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A FOLLOW-UP EXAMINATION OF THE FUNCTION OF THE LOWER EXTREMITY AFTER PELVIC TUMOUR EXTIRPATION INCLUDING THE ACETABULAR RING

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ABSTRACT. **Gait, hip muscular function and clinical features were analysed in 5 patients with chondrosarcoma of the pelvis operated with removal of the tumour, including the acetabular ring. The lower extremity thus remained intact. The aim of this study was to compare the functional results with those obtained in a previous investigation two years earlier. The same tests were used, but more attention was focussed to the functional part and thus step length, gait velocity, and active range of motion were added. At both examinations none of the patients had pain. All performed surprisingly well as regards work and gait. Clinical and objective findings were, however, less impressive. There was a direct relationship between hip extension strength and weight bearing on the operated leg, gait velocity and maximal walking distance. Moreover, the extension strength was also related to the formation of a new acetabular roof and to the age the individual represented, with preference to the young. Compared with the previous examination, 2 patients had made remarkable progress, 2 were unchanged but still showed good results and one showed less good results.**

Key words: Chondrosarcoma; pelvic tumour; gait; muscle force; acetabular ring

In a previous study a report was given of clinical assessment, gait, and hip muscular function in 7 patients with chondrosarcoma after pelvic tumour extirpation including the acetabular ring (5).

The results at clinical examination were less impressive than the functional results, such like walking and work capacity.

Pain had been alleviated. All patients had a marked pelvic tilt and a positive Trendelenburg sign. All patients except one used some kind of support in walking. Leg length difference was 6 cm, on average.

On gait analysis, all patients had reduced weight bearing time on the operated side. This was less pronounced in patients who had improved as regards pain, walking, and work capacity. These patients also showed the best hip extension power, which appeared more important from a functional point of view than did hip flexion and, surprisingly, hip abduction power.

Decisive for good function was osseous support for the proximal femur. This support could be applied either by the formation of a bone shelf from the remaining iliac bone, or by the iliac bone itself.

The results showed that a local radical extirpation—including the acetabular ring—of a pelvic tumour proved to be as recommendable a procedure from a functional point of view (5) as hemipelvectomy.

To analyse gait and muscle power in greater detail, an extended investigation of the above material was carried out 2 years following the previous study.

MATERIAL

Of the 7 earlier examined patients with chondrosarcoma operated with local extirpation of the pelvic tumour and with preservation of the limb (Figs. 1, 2), 2 had died of metastatic disease. Four men and one woman between 27 and 73 years of age remained. None of these had known metastases. Time of follow-up was 4 years 10 months, 8 years 8 months, 3 years 9 months, 11 years 11 months and 8 years (Table I). All patients had had the muscles iliacus, sartorius, rectus femoris and the adductors transected and the muscles biceps femoris, semimembranosus and semitendinosus detached from the ischial tuberosity in order to extirpate the tumour. For further details, see Table II.

One patient (K. L.) had prior to this investigation had one local metastatic soft tissue tumour in the hip region extirpated after the initial pelvic operation.

Another patient (A. K.) had had seven soft tissue tumours in the hip region extirpated. Part of the gluteus maximus muscle had been removed.

Aim of This Study

As this examination laid more stress on function, the following questions were asked:

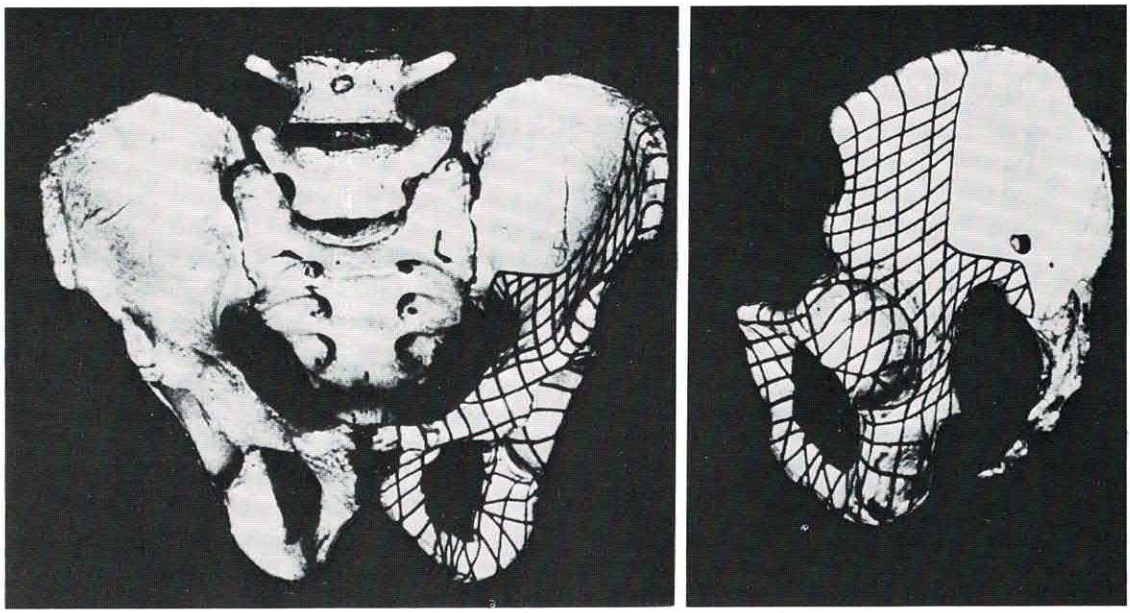

Fig. 1. Resected area of pelvis in patient K. S.

1. Pain on weight bearing, motion and at rest?
2. Maximal walking distance?
3. Need of walking aids?
4. Work capacity?
5. Leisure activity?
6. Technical aids?
7. Ability to ride a bicycle?
8. Ability to climb stairs?

Furthermore, the patients were asked if they had reached a state, that they considered permanent or if they thought that they could be further improved.

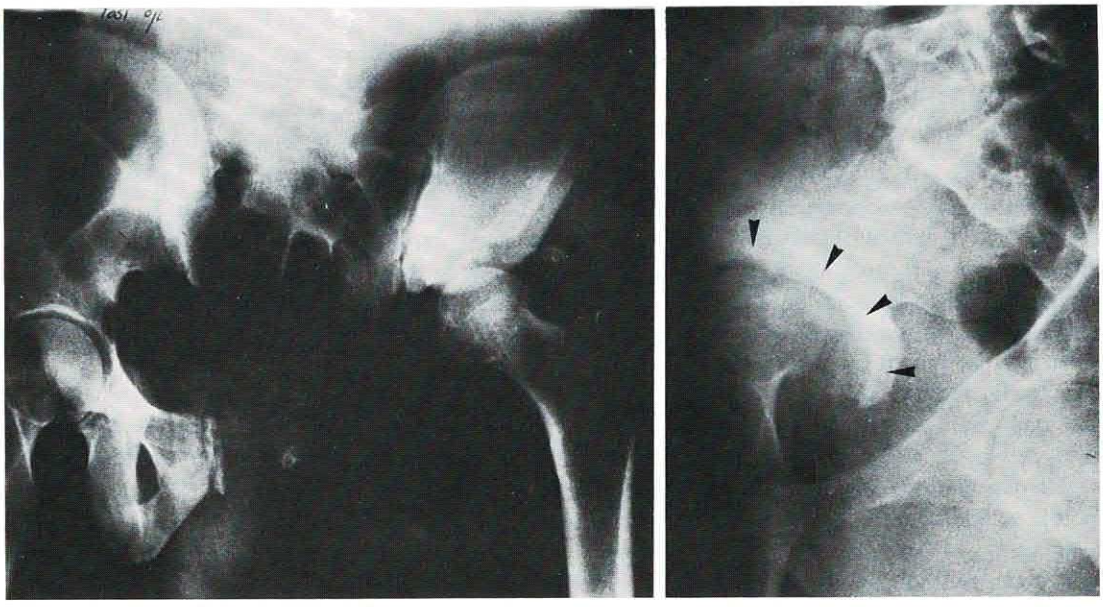

Fig. 2. Radiographs of patient in Fig. 1. *Left:* Immediately following surgery. *Right:* 19 months postoperatively. Note formation of new roof!

Table I. *Material*

Patient	No. I	Sex	Age I	Age II	Follow-up I	Follow-up II	Removal of femoral head	Leg length difference	Formation of new roof
P. H.	2	M	71	73	2 yrs 8 m	4 yrs 10 m	–	6 cm	Yes
A. K.	3	F	66	68	6 yrs 7 m	8 yrs 8 m	Yes	8 cm	–
K. S.	4	M	33	35	1 yr 6 m	3 yrs 9 m	–	2.5 cm	Yes
D. K.	5	M	59	61	9 yrs 10 m	11 yrs 11 m	Yes	6 cm	–
K. L.	6	M	25	27	5 yrs 11 m	8 yrs	–	6 cm	Yes

I=examination 1, previous study 1980.
II=examination 2, present study 1982.

