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INTERTROCHANTERIC DISPLACEMENT OSTEOTOMY FOR PAINFUL OSTEOARTHRITIS OF THE HIP

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The intertrochanteric displacement osteotomy can be regarded as a further development of the subtrochanteric osteotomy of the femur which was introduced by von Baeyer (1918) and Lorenz (1919). The method which Lorenz called bifurcation or Gabelung was mainly used for unstable hips, especially chronic congenital luxations and pseudarthroses of the femoral neck. Lorenz mentions osteoarthritis as an indication for the operation in an article in 1925. His follower Hass (1927) applied the method with good effect in some cases of grave osteoarthritis of the hip. Galland (1930) and Lowendorf (1933) also reported good experiences with the operation in one and two patients, respectively, suffering from "extreme osteoarthritis of the hip". Both these authors gave detailed descriptions of the operation and after-treatment. Hey Groves (1933) recommended subtrochanteric or intertrochanteric osteotomy for severe osteoarthritis especially with "varoid deformity or subluxation".

The principle of this treatment was that the painful hip was to be freed from all loading by direct transfer of the body weight from the pelvis to the femoral shaft. McMurray (1935) was the first to perform—following the same principle—a series of intertrochanteric displacement osteotomies for painful osteoarthritis of the hip and to publish the results. He himself called the operation bifurcation and the intention was to produce direct weight-bearing between the pelvis and shaft of the femur ("pelvic support").

It seems as though McMurray adopted the method as an alternative to arthrodesis in order to escape the disadvantages of this operation, primarily operation shock, long after-care, and back troubles, but none the less to achieve the desired freedom from pain. McMurray (1935):

"The bifurcation operation of Lorenz is simple, of short duration, and if performed correctly leads to a relief of pain and deformity with no loss of stability, and does not cause strain on the lumbar region".

Malkin (1936) reported good results from 14 osteotomies level with or below trochanter minor without displacement ("simple femoral osteotomy"), but with correction of faulty positions, especially adduction contracture.

A disadvantage was the long time the part had to be kept in a plaster cast. It was therefore an improvement when internal fixation began to be used (Blount 1943, Hoets 1949). However, it was not until the 1950's that internal fixation came into general use at osteotomies, and not until then did the method come into wider use. The varus osteotomy of Pauwels extended the indication field considerably, and the excellent results reported (1960) have certainly facilitated the spreading of the method on the Continent and in the Scandinavian countries (Figure 1).

OWN INVESTIGATION

Intertrochanteric displacement osteotomy was first used at the Orthopaedic Clinic in Lund in the 1940's. The first operation was carried

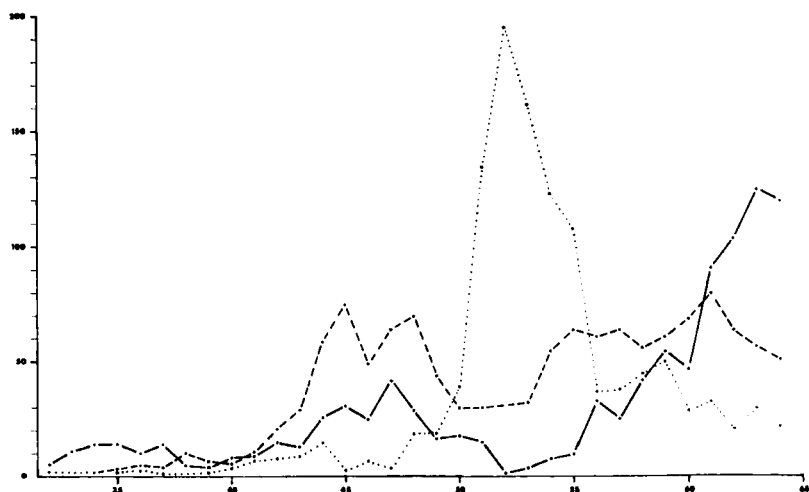


Figure 1. The relative frequency of the three most common operative procedures for osteoarthritis of the hip at five orthopaedic clinics in Malmö, Lund, Hålsingborg, Gothenburg, and Stockholm, Sweden, during the period 1935-1964.

