



Hemiarthroplasty for three- and four- part displaced fractures of the proximal humerus in patients over 65 years of age

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This is a prospective case series, in which the outcome of shoulder hemiarthroplasty in recent three- and four-part fractures of the proximal humerus was evaluated in patients over 65 years of age. From February 1993 to October 2002, 51 patients with 3- or 4-part fractures of the proximal humerus were entered into the study. The criteria for inclusion were age over 65 years and 3- or 4- part displaced fracture. The mean age of the patients was 73 years (range : 65 to 84). The mean follow-up was 5.5 years (range : 2 to 12). According to the Constant-Murley scale, the results were satisfactory or very satisfactory for 74% of the patients. Thirty nine patients (78%) experienced mild or no pain, 50% achieved active anterior elevation greater than 120°, while 40% had active lateral elevation of more than 120°. None of the patients experienced complete recovery of strength and full range of motion. Thirty four patients were able to resume all their daily activities. There were complications in 26% of the patients. Assessment following the Constant-Murley scale demonstrated that two thirds of the patients were pain free and regained a wide range of shoulder movement, while one third resumed their pre-fracture activities to a great extent. The majority of the patients did not recover normal strength.

Keywords : shoulder hemiarthroplasty ; humeral head ; displaced fracture ; proximal humerus ; elderly patients.

INTRODUCTION

Most comminuted fractures of the proximal humerus with moderate displacement can be treated non-operatively (7, 23, 27, 32, 35). Treatment of valgus-impacted fractures in young patients either non-operatively or with minimal internal fixation (21, 30, 35) has given good results. In the case of four-part fractures with displacement or dislocation of the articular surfaces, the blood supply of the humeral head is compromised. Closed reduction of these fractures is not possible, and surgical management remains the only option (6, 7, 23, 27).

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Irreducible three-part fractures cannot be treated without surgical intervention either (6, 27).

Closed reduction under fluoroscopy using stabilisation pins mounted on an external fixator, and the Ilizarov method have been applied with disappointing results. In young patients, however, three-part fractures can often be treated with open reduction and internal fixation (6, 18, 35). Avascular necrosis (6, 7, 18, 35) is the most common complication. Management of displaced three- and four-part fractures as well as of fracture dislocations of the proximal humerus in elderly patients either non-surgically or with open reduction and internal fixation does not result in satisfactory function in the majority of the cases (6, 7, 18, 23, 27, 35).

Hemiarthroplasty as a primary treatment alternative has been proposed in most relevant studies ; however, in some reports poor results were obtained (1, 6, 7, 10, 23, 24, 40). Hemiarthroplasty is suggested as a treatment option in three- and four-part fractures and fracture dislocations in older patients with osteoporotic bone with a compression fracture affecting more than 45% of the head, and split fractures when the separated part is greater than 45% of the humeral head (4-7, 13, 32).

In the present study, we report the outcomes in a case series of three- and four-part displaced fractures of the proximal humerus with comminution and/or dislocation in patients over 65 years of age.

PATIENTS AND METHODS

Between January 1993 and December 2002, we treated 26,223 patients with fractures, of which 1,217 had fractures of the proximal humerus (4.6%). Sixty three were three- or four-part fractures. Internal fixation was applied in five young patients with four-part fractures, while seven denied the procedure and preferred to be treated non-surgically. Hemiarthroplasty was applied to 51 patients over 65 years of age. The male-to-female ratio was 1 to 12. All women suffered from osteoporosis as demonstrated by DEXA examination of the lumbar spine. The average age was 73 years (range : 65 to 84). The right shoulder was affected in 19, the left shoulder in 32. The dominant side was affected in 17 patients. Most patients were retired farmers. Two male and one female patients presented ethanol abuse, three suffered from severe rheumatoid arthritis, and six were markedly

debilitated, with a very poor general health profile and limited expectations for function of their fractured arm. Thirty nine patients sustained direct injury of the shoulder and 12 fell on an outstretched arm. Most of the accidents (27) occurred at home, 11 during outdoor activities, 6 while farming and 7 were road traffic accidents. Antero-posterior radiographs of the shoulder, lateral scapular view and axillary views were obtained preoperatively (4, 32), as well as the Velpeau view in some cases. Five patients underwent CT scan examination. Twenty-nine cases were four-part fractures, 17 were three-part, and 5 were three-part fracture dislocations. Apart from the fracture of the head of the humerus, other concomitant injuries were present in the following cases : one patient had a fracture of the pelvis, one had subcapital fracture of the hip and fracture of the ipsilateral wrist ; one patient had fractures of the tibial condyles and a fracture of the ipsilateral wrist ; one had a fracture of the tibia and one had a fracture of the ipsilateral olecranon. There were no neurological or vascular injuries associated with the shoulder fractures.