METHOD

Clinical Examination

Besides the above-mentioned features being examined, the functional leg length difference was measured by placing plates under the foot of the operated leg until the anterior superior spines were horizontal.

The passive range of motion in all directions of motion was measured with a goniometer by two physical therapists, one of whom held the relaxed leg of the patient while the other physical therapist did the measuring. Flexion was measured with the opposite hip straight. Extension was measured with the opposite hip flexed in order to flatten the lumbar lordosis. Measurement of the

Table II. *Detailed surgical procedures for each patient*

Patient	Osteotomies	Iliopsoas	Hamstrings	Rectus femoris	Sartorius	Adductors	Glutei	Lig. sacrotuberale and sacrospinale
P. H.	Close to the symphysis. Just proximal to incisura ischiadica. A few cm of the anterior part of the crista is removed.	Iliacus divided	Origins divided	Divided	Divided	Larger part released	Released	Divided
A. K.	In the symphysis. Through ilium, 1 cm proximal to the acetabulum, dorsally towards incisura ischiadica	Suture to the anterior superior spine	Decorticated from ischial tuberosity	Suture to anterior superior spine	Suture to anterior superior spine	Divided medially	Ala ossis ilii dissected free. Suture to the externus aponeurosis	Divided
K. S.	In the symphysis. At incisura ischiadica	Iliacus and iliopsoas divided	Released	Origin divided	Origin divided	Divided at insertions	Released	Divided
D. K.	Three cm proximal to the acetabulum. Incisura ischiadica is dissected free	Divided close to insertion	Released blunty	Released	Released		Released from ala ossis ilii	Lig. sacrospinale divided
K. L.	Through os pubis of the opposite side. Just proximal to the acetabulum		Origins divided			Released	In- and outside of ala dissected free	

No detailed report in the muscular reconstruction.

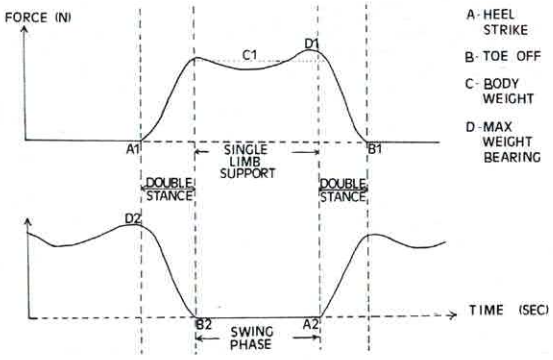

Fig. 3. Weight bearing on one leg (*top*) as recorded by the electronic walk-way. The upper curve describes the vertical forces produced during weight bearing of the foot, from heel-strike to toe-off. The lower curve shows the opposite leg in the swing-phase.

active range of motion was added in the present examination. Trendelenburg's test was carried out. No radiological examination was done.

Gait Analysis

Estimation of the gait pattern was made partly by subjective observations (i.e. Trendelenburg gait and symmetrical movements of the upper extremities), partly on an electronic walk-way as described by Rydell (6).

All patients wore shoes built-up to compensate leg length difference.

Three or four registrations were made per patient. The calculations were made on the curve that best represented the way of walking corresponding to the normal way.

Time

The time of single limb support (swing phase of the opposite leg) was noted. The ratio was calculated between the means of the single limb supports of the operated and the non-operated leg, as a measure of the weight bearing time of the operated leg.

Maximum weight bearing

The maximum load put on the operated leg during single limb support (the maximum vertical force) was defined as a line from the base line to the highest peak of the stance-phase curve. The line was measured in mm. The ratio was calculated between the means of the amplitudes of the operated and the non-operated leg during single limb support as a measure of the maximum weight bearing of the operated leg (Fig. 3).

Step frequency

Step frequency (cadence) was controlled and determined with the help of a stop watch and calculated from the

Table III. *Walking ability*

Patient	No.	Maximum walking distance		Walking aid	
	I	I	II	I	II
P. H.	2	500 m	700 m	2 crutches	1 crutch
A. K.	3	1 km	1 km	2 crutches	2 crutches
K. S.	4	Unlimited	7 km	None	None
D. K.	5	Unlimited	2 km[a]	1 crutch	1 crutch
K. L.	6	Unlimited	1 km	1 crutch	None

I=examination 1, previous study 1980.
II=examination 2, present study 1982.
[a] in reality, no change I/II.