— Osteotomy. - - - - Arthrodesis. ···· Arthroplasty.

out in 1942 for osteoarthritis. Thereafter, isolated operations were performed, at the most two a year, but solely for non-union of the femoral neck. Since 1958 when 4 patients were operated, the frequency has increased year by year; in 1964, there were 40 operations.

The purpose of the present investigation was to obtain the opinion of the patients concerning the results of the operation, to get a clearer idea of the advantages and disadvantages of the operation, and to make a comparison with other reports. The appraisal of the results was based on the answers given by the patients to questionnaires, on hospital records, and on X-ray pictures. An observation time of at least 2½ years was chosen as the radiographic appearance of the osteoarthritic changes can improve up to 2 years after the operation (Nissen).

MATERIAL

During 1958–1964, 106 patients were operated by intertrochanteric displacement osteotomy for painful osteoarthritis of the hip. One patient was operated in both hips (1961 and 1963) which made the number of primary operations 107.

Of the 106 patients, 14 were excluded from the material for the following reasons; 2 died in connexion with the operation (*vide infra*) and 4 have since died of other illnesses that had no connexion with the operation; 8 were not available or did not wish to take part in the investigation. From the case records of these 8, it appears that 6 healed normally and, as far as can be gathered, with good results, whereas 2 had trouble with healing; however, one was free from pain and did not need re-operating. The other patient had non-union twice but finally healed with good result after the third operation.

Of the remaining 92 patients (93 primary operations), 54 were women and 38 were men. The mean age of the women was 58.8 years, and of the men, 59.5. The youngest patient was 36 years old and the oldest 78 (Figure 2).

53 patients were operated in the right hip, 38 in the left, and one on both sides. 51 of the patients had had symptoms for 1–5 years before the operation, 21 for 6–10 years, and 20 for more than 10 years. 25 had an established osteoarthritis with varying symptoms also in the other hip.

AETIOLOGICAL COMPOSITION (PRESUMPTIVE CAUSE)

In 58 cases (59 hips) the reason for the osteoarthritic changes could not be determined and was regarded as primary (idiopathic) osteoarthritis. 14 patients had had some degree of rheumatic activity in other joints where involvement also of the operated hip could not be excluded, but the radiographs suggested osteoarthritic changes. The 20 remaining hips had secondary changes after: dysplasia coxae (13

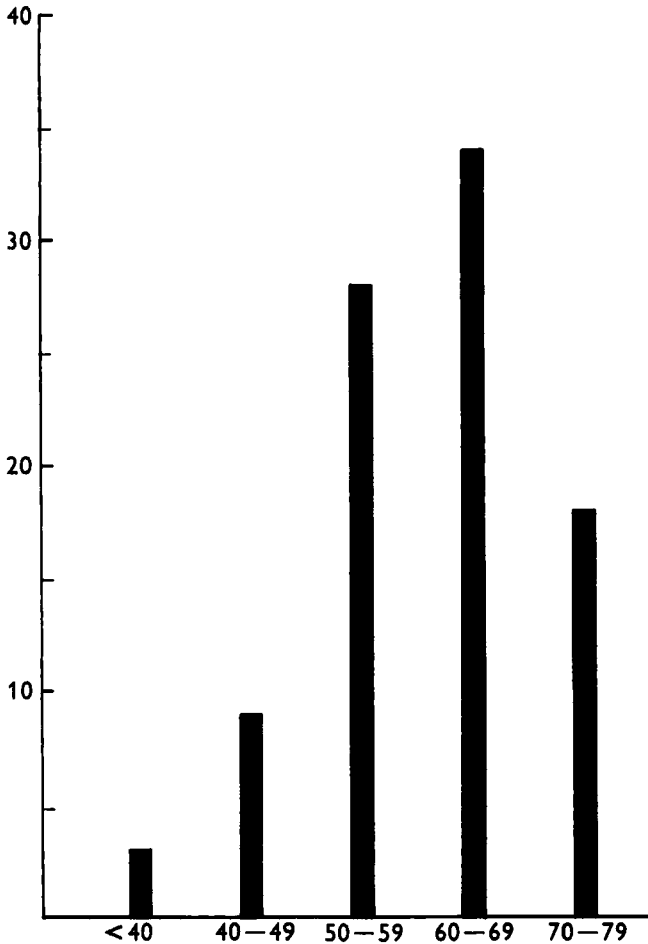


Figure 2. Age distribution.

cases), coxa vara (1 case), epiphyseolysis capitis or coxa plana (6 cases), and unspecific coxitis (1 case).