All surgeries were performed by two consultant orthopaedic surgeons. Forty two fractures were treated between the 2nd and the 5th day and 9 between the 11th and 14th day after the injury. Antibiotic prophylaxis with 2nd generation cephalosporin and aminoglycoside was started one hour before operation and was administered for two days. The operation was performed under general anaesthesia through an anterior deltopectoral approach. Thirty-five "Cofield" type and sixteen "Global" type (De Puy, Warsaw, USA) modular neck hemiarthroplasties were implanted with bone cement. Hospitalisation time ranged between 3 and 42 days (mean : 14 days). Blood transfusion was necessary for six patients, four of which had an additional major bone fracture. All patients received low molecular weight heparin for thromboprophylaxis. Rehabilitation started from the first postoperative day according to Hughes and Neer's protocol (3, 20, 23).

During follow-up, shoulder function was assessed according to the Constant-Murley scoring scale. Interviews of the patients revealed the degree of pain relief, the function of the shoulders in daily activities, the range of active motion in all directions as measured with a goniometer, as well as muscle strength. Radiographic examination focused on the presence of radiolucent lines, and the position of the prosthesis and the tuberosities.

All patients were examined regularly, i.e. 3 and 6 weeks and 3, 6 and 12 months after operation and once a year subsequently. The follow-up ranged from a mini-

imum of 26 months to 12 years. Scores from all measurements in the Constant-Murley scale were classified on the basis of age, gender, length of follow-up, dominant or non-dominant arm fractures and the time elapsed between injury and operation. Scores between 76 and 100 points were graded as excellent, between 51 and 75 as good, between 26 and 50 as fair, and between 0 and 25 as poor.

RESULTS

One patient died from pulmonary embolism on the fifth postoperative day. Eight patients died in the first postoperative year for reasons unrelated to the shoulder fracture or the operation. One patient with severe osteoporosis sustained an incomplete fracture during preparation of the humeral diaphysis. Implant position examined with postoperative radiographs revealed a higher than normal placement in two patients, a lower placement of the prosthesis in three shoulders and excessive retroversion in two other patients. The minor tuberosity was not repositioned anatomically in three patients.

According to the Constant-Murley scale, the overall mean score was 57.5. Functional results were rated as excellent in 17 patients (34%), good in 17 (34%), fair in 3 (6%), and poor in 13 (26%).

Analysis of each separate parameter presented in the functional evaluation scale showed the following results (fig 1a, b, c) :

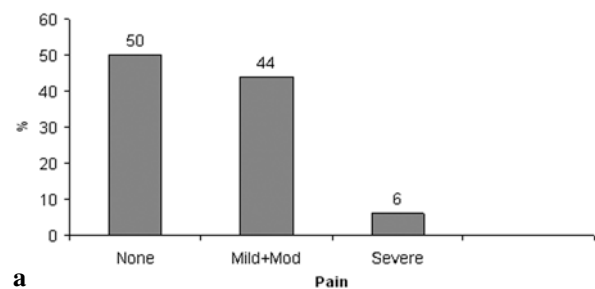
Pain (table Ia)

Twenty-five patients reported no pain during either daily activities or sleep. Fourteen patients experienced mild, tolerable pain especially during night as well as during daily activities. They were able to participate in the same activities as pre-operatively. They had to change the body position if they slept on the operated shoulder. Eight patients had continuous mild pain, which increased during activities especially when lifting heavy objects. They could not lie on the operated shoulder for more than a few minutes. In their reports, they mentioned a painful arc of movement of the injured shoulder, which was also experienced prior to the fracture. This was attributed to pre-existing subacromial impingement. Three