Table IV. *Range of passive hip motion*

Patient	No.	Flexion				Extension				Abduction			
		Op		Non-op		Op		Non-op		Op		Non-op	
	I	I	II	I	II	I	II	I	II	I	II	I	II
P. H.	2	70°	70°	110°	110°	0°	0°	0°	0°	20°	20°	20°	30°
A. K.	3	135°	110°	120°	120°	30°	20°	0°	10°	35°	50°	20°	30°
K. S.	4	90°	120°	125°	140°	10°	15°	0°	0°	15°	25°	30°	20°
D. K.	5	90°	80°	95°	100°	0°	10°	0°	0°	20°	15°	25°	25°
K. L.	6	90°	80°	120°	125°	−15°	10°	0°	0°	25°	15°	35°	20°

I=examination 1, previous study 1980.
II=examination 2, present study 1982.

curve. The walking distance was doubled to 10 m in order to obtain more reliable values.

One of the prerequisites in modern gait analysis is the estimation of step length and gait velocity (as described by Lamoreux & Todd (2), which were measured in the present examination as an additional procedure. Step length was measured by letting the patient step on a stamp pad and the distance between the first and the last heel print on a 5 m distance was divided by the number of steps. Gait velocity was calculated by a stop watch on a 10 m distance and was registered in metres per second.

Muscle Force Analysis

The maximum isometric strength in flexion, extension and abduction of the hip was measured with the Cybex II isokinetic dynamometer (Lumex, New York). The muscle torque produced was registered with strain gauges on the lever arm and registered by a Gould Brush 220 recorder (Gould Inc. Instrument Systems Division, Cleveland, Ohio). The method was described by Hislop & Perrine (1) and by Moffroid et al. (4).

The ratio in per cent between the maximum torque (Nm) of the operated and the non-operated hip was used as a measurement of the strength of the operated hip. The strength in flexion and extension was measured in 45° of flexion and without support for the foot. The strength in abduction was measured in the neutral position and also in the supine position, as the patients had difficulties abducting the leg against gravity. The patients were instructed to avoid outward rotation of the hip when testing flexion and abduction strength.

The aim was to prepare optimal conditions for activity from the iliopsoas and gluteus medius, respectively. Markhede (3) has made measurements of hip abduction in the Cybex II. In our previous examination the axis of rotation of the apparatus was beside that of the hip joint, and registration was made of both uni- and bilateral abduction. In the present examination the method has been further developed in so far as the table and a special construction on the resisting arm have been arranged, so that the axis of rotation of the apparatus lies under that of the hip joint. Only unilateral abduction was tested and the pelvis was fixed. Though the methods were not alike, there was a good conformity between them.

Outward rotation				Inward rotation			
Op		Non-op		Op		Non-op	
I	II	I	II	I	II	I	II
	40°	-	30°	−20°	−20°	-	30°
	80°	-	35°	-	90°	-	20°
15°	15°	25°	10°	0°	0°	30°	20°
	50°	-	30°	-	20°	-	10°
	20°	-	30°	-	10°	-	20°

Summary of Additional Factors Studied at the Present Examination

As the aim of the present examination was to illustrate more closely what the surgical procedure could permit, concerning function, special parts have been added or extended as follows:

1. More comprehensive questions have been asked concerning
   (*a*) pain
   (*b*) leisure activity
   (*c*) technical aids
   (*d*) ability to ride a bicycle and climb stairs.
2. Passive range of hip rotation has been tested.
3. Active range of motion of the hip has been measured in greater detail.
4. A further development of measuring the hip abductor force has been undertaken.
5. Step frequency has been tested with a stop watch over a doubled walking distance.
6. Step length and gait velocity have been recorded.

RESULT

Clinical examination (Table III–V)

No patient complained of pain in the hip region, but discomfort of short duration occurred after strain. All patients considered their maximum walking distance to be satisfactory (Table III).

Case histories

One patient (P. H.) was retired and had had several myocardial infarctions, but worked every day in his carpenter's workshop—he sawed, carried firewood and had even climbed the roof to mend a hole. He used a pair of reacher tongs and a glider chair and did not think that he had improved since the previous examination. He could not ride a bicycle, but managed stair climbing in the normal way, i.e. putting one leg in front of the other.

A female patient (A. K.) was also retired but worked every day at her loom. She devoted herself to active club work and sometimes on these occasions used a wheel chair. She could manage neither bicycling nor normal stair climbing. Four hours a week she got household help for household chores, shopping, and laundry. She still noticed some improvement.

Another patient (K. S.) was a full-time musician, sitting or standing for hours playing the double bass. His occupation required that he travel every week to engagements. He was very active in his spare time and had arranged to train bicycling indoors on the racing bicycle that he otherwise used for transportation. Every day he carried out an advanced strengthening program, climbed stairs two steps at a time and could swim several hundred metres at a time. During winter he could use social transportation for the handicapped. He too noticed improvement.