On two dysplastic hips, shelf operations had been carried out 8 and 5 years earlier. One hip was operated on for a pertrochanteric fracture six months earlier; one had been drilled, according to Graber Duverney, 7 years earlier; on one an acetabular cyst had been plugged 4 years earlier.

INDICATIONS

In short, it can be said that the only indication for the operation in this material was disabling pain caused by osteoarthritis, 85 per cent

of the patients had received conservative treatment (X-ray radiation, physical therapy, cortisone injections) for varying periods before the operation. The clinical criteria for the operation in this material can be considered rather liberal, and the operation was many times done as an alternative to arthrodesis or joint resection. Table 4.

Many authors have found that the full effect of the operation is attained more often in cases with moderate changes (*inter alios*, Nissen 1966, Harris & Kirwane 1964, Nicoll & Holden 1961, Weber 1959) and a tendency to operate earlier in the course of the disease was observed in the literature. King & Dooley (1962), however, found the improved radiographic appearances not sufficiently striking to warrant operation at an earlier stage of the disease. Pauwels (1960), *inter alios*, has also shown with his results that the reparative powers can come into play also in advanced osteoarthritis and in high age, but he too recommends that the operation be done while the articular function is still fairly intact.

Most recent authors demand a certain minimum regarding the extent of movement in the sagittal plane, generally, 60–90° flexion from a not too large flexion contracture (Weber 1959: 90°; Nissen 1963: 90°; Blount 1964: 60°; Cauchoix *et al.* 1965: 80°; Judet *et al.* 1965: 40–60°). Nissen (1963) recommends investigation under general anaesthesia to determine the precise flexion capacity (“anaflexion”) in painful osteoarthritic hips and maintains that the range of mobility can thereby be twice as large as when the patient is conscious, owing to absence of protective muscle spasm.

As contra-indications, the following have been mentioned: Severely deformed joints with pronounced articular incongruence and no longer existing joint space, active rheumatoid arthritis, protrusio acetabuli, and instability in the joint which cannot be corrected by the operation (varus osteotomy).

OPERATION

Not all osteoarthritic hips can be treated with the same type of osteotomy because of the dissimilarity and difference in degree of the changes. Pre-operative planning is of value here. By angulations or rotation in the osteotomy, faulty positions can be corrected and thereby articular congruence and possibly in favourable cases also mobility can be improved. Weber (1959) recommends examination of the articular congruence in TV-fluorescence with the patient under anaes-

thesia. This method has also been used at this clinic in some cases immediately before the operation, which for the past three years has been routinely performed with the aid of TV-fluorescence.

Wedge osteotomies were made in 15 cases, varus osteotomies in 12, and valgus osteotomies in 3; otherwise, displacement osteotomies were made without correcting wedges or angulations. Tenotomy of the adductor or iliopsoas musculature was made twice in connexion with the operations.

During the first 2 years (1958-59) solely external fixation in the form of double hip spica was used, except in one instance where an internal fixation was also made with wire. In 1960, the Kessel plate came into use; and since then, internal fixation in some form has been used in all cases except 2 (1961), Table 1.

Table 1. Fixation method at 93 primary operations

Tupman instrumentarium	77
Wainwright instrumentarium	5
Kessel instrumentarium	4
McLaughlin instrumentarium	1
Double hip spica solely	4
Screw + plaster cast	1
Wire + plaster cast	1

After Treatment

The patients were usually confined to bed for the first 4-6 weeks. Thereafter, training in a walker was started with successively increasing weight-bearing. However, this varied somewhat from case to case; some of the patients were walking already 2½-3 weeks after the operation, whereas in a few cases weight-bearing was postponed up to 12 weeks, as fixation of the osteotomy was presumed to be insecure. The patients were discharged when they had learned to walk with trestles or crutches.