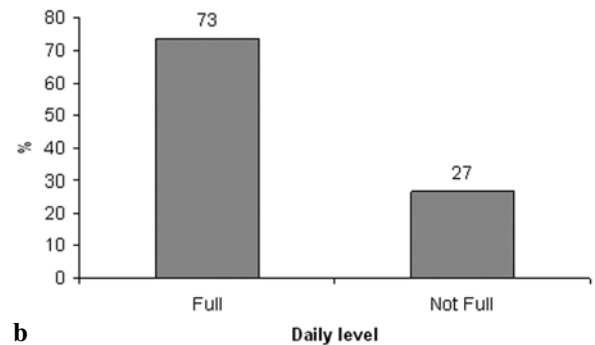
patients complained of severe pain, which worsened as they moved or lifted weight. Moreover, their sleep was interrupted due to pain. Two of

Table Ia. — Pain

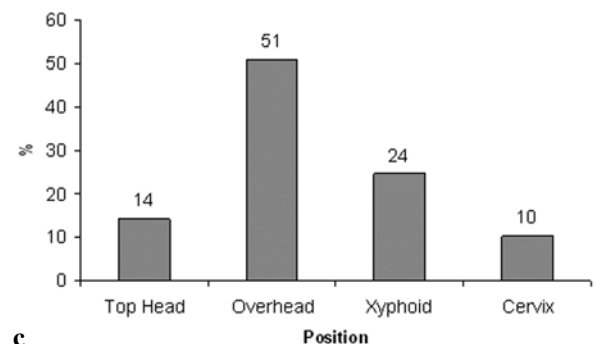
Pain	No of Patients
None	25
Mild	14
Moderate	8
Severe	3



a



b



c

Fig. 1. — a. Percentage of patients according to the Constant-Murley scale for pain ; b. Percentage of patients according to the Constant-Murley scale for level of everyday activity ; c. Percentage of patients according to the Constant-Murley scale for position reached by the hand.

them suffered from severe rheumatoid arthritis affecting multiple joints. The third patient had sustained a high-energy comminuted fracture after a fall on the shoulder.

Levels of everyday activity (table Ib)

Full activity

Thirteen patients did not regain full activity due to severe rheumatoid arthritis (3 patients), alcoholism (3 patients), and poor general health (7 patients). They all had moderate to poor movement of the shoulder as they were not able to engage in full activity even prior to the fracture. Three of them did not comply with the rehabilitation program and experienced severe limitation of arm function due to severe postoperative pain.

Full participation in excursions, and sport and other activities

The aforementioned thirteen patients could not participate in excursions and various social events, whereas eight patients with moderate pain were able to participate to some extent, avoiding tiring or long excursions.

Sleep

Thirty nine patients did not complain of any problems while sleeping, whereas eight could sleep on the operated shoulder for short periods only. Three patients could not sleep on the operated shoulder without interruption of sleep.

Position reached by the hand (table Ic)

Forty nine patients could bring their hand up to the level of the waist at the back and up to the

xyphoid at the front. Thirty seven patients could reach their neck but thirteen patients could not (3 alcoholics, 3 with severe rheumatoid arthritis, 6 debilitated from chronic illnesses and one who had the most severe fracture with periarticular soft tissue damage). Thirty two could reach the top of their head and a subset of 25 patients with four-part fractures (8 patients) and three-part fractures (17 patients), could bring their hand over their head.

Range of Movement

Anterior and lateral elevation (tables Id, e)

Forty nine patients could elevate the arm up to 30° anteriorly and laterally. Thirty seven patients lifted their arm up to 90°. Thirty two patients reached an anterior elevation of 120° and 31

Table Ic. — Position reached by the hand

	No of patients
Up to the Xyphoid	12
Up to the cervix	5
Up to the top of head	7
Over the head	25

Table Id. — Anterior Elevation

	No of patients
31° - 60°	12
61° - 90°	5
91° - 120°	7
121° - 150°	20
151° - 180°	5

Table Ie. — Lateral Elevation

	No of patients
31° - 60°	12
61° - 90°	6
91° - 120°	11
121° - 150°	17
151° - 180°	3

Table Ib. — Everyday Activities

	No of patients
Full Activity	37
Participation in excursions	37
Sleep without problems	39