One patient (D. K.) was a full-time business man, who did a lot of travelling. He exercised every day on his

Table V. *Active hip motion*

Patient	Flexion		Extension		Abduction	
	Straight leg raising	Standing	In lateral position	Prone	Supine	In lateral position
P. H.	Cannot	45°	Yes	Not tested	Yes (with rectus & tensor)	Cannot
A. K.	Cannot	20°	Cannot	Cannot	Cannot	Cannot
K. S.	30°	50°	Yes	Yes	Yes	Yes
D. K.	Cannot	40°	Yes	Cannot	Yes (with rectus & tensor)	Cannot
K. L.	Cannot	30°	Yes	Cannot	Yes	Cannot

Adduction and rotation not tested.

bicycle ergometer and managed stair climbing normally. He used a cane, but had not noticed any improvement since the previous examination. One day each week-end he stayed in bed for psychological reasons.

One patient (K. L.) was a full-time engineer. In his spare time he was football trainer. He then moved in a jumping, limping but "distance gaining" way of running. He climbed the stairs in a normal way, used no technical aids and considered his hip to be still improving, especially after abandoning the cane. He could not ride a bicycle due to limited ability to bend the knee after a fracture of the patella.

Work capacity

All in all, the same activities were retained but with an improved capacity compared with the previous examination.

Leg length difference

Leg length difference was unchanged compared with the previous examination.

Passive range of motion

The passive range of motion is shown in Table IV. All patients had for their age a normal range on the non-operated side. After the operation, *flexion* had decreased compared with the non-operated side in all patients. Three patients (P. H., D. K. and K. L.) could not flex to 90°, but enough to sit comfortably. In one patient (P. H.) *extension* was unchanged 0°, but otherwise increased and in one (A. K.) reached to 20°. The differences in *abduction* vis-à-vis the non-operated side were negligible except in one patient (A. K.) who had increased 20°.

Adduction was increased in all patients on the operated side, but not registered, as it was impossible to determine when pelvic movement had started.

Outward rotation was in every case except one (K. L.) increased on the operated side. One patient

Table VI. *Gait analysis*

Patient	No. I	Walking aid	Weight-bearing: Time (op/non-op) I	Time (op/non-op) II	Load (op/non-op) I	Load (op/non-op) II	%body weight on op. limb I	%body weight on op. limb II	Ability to walk without walking aid
P. H.	2	1 crutch	0.75	0.94	0.77	0.70	77%	68%	Cannot
A. K.	3	2 crutches	0.75	0.72	0.25	0.15	25%	16%	Cannot
A. K.	3	1 crutch	-	0.55	-	0.67	-	68%	
K. S.	4	None	0.75	0.87	1.00	0.88	100%	100%	
K. S.	4	None	-	0.92	-	0.99	100%	100%	
D. K.	5	1 crutch	0.92	0.88	0.78	0.81	78%	78%	Cannot
K. L.	6	1 crutch	0.93	0.92	0.75	0.76	75%	80%	
K. L.	6	None	0.69	0.77		0.99	100%	100%	

I=examination 1, previous study 1980.
II=≡examination 2, present study 1982.

Table VII. *Muscle force analysis in "Cybex II"*

The torque of the operated hip in relation to the torque of the opposite hip

Patient	No.	Flexion		Extension		Abduction	
		I	II	I	II	I	II
P. H.	2	15%	20%	68%	52%	69%[a]	65%[a]
A. K.	3	Cannot	Cannot	65%	59%	20%	18%
K. S.	4	33%	28%	90%	116%	63%	55%
D. K.	5	48%	51%	86%	71%	50%[a]	61%[a]
K. L.	6	14%	5%	77%	97%	36%	48%

Adduction and rotations not tested.
I=examination 1, previous study 1980.
II=examination 2, present study 1982.
[a] Not according to instruction.

(A. K.) had developed an abnormally large range of motion.

Inward rotation was reduced in 3 patients (P. H., K. S., K. L.), one of whom (P. H.) had an outward rotation contracture of 20°. In 2 patients (A. K., D. K.) inward rotation had increased and in one (A. K.) reached 90°.

Compared with the measuring of the passive range of motion at the previous examination, one patient (K. S.) had an increased flexion and abduction, one patient (K. L.) had got full extension but reduced abduction, and one (A. K.) reduced flexion and increased abduction.

Range of motion of the knee was normal with the exception of 2 patients (A. K. and K. L.) who had certain limitations due to fracture of the tibia and patella respectively.