Primary Complications

Two patients (1.8 per cent) died in relation to the operation. One of them, a 62-year-old woman with gastric ulcer had a postoperative bleeding and shock with accompanying anuria and died on the twelfth

day after the operation. The other, a 54-year-old man, went *ad mortem* because of postoperative ileus and cardiac insufficiency.

Wound infection occurred after primary operation in 7 cases and after re-operation in two cases, one of which lasted for a considerable time and demanded removal of the osteosynthesis material 4 months later. The osteotomy was fully healed 6 months later.

Six patients had venous thrombosis in the lower extremities, despite prophylactic anticoagulant therapy.

Secondary Complications

Non-union occurred in 15 cases (16 per cent of 93 primary operations). Non-union characterized the 12 cases which, because of painful instability in the osteotomy, were re-operated 7–27 months after the primary operation and the 3 cases which 2 years or more (2 years 4 months–5 years 4 months) after the operation still did not show radiographic signs of bone union. The latter 3 patients were not re-operated. One of them was practically free from pain and was completely satisfied with the result; one did not want to undergo further operations. The third was judged non-operable because of cardiac insufficiency.

Eleven of the patients were women, aged 52–74 years, mean 67.7 years, and 4 men aged 64–70 years, mean 64.8 years. The joint changes in 7 of the patients were described as grave, 6 as medium, and 2 as slight. Varus osteotomy had been performed on 6 hips with the removal of a wedge, which means that half of the varus osteotomies had not united after the primary operation. On the other 8, displacement osteotomies were made without angulation. Fourteen were fixed with Tupman nail-plates and one with a Wainwright spline. The patients were able to sit on chairs 3–6 weeks after the operation. Walking without weight-bearing was begun on average 6½ weeks after the operation, and with weight-bearing 1–2 weeks later. Thus, mainly the same after-treatment as for the material otherwise. One patient had a brief and superficial wound infection and another a thrombosis in the lower leg. Apart from that, there were no primary postoperative complications.

Causes of Non-Union

A combination of several factors, such as age, degree of activity after mobilization, body weight, range of mobility in the operated hip, the condition of other joints, etc., can influence the rate of union. In all cases except possibly one, there was, however, a common factor: in-

sufficient stability in the osteotomy, in 6 cases due to poor contact between the bone ends because of diastasis and/or displacement over half of the bone width. In a further 5 cases, the nut between the nail and plate loosened. When the patients are mobilized before consolidation has taken place in the osteotomy, such a lack of stability must be of decisive importance for the outcome. As evidence of this 6 of the Tupman plates broke at a later stage. Furthermore in 3 cases, all the screws to the plate broke and in a fourth case, three screws out of four loosened.

Delayed Union

Delayed union occurred in 16 cases, where radiographic signs of union were delayed up to 2 years. Among these, four cases of plate breakage occurred and in 5 cases, the nut between nail and plate loosened.

Frequency of Re-operations

Twelve patients were subjected to re-operations with removal of sclerotic bone and a new osteosynthesis. Of these, 7 were united during the course of 12 to 22 months. Of the 7 patients, 4 were free from pain, 2 improved, and 1 failed to improve. Of the other 5, 2 had not fully united at the follow-up 12 months after the re-operation, but both were improved and were considered to be in good healing.

The 3 remaining patients did not proceed to bony union and had to be operated for the third time. At the time of this investigation 2 had fully healed whereas the third at ten months postoperatively had not.

The osteosynthesis material was removed at a separate operation 6 times in these 12 patients. In the material otherwise, 15 Tupman nail-plates were removed for the following reasons: 13 plates because the patients had tenderness over the end of the nail, 1 because of infection, and 1 because of penetration of the nail into the joint.

RESULTS

Pain Relief

Special importance was attached to the opinion of the patients regarding the pain-relieving effect at this is the primary indication of the operation. Results in the following presentation refer to the first operation. The cases that demanded re-operation are considered failures.