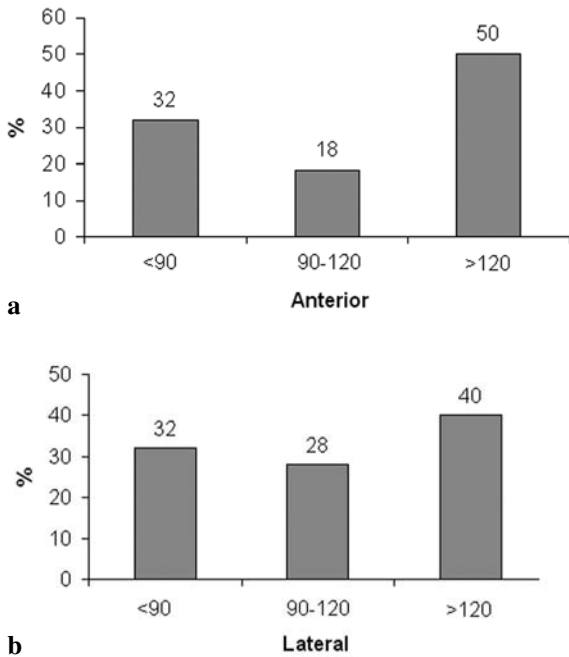


Fig. 2. — **a.** Percentage of patients according to the Constant-Murley scale for anterior elevation ; **b.** Percentage of patients according to the Constant- Murley scale for lateral elevation.

patients had similar lateral elevation. Twenty five patients reached an anterior elevation of 150° and 20 a similar lateral elevation. Five patients had anterior elevation more than 150°, and three had lateral elevation over 150° (fig 2a, b). None of the patients could reach an anterior or lateral elevation of 180°.

External Rotation (table If)

Thirty seven patients placed the palm of their hand at the back of their head with the elbow at the front and 35 patients placed the palm of their hand at the back of their head with the elbow at the lateral side. Thirty two placed the palm of their hand on the top of their head with the elbow at the front and 28 placed the palm of their hand on the top of the head with the elbow at the side. Five were able to elevate their arm over the top of their head (fig 3a).

Table If. — External Rotation

	No of patients
Hand behind the head – elbow front	2
Hand behind the head – elbow back	3
Hand top of head – elbow front	4
Hand top of head – elbow back	23
Full elevation from the top of head	5

Table Ig. — Internal Rotation

	No of patients
Dorsum of hand to buttock	6
Dorsum of hand to lumbosacral junction	6
Dorsum of hand to waist (3 rd lumbar vertebra)	12
Dorsum of hand to 12 th dorsal vertebra	18
Dorsum of hand to interscapular region (CV7)	7

Table Ih. — Muscle strength

Resistance in full abduction 90°	No of patients
*25 lbs	0
15 lbs	2
12 lbs	7
0 lbs	18
5 lbs	10

*1 lb = 454 gr

Internal rotation (table Ig)

Forty nine patients brought the dorsum of their hand to their buttock and forty three to the lumbosacral junction. Thirty seven brought the dorsum of their hand to the waist (3rd lumbar vertebra), 25 to the 12th dorsal vertebra and 7 to the Interscapular region (7th dorsal vertebra) (fig 3b).

Muscle Strength (table Ih)

Abduction with the elbow in full extension holding 25 lbs (11.3 kg) could not be achieved by any patient when either the operated or the normal arm was tested. Two patients abducted their arm in full extension holding 15 lbs (6.8 kg) and seven patients with 12 lbs (5.4 kg). Eighteen patients were able to perform the same test under resistance of 10 lbs (4.5 kg) and 10 patients under resistance of 5 lbs (2.3 kg).