Active range of motion (Table V)

Flexion. Four patients (P. H., K. S., D. K. and K. L.) could lift the operated leg from a supine position. Three of them (P. H., D. K. and K. L.) did so by tilting the pelvis and bracing the non-operated leg against the table. However, no flexion of the hip was noticed. The leg hung rather in the soft tissues of the hip. One patient (D. K.) showed a marked outward rotation of the hip and a visible contraction of the rectus femoris and tensor fasciae latae. Only one patient (K. S.) could carry out straight leg raising to 30° flexion.

One patient (A. K.) could not lift her leg from the table. All patients were able to clear the foot from the ground when standing. One patient (A. K.) did so by bending the knee and in doing this the hip was momentarily flexed a little, while the rest of the patients lifted the foot with some kind of active hip flexion.

Extension. Hip extension in the lateral position from 30° flexion with flexed knee in order to test the gluteus maximus muscle could be carried out by all patients except one (A. K.). One patient (K. S.) was the only one, who culd extend the operated leg from the prone position, i.e. against gravity.

Abduction. Abduction by the gluteus medius, i.e. supine with the hip straight and not outwardly rotated, could be done by 2 patients (K. S., K. L.). Two patients (P. H., D. K.) performed the abduction test with the hip in marked outward rotation and with visible contraction of the rectus and the tensor. Only one patient (K. S.) could abduct the leg from the lateral position with a clear both visible and palpable contraction of the gluteus medius. One patient (A. K.) was not able to do an abduction.

Active range of motion in adduction and rotation was not tested, as it was considered less important.

Trendelenburg's test was in all cases positive as in the previous examination.

tep frequency teps/min)			Step length (cm)	Walking speed (m/sec)
	II	IIa	II	II
5	74	78	61	0.798
6	56	63	42	0.438
	49	53	27	0.239
4	100	100	80	1.333
	85	83	71	0.980
7	84	83	63	0.877
0	84	80	81	1.080
0	86	80	80	1.067

Gait analysis (Table VI)

In comparison with the previous examination 2 patients (K. S., K. L.) gave the impression of having improved their gait considerably. This was also confirmed by all the analyses of the gait. The other three seemed to walk as well as 2 years previously which was confirmed by the recordings from the walk-way concerning 2 patients (P. H., D. K.). One patient (A. K.), however, showed over all less good results.

One patient (PH), who walked normally with two crutches at the previous examination, but also managed a test with one only used one crutch normally this time. A comparison of registration curves showed that the ratio between the operated and the non-operated leg concerning time of weight bearing of the single limb support had increased from 0.75 to 0.94. Weight bearing on the operated leg as a percentage of body weight had decreased from 77% to 68%. Step frequency was almost unchanged, 75 compared with 74 steps/min. Step length was 61 cm and gait velocity 0.798 m/sec. The patient's heart insufficiency was the reason for the limitation in walking distance.

One patient (A. K.) could only walk with two crutches at the previous examination. This time recordings were made with both one and two crutches. She could not walk without aid. A comparison between the recordings with two crutches shows that the ratio between the time of weight bearing of the operated and non-operated leg was almost equal, 0.75 and 0.72. On the other hand, the operated leg took only 16% of the body weight, implying a very little load on the hip, compared with 25% at the previous examination. Step frequency calculated from the curve was at the previous examination 66 steps/min and now 56 steps/min but the calculation of step frequency made at the present examination over a longer distance for control was 63 steps/min, indicating no great difference.

Step length was 42 cm and gait velocity 0.438 m/sec. When walking with only one crutch, weight bearing on the operated leg was 68% of the body weight, but weight bearing time only half that of the non-operated leg.

Step frequency was 53 steps/min, step length only 27 cm and gait velocity 0.239 m/sec. Very slowly, with a marked limp and very short steps was she able to walk with only one crutch.

One patient (K. S.) walked at both examinations without walking aids, but at the present time with much less Trendelenburg limp. This kind of limping was otherwise very striking in patients walking without support. Walking with the same step frequency (85 steps/min) as before (84 steps/min) and with the velocity 0.98 m/sec, for this patient more slowly than normally, his ratio of weight bearing time was 0.92 as compared with 0.75 at the previous examination. Thus, with the same step frequency he put more weight on the operated leg at the present examination. Step length was 71 cm.

A comparison of the registrations at his normal gait velocity showed, that the step frequency had increased from 84 to 100 steps/min. Step length was at the present examination 80 cm and the velocity 1.333 m/sec.