Table 2. Degree of pain after operation

None	Slight or occasional	No change or worse	Total
43	31	18	92

Of the 15 non-union cases, only 1 was permanently pain-free, whereas the other 14 constitute the main part of the 18 cases that failed after the first operation. Of the 4 others in this group, 1 had a grave osteoarthritis with wandering joint socket after unspecific coxitis a few years earlier; 1 had local necrosis of the femoral head with nail penetration; 1 had osteoarthritis of medium severity whose osteotomy healed late in a strongly varus position; 1 had grave osteoarthritis after a pronounced and untreated dysplasia with subluxation.

Walking Capacity

Regarding the walking capacity, 56 (61 per cent) considered that they had improved, 9 (10 per cent) had no definite idea or thought they were unchanged, and 27 (29 per cent) regarded it as worse because of varying degrees of pain in connexion with walking and standing. This last group contains the 18 unimproved cases (Table 3). Of the other 9 in this group, 6 had grave joint changes and 3 had rheumatism with pain also in other joints; 3 had no pain when resting; and 6 were improved (Group: Slight or occasional).

Mobility

The range of mobility was not determined by any standardized technique before and after the operation in this material; therefore precise information about the extent of mobility must be omitted. A general impression at postoperative examinations, however, has been that the mobility has remained unchanged or become slightly reduced, and that the latter more often occurred in the gravely afflicted joints. Bony ankylosis occurred in one case.

X-Ray Findings

After Osborn & Fahrni (1950) at follow-up investigations found that none of their clinically successful cases, 61 out of 75 (81 per cent), showed signs of progress of the joint changes radiographically, infor-



Figure 3. Female, age 53. Pain in right hip of 9 yrs duration. A. Five yrs before operation. B. Immediately before op. C. Immediately after op. D. Eight months after op. No pain. E. Five yrs after op. Free from pain. Successive regress in joint changes.

Figure 3 A.

mation about arrest or regression of the osteoarthritic changes has been given in most reports. Other authors have warned against liberal interpretation of these signs. The apparent increase in joint space has been considered to be the result of faulty radiographic technique (Arden 1957) or due to altered position of the femoral head in the acetabulum (Hirsch 1960).

At a survey of the X-ray picture material, it was found that the appearance of the joint changes had successively improved in 61 cases (66 per cent) (Figures 3 and 4). Seemingly, at least, the joint space often increased, the articular contours became more even, and sclerotic areas or cysts regressed. Similar signs were sometimes observed in cases where the bone failed to heal, and in 2 cases in the non-operated hip.

In 4 cases (4.4 per cent) the joint deteriorated. The postoperative course was uncomplicated; 3 healed within 4-6 months and could be described as good results (2 in the Group "Good" and 1 "Excellent"). One had non-union (Group "Poor") and had to be re-operated.

Table 3. Patients' assessment of operation

Excellent	Good	Fair	Poor	Total
19	47	7	19	92

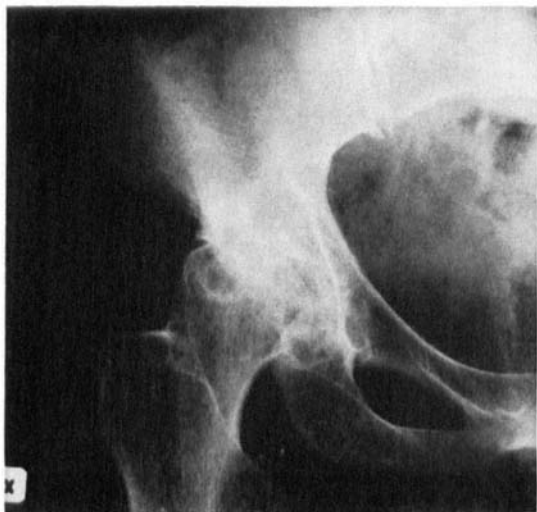


Figure 3 B.



Figure 3 C.



Figure 3 D.



Figure 3 E.