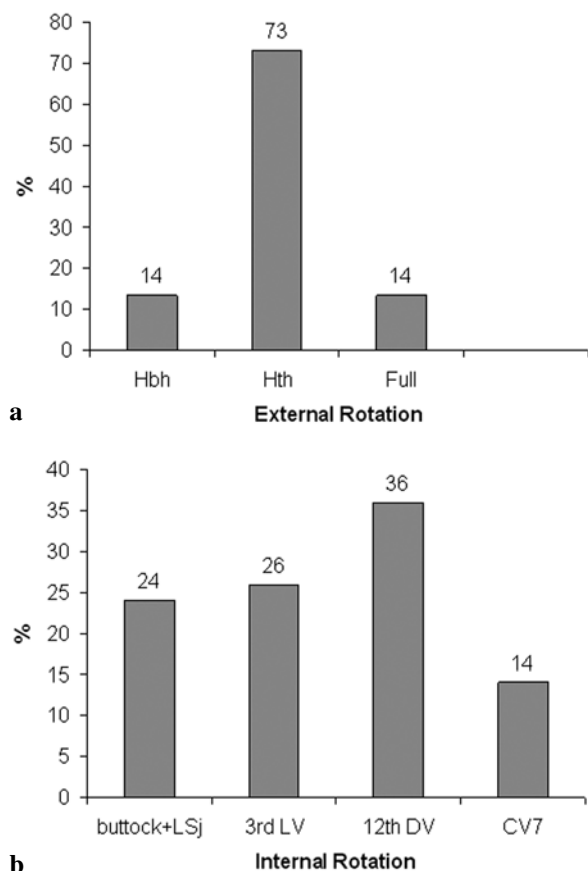


Fig. 3. — **a.** Percentage of patients according to the Constant-Murley scale for external rotation ; **b.** Percentage of patients according to the Constant-Murley scale for internal rotation.

Complications

There were complications in 13 (26%) of the cases. There was one incomplete fracture of the humeral diaphysis during intraoperative preparation. An acute postoperative *Staphylococcus aureus* infection developed in a patient with severe rheumatoid arthritis in the second postoperative week. The patient underwent two surgical debridements and was administered antibiotics intravenously for two weeks and orally for six more weeks. At the follow-up examination, he presented pain and stiffness of the arm and limited activity. Two patients suffered from rupture of the rotator cuff, one of which presented superior instability

and the other anterior-superior instability, both without pain. They denied further surgical treatment. Two more patients had superior instability due to too proximal placement of the prosthesis. They experienced moderate pain and some restriction in motion. Three patients presented inferior instability due to lower positioning of the prosthesis, which resulted in a reduced range of painless motion. The prosthesis was positioned in excessive retroversion in two patients who experienced mild discomfort during external rotation.

Radiographic evaluation

Grade 2 heterotopic ossification occurred in one patient and Grade 1 in 15 (30%) patients. Ten years after operation, one patient developed severe but painless degenerative changes of the glenoid, however, he maintained a functional ROM. Radiolucent lines 1-mm wide were detected in 9 patients. Loosening of the prosthesis was not observed in any patient. Three patients developed osteolysis of the greater tuberosity and of the lateral cortex of the metaphysis, without any pain or functional limitations.

DISCUSSION

We have used primary hemiarthroplasty to treat a group of patients over 65 years of age with three- and four-part fractures of the proximal humerus, with successful outcomes in two thirds of these patients. The degree of soft tissue damage, improper placement of the implant, and the patient's poor physical condition negatively affected the final functional outcome. The number of male subjects was rather small (8%), and therefore, there was not enough evidence to analyse the influence of gender on the results. The patients in good physical condition, who complied with the rehabilitation program, achieved very good results (28). Improvement of the shoulder function is a relatively slow process during which the patient should be closely followed (7, 11, 23).

Certain categories of patients such as alcoholics, non-cooperative individuals, those suffering from

chronic physical and/or mental health problems, or those who did not conform to a rehabilitation protocol presented suboptimal outcomes (7, 19, 23, 35, 41).

Hemiarthroplasty of the shoulder is a demanding operation which requires attention to many significant technical details (15). As Key and Amstutz (22) pointed out, Neer's exceptional results may be attributed to his experience in dealing with such injuries over 30 years. Unfortunately, due to the small number of cases necessitating such an operation, not many surgeons have adequate experience. In many study reports, the number of patients examined did not exceed thirty or forty, while the patients were operated on by several surgeons. In a number of such studies the patients came from multiple centres (2, 10, 17, 19, 22, 28, 36, 39, 40).

A patient with a three- or four-part fracture of the proximal humerus should first be assessed with respect to his/her general physical and mental health status, as this may influence the results during the postoperative rehabilitation period. These issues should be focused on prior to opting for hemiarthroplasty or non-operative fracture management. Of equal importance is the type of fracture. A valgus-impacted three- or four-part fracture should be treated with the least traumatic method of open reduction and internal fixation (26). In the case of a non-displaced fracture, we opt for non-operative management (7, 23). In the case of a young, active patient with good bone quality and a displaced fracture, we always attempt open reduction and internal fixation.