The ratio of the operated and non-operated leg concerning time of weight bearing had also increased from 0.75 to 0.87.

Due to higher speed, weight bearing as a percentage of body weight was more than 100% on both legs. It was, however, larger on the non-operated leg, which explains the figure 0.88 showing the ratio between weight bearing on the operated and non-operated leg. This patient had accordingly increased his normal gait velocity and put more weight for a longer time on his operated leg as compared with the previous examination.

One patient (D. K.) gave no impression of having altered his gait with a cane since the previous examination. This was confirmed by the comparison between the objective recordings. The ratio of weight-bearing time between the operated and non-operated leg had decreased from 0.92 to 0.88. 78% of the body weight was put on the operated leg at both times of recording. Step frequency had increased from 77 to 84 steps/min. Step length was 63 cm and gait velocity 0.877 m/sec at the present examination. This patient was considered to demonstrate no change.

One patient (K. L.) walked at the previous examination with a crutch, but was able to walk short distances without it. At the present examination he normally walked without any kind of aid. Registrations were made at both times with and without a crutch.

Crutch walking gave very similar recordings, besides step frequency having increased from 70 to 84 steps/min. Walking without support showed an increase from 0.69 to 0.77 concerning the ratio of time of weight bearing between the legs. Step frequency had increased from 70 to 86 steps/min. Step length was 80 cm and gait velocity 1.067 m/sec at the present examination.

Muscle force analysis (Table VII)

In comparison with the previous examination the differences were as follows.

Flexion: Two patients (P. H., D. K.) had increased 5 and 3%, respectively. Two patients (K. S., K. L.) had decreased 5% and 9%. One patient (A. K.) could not produce any muscle force in flexion.

Extension: Two patients (K. S., K. L.) had increased more than 20%, 3 patients (P. H., A. K., D. K.) had decreased between 6–16%.

Abduction: One patient (K. L.) had increased 12%, 2 patients (A. K., K. S.) had decreased 2% and 8%, respectively, and 2 patients (P. H., D. K.) could not follow the instructions.

Adduction and rotation were not tested due to lack of equipment.

One patient (P. H.) had an outward rotation contracture of the hip that caused problems in carrying out the flexion and abduction tests according to instruction. In both cases the lateral hip flexors, i.e. the rectus femoris and tensor

fasciae latae were visibly active. Extension strength at the previous examination was 68% and now 52%.

One patient (A. K.) could not on any occasion flex the hip. Extension was earlier 65% and now 59%. Abduction strength was 20 and 18%, respectively. No great difference existed compared with the previous testing.

One patient (K. S.) flexed his hip with 33% of the hip flexion strength of the non-operated hip at the previous examination and with 28% at the present one. Extension strength had increased from 90 to 116%.

The results from the recordings of abduction strength were 63 and 55%, a decrease since the previous examination.

One patient (D. K.) compensated his weakness of the iliopsoas and gluteus medius by outwardly rotating his hip using the lateral hip flexors to flex and abduct. Extension strength was earlier 86% and at the present examination 71%.

The flexion strength of one patient (K. L.) was earlier 14% compared with 5% now. According to the examiner's judgement, the difference was not due to a deterioration, but the patient had instead in a better way followed instructions at the present examination. Extension strength increased from 77 to 97% and abduction strength from 36 to 48%.

DISCUSSION

The usual operative treatment of chondrosarcoma of the pelvis is hemipelvectomy. However, in 7 cases the tumour was radically removed including the acetabulum but preserving the leg. Besides a preliminary report (5) little has been published on the surgical procedure and postoperative function with special regard to gait and muscle force.

Markhede (3) has used the isokinetic dynamometer to examine hip muscle function after extirpation of certain hip muscles due to tumour disease.

The aim of this study was to see, if any change had occurred two years after a previous investigation (5) using the same tests and putting more stress on the functional part by adding a few parameters, such as active range of hip motion, step length and gait velocity. It was noticed with surprise, at both examinations, how well the patients performed considering gait and also work capacity in spite of the less impressive results exhibited by clinical and objective findings.

Compared to the previous examination 2 patients (K. S., K. L.) had made remarkable progress in both gait and general condition and 2 patients (P. H., D. K.) gave the same impression as 2 years earlier. One patient (A. K.) gave the impression of having improved her general condition, but the findings showed slightly poorer results.

In all it may be said, that improvement in muscular function seemed to be related to age with younger individuals improving more than older.