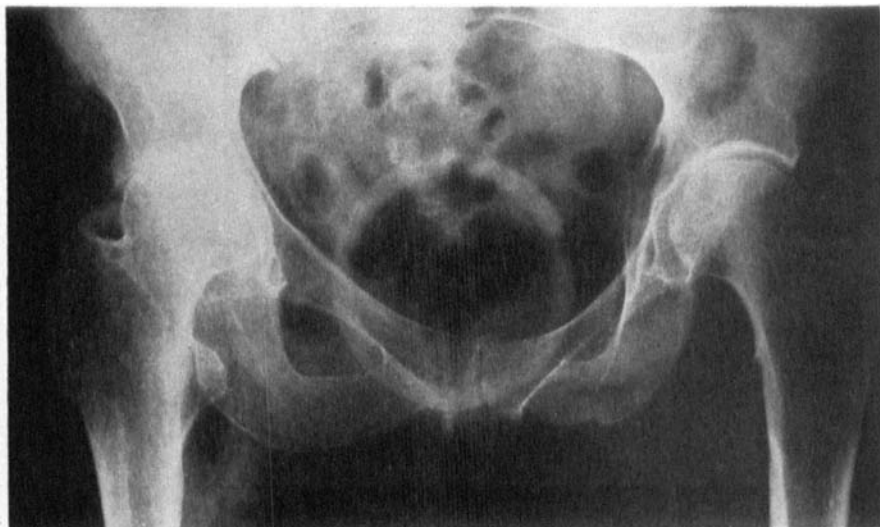


Figure 4 A.

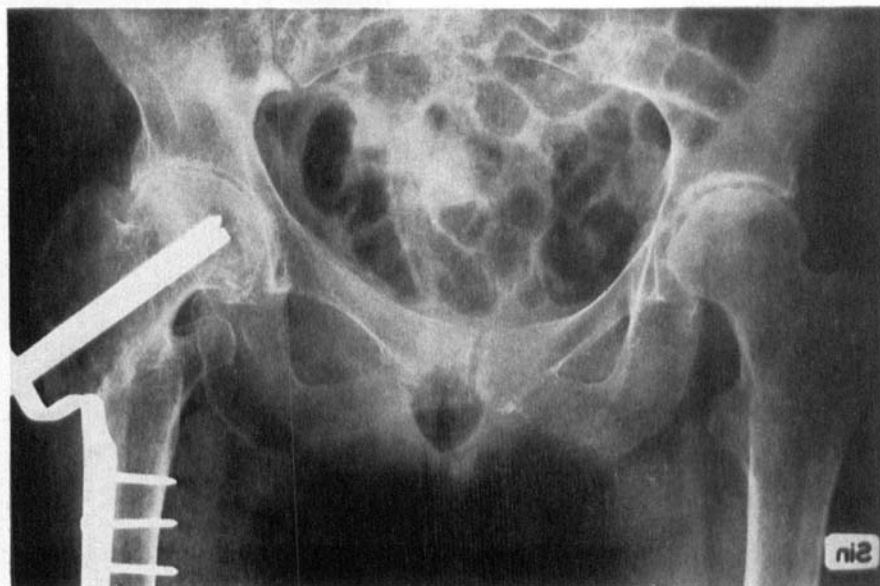


Figure 4 B.

Figure 4. Female, age 59. Painful osteoarthritis right hip of three yrs duration. Rheumatic activity intermittently in most other joints. A. Immediately before operation. Severe reduction in joint space right hip. Slightly reduced joint space left hip. B. Two yrs 4 months later: apparent improvement in joint changes on right side whereas the left hip shows signs of progress.

Patients' Assessment

The patients were asked what they thought of the result of the operation as a whole, from the aspect of both pain relief and function.

After the first operation, 66 (72 per cent) of the patients were satisfied, whereas 26 (28 per cent) had not obtained the desired effect. Eight of the latter had less pain than before the operation (see Figure 1) but the effect did not meet their expectations regarding mobility and walking capacity.

No influence on the subjective results with regard to age, degree of osteoarthritis, or observation period was demonstrable in this material.