In addition, it appears that the outcome of the operation will be affected in patients who have a history of trauma of the shoulder ; especially if they had previous operations, with scars, adhesions and constrictions of the periarticular soft tissue. In such cases the results are usually inferior in comparison to patients with no history of shoulder trauma. Several authors have also claimed that the type of fracture and the condition of the soft tissues are also prognostic factors, and should not be overlooked if the surgeon wants to avoid poor outcomes (1, 7, 17, 27).

Severe comminution combined with loss of anatomical landmarks makes the procedure a real

challenge for the surgeon. Lengthening in excess of 1 cm may result in pain. Shortening of more than 1 cm will affect active motion ; if it exceeds 2 cm the muscular strength will be considerably reduced (6, 11). Our observations on a small subgroup of patients with imbalanced joints are in accordance with other authors' findings.

The ideal outcome of a shoulder hemiarthroplasty is recovery of function without pain during everyday activities, with strength almost equal to the pre-fracture state. Elevation less than 90° and external rotation less than 30° should be considered as a non-satisfactory result.

There are several methods to evaluate the results (8, 9, 22, 29). The Constant-Murley scale has been broadly accepted and used (8, 23). Hemiarthroplasty has satisfied the pain criterion for most of our patients, which is very important for older individuals because it allows them to relax. Considerable pain relief after hemiarthroplasty has been confirmed in several other studies (1, 6, 7, 10, 17, 19, 22, 23, 37-40). However, 16% of the patients in this series gave contradictory answers, i.e. four patients reporting moderate pain had difficulty moving their shoulder ; however, they were satisfied with the results of the operation. On the other hand, four patients with a good range of painless movement replied that they were not completely satisfied because of some limitation in the arm elevation and/or internal rotation. Few patients complained of either moderate or severe pain. Dawson *et al* (9) found that 98.3% of middle-aged patients (mean age : 57.4 years), who were to have an operation on the shoulder, had some kind of local painful condition prior to the fracture.

Assessment of strength examining the shoulder in full abduction against resistance comprises 25% of the Constant-Murley scale rate. If good movement and stability of the shoulder are not achieved, full strength may not be recovered. None of the 25 patients who were regarded as having 'very good movement' was able to elevate 25 lbs (11.3 kg) using either arm in abduction. The age, general health and physical condition of the patient, the stability and the anatomical position of the implant and the tuberosities, as well as the post-operative physiotherapy seem to play a decisive

role in regaining adequate strength and mobility. We found it almost impossible for an older individual to raise the arm to full abduction while holding a weight of 25 lbs (11.3 kg), even if the person exercises regularly. We have examined young, healthy volunteers with normal joints and found that only those who were engaged in manual work or exercised systematically could lift that weight. One third of those who worked in an office could not lift it. Therefore, we suggest re-assessment of the parameter of strength in the Constant-Murley scale in future studies examining samples of individuals of different ages.

In the present study, there were a few patients who complained because they did not have good movement and an even smaller number who complained of not having enough strength. However, they did not report any pain and were therefore satisfied. Assessment of this subgroup of patients has demonstrated a C-M score of 15.4 (7.7 for action and 7.7 for limb position), which is a very good result indicating adequate restoration of shoulder function (7, 12, 14, 16, 19, 36).

Very few patients were unable to resume their daily activities; they were able more or less to take care of themselves. The result for range of movement was good (23.6 C-M) for the subgroup that underwent physiotherapy for a long time, similar to the findings of most relevant studies. The most compliant patients in the post-operative rehabilitation program were able to lift their hand over the top of their head.

We did not observe, in contrast to other authors, a close relationship between movement and age (2, 17, 23, 26, 29, 39); however, poor general health was correlated with limited range of movement. The majority of the patients experienced gradual improvement of function in a two-year period after the operation.

A considerable number of complications has been reported in most studies following hemiarthroplasty for three- and four-part fractures of the shoulder (1, 11, 17, 22, 23, 25, 28, 31, 34, 37). Despite this, anatomical restoration of the joint and the tuberosities and prolonged rehabilitation may give very good to excellent results for the majority of patients over 65 years of age.

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