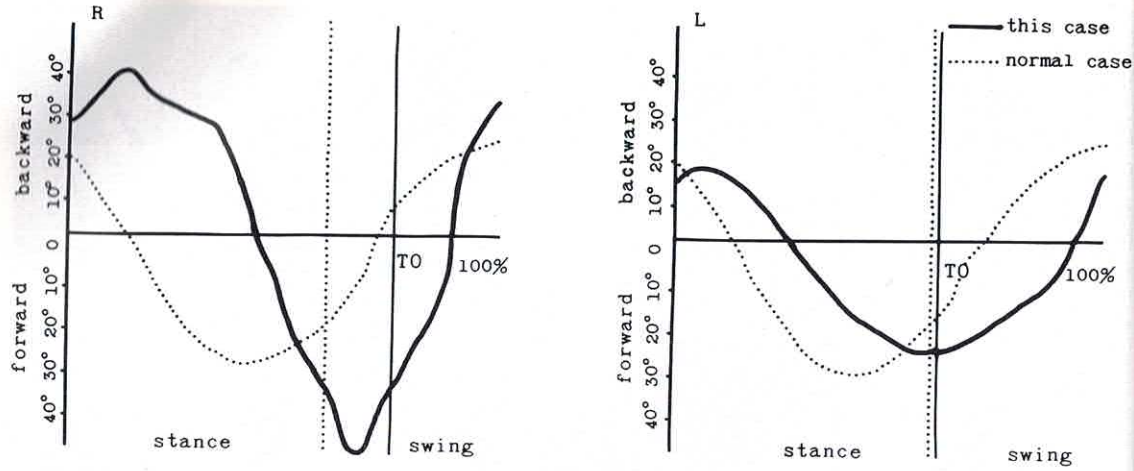

Fig. 3 B. Range of motion during one walking cycle (shoulder).

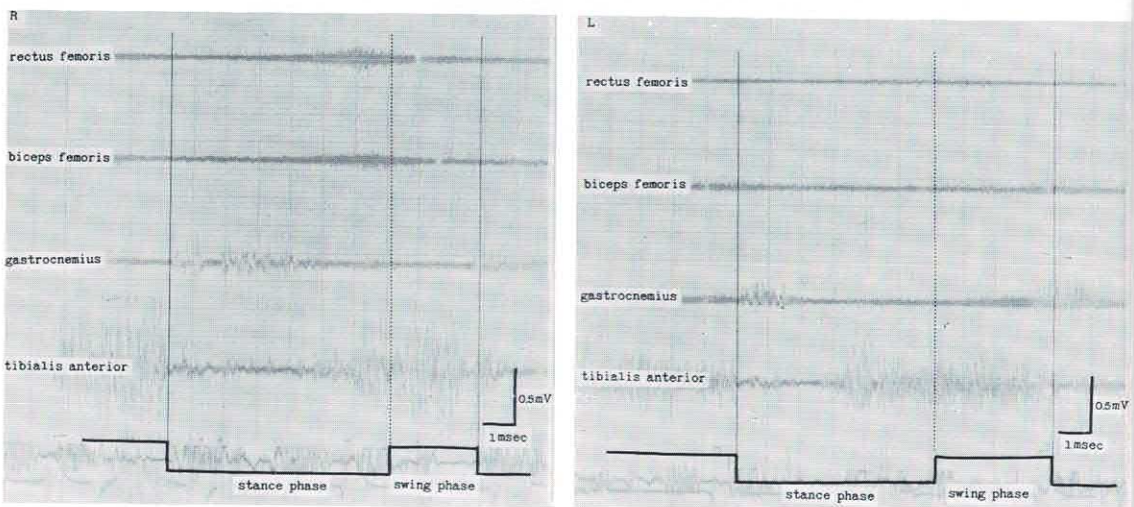

Fig. 4. Muscular activity during one walking cycle.

3) Different step lengths due to different fused positions of both hips and knees.

4) An increase in the range of motion of the right shoulder. Normal human locomotion is a sequential process of falling and recovery. Loss of this process left this patient with no alternatives besides using the remaining ankle and other foot joints. Forward propulsion was possible by swinging out and rotating externally the upper body on the weight bearing limb that served as the axis for this motion (Fig. 3 A, B).

The biomechanical and somatic factors that contributed to the standing and walking ability of this patient were as follows:

1) Good stability of non-tender and immobile larger joints of the lower extremities.

2) Both hips and knees were fused in such a way that a wide base was permitted for sufficient stability. The posture resembled basic dynamic postures usually seen in boxing or other martial arts like karate or judo.

3) Preservation of the ankle and other foot joints was possible which facilitated equilibrium of body support.

4) In the standing position the cervical spine was fused in such a way that a three-metre front view was permitted.

5) Except for slight disorder of the shoulder, other joints of the upper extremities were functioning well.

Lastly, although these factors favour compensation to a certain degree, no matter how ineffective it seems to be, yet the main reason for this patient to walk was his rigorous and strong desire to overcome the hardship of immobilization.

Address for offprints:
Takanobu Matsunaga, M.D.
Dept of Orthop Surgery
Gifu Univ School of Medicine
Gifu, Japan