Passive range of motion

All patients had a satisfactory range of hip motion, that had increased in all cases since the previous examination. This was not accompanied by any noteworthy increase in function except in one patient (K. L.), who got rid of a flexion contracture. One patient (A. K.) had an abnormally large range of motion and also least impressive results in all other tests, which shows that good range of motion does not mean good function unless accompanied by muscular control.

Gait

Two patients (K. S., K. L.) had markedly improved their gait. One (K. S.) had a less pronounced Trendelenburg limp when walking with the same step frequency as at the first examination, but had chosen to increase his normal gait velocity in spite of the more pronounced limp that then occurred. The other patient (K. L.) had let go of his cane, even though his limp became more obvious then. Both patients had markedly improved in weight bearing and step frequency. One patient (P. H.) had let go of one cane, but otherwise did not show any change. The other patients had not changed their gait.

As step length was measured only at the present examination, gait velocity could not be compared between the examinations. The two young men (K. S., K. L.) had a faster normal gait than the two older men (P. H., D. K.) who had a functionally satisfactory gait velocity, while one patient (A. K.) walked slowly and cautiously. The three older patients thought, that too much weight bearing was bad for the hip. The development of a new hip joint roof, a stronger gluteus maximus muscle and by that an improved gait, might have improved the gait, if the patients had not had this opinion. It might seem remarkable, that one patient (A. K.) felt, that she still made progress, when her test results showed the opposite. The reason might be, that adaptation to the situation and an improved compensatory technique did not show in the objective test results.

Muscle force analysis

Differences less than 15% may be regarded as muscle force of equal value.

Flexion. The demand for strength in hip flexion to manage the activities of daily living is not greater than that of lifting the foot up a step or a curb, while the range of hip flexion must be large, e.g. to be able to rise from a chair. The flexion force of the iliopsoas muscle was very weak in all patients, which did not change between the examinations. This was thought to be due to the bad lever arm condition of the muscle being shortened as a result of the operation. Despite this weakness all patients except one could lift the foot up a step using the lateral hip flexors at the same time.

No great difference could be seen in flexion force since the first examination.

Extension. Of all tested muscles the gluteus maximus was the strongest in all patients. The muscle was not incised during the operation. One patient (K. S.) increased his strength from 90 to 116%, indicating that he was stronger on his operated side. Another patient (K. L.) had abandoned his cane, increased 20%, and was now almost as strong as on the non-operated side. Good hip extension strength was related to weight bearing on the operated leg and consequently also to ability to walk without a cane, to gait velocity and to maximal walking distance.

It was also obviously related to formation of a hip joint roof on the os ilium, to an intact femoral head and to young age. One patient (A. K.) who did not put any weight on her hip, walked with two crutches and had no hip joint roof or femoral head, consequently showed little strength in hip extension.

Abduction. All patients compensated for the bad lever arm condition of the gluteus medius by using the tensor fasciae latae and rectus femoris when trying to abduct. When instructed to use the gluteus medius in the supine position the torque was half of the torque of the non-operated side in the strongest patient (K. S.). This, however, was not sufficient to abduct the leg against gravity. On weight bearing, the bad lever arm condition grew even worse making it impossible to avoid a Trendelenburg gait. One patient (K. L.) showed an increase since the previous examination, which corresponded to his increase in weight bearing. The increase was less than 15%, but in this particular instance the increase was so marked in comparison with initial registrations, that it can still be regarded as a real and valid increase.

When, with regard to the tumour, surgery can be radical without necessarily depriving the patient of the lower limb, a satisfactory functional result can be expected. This material shows that though gait ability and hip muscle strength are reduced, function is surprisingly good many years after the operation. An important factor to consider is also the psychological advantages.

REFERENCES

1. Hislop, H. & Perrine, J.: The isokinetic concept of exercise. JAPTA *47*: 2, 1967.
2. Lamoreux, L. W. & Todd, F. N.: The importance of time and distance measurements for analysis of human walking. Presented at World Congress of ISPO, INTERBOR & APO, Montreux, Switzerland, Oct. 8–12, 1974.
3. Markhede, G.: Function preserving surgery for extirpation of malignant soft tissue tumours. Thesis. University of Gothenburg, Sweden, 1980.
4. Moffroid, M., Whipple, R., Hofkosh, J., Lowman, E. & Thistle, H.: A study of isokinetic exercise. JAPTA *49*: 7, 1969.
5. Nilsonne, U.: Kreicbergs, A., Olsson, E. & Stark, A.: Function after pelvic tumour resection involving the acetabular ring. Internat Orthop (SICOT) *6*: 27–33, 1982.
6. Rydell, N.: Forces acting on the femoral head prosthesis. Thesis. University of Gothenburg, Sweden, 1966.

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