Table 4

Patients' assessment	Degree of joint changes*			
	Light	Medium	Severe	Total
Excellent	1	4	14	19
Good	5	17	25	47
Fair	2	3	2	7
Poor	1	8	10	19
Total	9	32	51	92

* 'Light' describes incipient changes with slightly reduced joint space or marginal osteophytes; 'medium' describes cases with more conspicuous reduction of the joint space, more pronounced osteophyte formation, and some degree of cysts or sclerosis but no incongruity of the articular surfaces owing to collapse of subchondral bone; hips with further changes were described as 'severe' where joint space had practically disappeared, at least in one part of the joint in connexion with articular incongruity, sclerosis, and cyst formation in the cancellous bone.

DISCUSSION AND CONCLUSIONS

In osteoarthritis of the hip, pain is the most important of the symptoms. It is usually pain that impels the patients to seek help. Severe degrees of stiffness and contractures are often tolerated as long as the hip is relatively free from pain.

The pains are thought to be triggered off mainly from sensible nerve fibres in the subchondral spongiosa, the joint capsule, and contracted musculature. The release factor is presumed to be increased pressure and tension in these structures. This opinion was convincingly advanced by Pauwels (1960) who considers osteoarthritis to be a bio-mechanical problem, whose cause is in the last resort due to a disproportion between the mechanical loading of the hip and the toler-

ance of the tissues. He also believes that the biological component, the congenital or acquired static insufficiency of the tissue, hardly allows itself to be estimated or influenced therapeutically, whereas the effect of the mechanical component (increased articular pressure and limited weight-bearing surface) can be counteracted or adapted to the reduced resistance of the tissues.

During the past 15 years, however, the haemodynamic factors have attracted increasing interest. Up to 1953, when Trueta & Harrison with arterial contrast investigations could show that the blood flow to the upper end of the femur was increased in osteoarthritis, it had been believed that the changes were ischaemically conditioned. It has also been possible with intraosseous phlebography to compare the resorption in healthy hips and osteoarthritic hips. In this respect, various authors have established that delayed resorption and modifications in the venous circulation in the upper end of the femur is the rule in osteoarthritis of the hip (*inter alios*, Meriel, Ruffie & Fournié 1955, Hulth 1959, Phillips 1966).

Arterial hyperaemia in connexion with insufficient venous return causes an increase of the intraosseous blood pressure and expansion of the venous sinusoids. The outflow is rendered difficult primarily by sclerosis, fibrosis, and cyst formation in the spongiosa, and possibly also by increased tension and fibrosis in the joint capsule because most of the veins that drain the upper end of the femur pass the joint capsule at its attachment on the femoral neck. The pain will thus partly, at least (Hulth 1959, Phillips 1966), or in the main (Meriel *et al.* 1955, Trueta 1963) be caused by intraosseous pressure increase with pain release via paravascular and subchondral nerve fibrils.

The working mechanism of displacement osteotomy is still not clear. Change in the mechanical conditions, i.e. mechanical unloading of the joint, relaxation of muscle contractures, and capsule tightening with accompanying reduction of the articular pressure and possibly better articular congruence or changed articular contact have been considered by many (McMurray 1935, Malkin 1936, Osborne & Fahrni 1950, Campbell & Jackson 1955, Pauwels 1960) to be the main explanation. Most recent authors, however, consider co-action between mechanical and biological factors to exist (Blount 1964, Knodt 1964, Nicoll & Holden 1961, Nissen 1963, 1966, Leger 1964, Ottolenghi 1962, Phillips 1966, 1967, Trueta 1963, Weber 1959), which is highly probable. We know that immediate pain relief can be obtained after both forage (drilling according to Graber Duverney 1930, McKenzie 1936) and "muscle re-

lease" operations (Voss 1955), but the effect, as a rule (Shaw & Harris 1960, Leach & Premer 1963), is only temporary and does not convincingly influence the course of the osteoarthritis. The usually immediate effect of displacement osteotomy on the pain probably occurs according to the same action mechanism, i.e. to some extent, a combined effect of forage and muscle release. However, the effect is usually very prolonged (*inter alios*, McFarland 1954, Robins & Piggot 1960, Nicoll & Holden 1961, King & Dooley 1962) or possibly permanent, and is as a rule accompanied by a radiographically demonstrable arrest or regression of the osteoarthritic changes, which suggests a profound metabolic change (Wardle 1955).

The prerequisites for producing such a reparation process is division of the bone with some degree of displacement (Nissen 1963, 1966), which in time results in adaption of the architectural pattern of trabeculae of the head and neck of the femur to the changed mechanical stresses, according to Wolff's Law of Transformation (1892).

This mechanical stimulant, according to Nissen, is not restricted solely to the upper end of the femur but transmits also over the joint if the joint is stable. Nissen has also experimentally shown that the bone cells are very sensitive to "any change in stress derived from the displacement of an osteotomy"; without displacement, no remodelling occurs and osteoarthritis is not arrested; on the other hand, only a displacement of some millimeters is required to obtain this effect. This also supports the now widely accepted opinion that the displacement should not exceed one-third to a half of the bone width in order not to jeopardize union. Proof of this reparation process's being accompanied by an improved circulation has been given by Phillips (1966) and Phillips *et al.* (1967). These researchers performed phlebography in 37 hips immediately before osteotomy and found—except in two cases—disturbances in the venous return flow which corresponded to the degree of the osteoarthritic changes. Phlebography of 29 of these hips was again made 12–20 months later. Normal phlebograms were found in 24; whereas in 5, they were still clearly pathological, one of which showed significant deterioration. Of the 24 with normal phlebograms, 21 had no pain postoperatively and 3 were improved. Some pain relief was observed also in the 5 that did not show signs of improved circulation. In 19 out of 29, there were radiographic signs of regression of the joint changes; none showed signs of progress.

The results achieved in this material confirm the effective pain-relieving and reparative qualities of the operation also in advanced

osteoarthritis. After the primary operation, 74 of the patients (80 per cent) thought that the effect fulfilled or exceeded their expectations regarding pain, which well agrees with other reports. At the time of this investigation, 10 of the re-operated patients—a total of 84 patients (91 per cent)—were improved regarding the pain. Judged by the appearance of the joint changes on X-ray, the progress of the osteoarthritis had been arrested or had gone into regression in 88 patients (95.5 per cent), whereas deterioration had occurred in 4 patients (4.5 per cent).

On the debit side, in our experience, there was primarily a considerable frequency of non-union which demanded re-operation. This has been the most frequently occurring reason for failure in this material and has a close connexion with the osteosynthesis methods used. With more effective fixation methods, the number of successful cases could be further increased.

Among the advantages of the operation, first and foremost is pain relief which, from the standpoint of degree and durability, can be matched only by a successful arthrodesis. Faulty positions can be effectively corrected and, generally speaking, it seems as though the patient maintains the pre-operative extent of mobility. The operation itself, in most cases, is simpler than alternative methods, and the after-treatment, compared with, for instance, arthrodesis and cup-arthroplasty, is considerably easier for the patient. In bilateral cases, the operation can be carried out on both sides or can be combined with any other method. There can be no doubt that the operation to a large extent arrests the osteoarthritic development or converts it to reparation of both head and joint socket. It therefore seems rational to intervene relatively early in the course of the disease, preferably before contractures and articular incongruity have had time to become established, i.e. before the joint has become more or less disorganized.

SUMMARY

The author has evaluated the effects of intertrochanteric displacement osteotomy of the femur on 92 patients operated for painful osteoarthritis of the hip. The results were based on interviews by letter, case histories, and radiographs. The development of intertrochanteric osteotomy and views on indications and mechanism of pain relief are briefly presented and discussed.

There were 2 postoperative deaths (1.8 per cent). Apart from this, the major complication was non-union in 15 cases (16 per cent).

The benefits of the operation were confirmed. Assessing the general results of the primary operation (pain relief and function) 19 patients thought they were excellent, 47 good, 7 fair, and 19 poor; 14 of the latter, because of non-union. This figure (19 poor) was reduced to 9 after secondary procedures.

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