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Total shoulder arthroplasty — Arthroplasty for glenohumeral arthropathies: Results and complications after a minimum follow-up of 8 years according to the type of arthroplasty and etiology

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KEYWORDS
Shoulder arthroplasty;
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Long term;
Complications

Summary
Introduction: Arthroplasty for glenohumeral arthropathies have specific complications and the final results are sometimes more dependent upon the type of shoulder arthroplasty than the initial etiology. The aim of our study was to evaluate the rate of complications and the functional improvement with different types of shoulder arthroplasties after a minimum follow-up of 8 years.
Materials and methods: This was a multicenter retrospective study of 198 shoulders including 85 primary osteoarthritis of the shoulder, 76 cuff tear arthropathies, 19 avascular necrosis and 18 rheumatoid arthritis. Arthroplasties included 104 anatomic total shoulder arthroplasties (TSA), 77 reverse arthroplasties and 17 hemiarthroplasties. Ten patients had their arthroplasty revised, and 134 patients with TSA were able to be present at the final follow-up or provide information on their case. Function was evaluated by the Constant-Murley score and loosening by standard radiographs.
Results: In the group with primary osteoarthritis of the shoulder, there were eight complications (11%) including six (8.3%) requiring implant revision. In the group of rotator cuff arthropathies, there were nine (14.7%) complications including four (6.5%) requiring implant revision. In the group with rheumatoid arthritis, there was one complication, and no surgical revision was necessary. There were no complications in the group with avascular necrosis. Glenoid migration occurred in 28.5% of anatomic TSA, and 3.4% of reverse arthroplasties. This difference was significant ($P < 0.001$). The Constant-Murley score was significantly improved in all etiologies.

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Conclusions: Glenohumeral arthropathies can be successfully treated by arthroplasty. Anatomic TSA was shown to be associated with a high risk of glenoid loosening at radiographic follow-up, which makes us hesitate to use the cemented polyethylene implant, especially in young patients.
Level of evidence: IV — Retrospective study.

Introduction

The first series of shoulder arthroplasties published by Neer in 1970 [1], involved fractures of the proximal humerus, and hemiarthroplasties were used in those cases. Functional recovery and range of motion were satisfactory. It was only later that the results of total shoulder arthroplasty (TSA) with placement of a glenoid component were reported. [2]. The indication was mainly primary osteoarthritis of the shoulder. The indications were later extended to other glenohumeral arthropathies, in particular rheumatoid arthritis [3], avascular necrosis [4] and rotator cuff deficiencies [5]. The results of TSA were disappointing for the latter cases, because of the risk of glenoid loosening due to the rocking horse effect, [6] and function was not satisfactory with hemiarthroplasty [7]. After several attempts with constrained arthroplasty, reverse arthroplasty according to Grammont's principles [8] has become the treatment of choice in this type of case. Thus, over time, indications for different types of arthroplasty have become as follows [9]: hemiarthroplasty is usually indicated in patients with an intact rotator cuff and little or no glenoid wear, that is for avascular necrosis, reverse shoulder arthroplasty is indicated in insufficiency of rotator cuff, in particular in shoulder arthritis with cuff tear arthropathies, but also in rheumatoid arthritis; TSA is indicated in other cases with intact cuffs and worn glenoids, which include most cases of primary shoulder osteoarthritis. However, each type of arthroplasty has its disadvantages. There is a risk of glenoid wear with hemiarthroplasty [10] although the results of a recent study with more than 8 years of follow-up show that the risk of complications or revision surgery are low for ideal indications [11]. There is a higher risk of complications with reverse arthroplasties, in particular infectious complications, although this was mostly associated with revision arthroplasties [12] while survival of this arthroplasty for the indication of cuff tear arthropathies was 97% at 10 years [13]. Torchia et al. [14] reported a 44% risk of glenoid loosening with TSA after a mean 12 years of follow-up. Even if this was not associated with functional deterioration or a high rate of revision surgery, the number of loosenings reported in the literature increased markedly with follow-up [15].

Thus, the overall benefit of these different types of arthroplasties for functional improvement, complications, surgical revisions and potentially harmful loosening, has not been clearly established. Although TSA, seem to provide the best results in particular for shoulder osteoarthritis [16], the patient's initial condition is often less serious than with other etiologies. Finally, it is often difficult to determine whether the results obtained are due to the type of arthroplasty used or the initial etiology. The aim of our study was to evaluate the rate of complications, revisions, loosening and functional improvement with different types of shoulder arthroplasties, implanted for glenohumeral arthropathies and followed up for at least 8 years. Our hypothesis was that primary shoulder osteoarthritis or anatomic TSA respectively, does not have the best functional improvement and is not associated with a lower risk than other etiologies and types of implant after a sufficiently long follow-up.

Materials and methods

This was a multicenter retrospective study performed for the French Western Society of Orthopedics on all primary intention shoulder arthroplasties performed between January 1, 2000 and December 31, 2002, for a degenerative glenohumeral arthropathy. Only the following etiologies were included: primary shoulder osteoarthritis, rotator cuff arthropathies, non-traumatic avascular necrosis of the humeral head and rheumatoid arthritis. Patients were reviewed in 2010 and 2011 for a follow-up of at least 8 years. A total of 198 arthroplasties were implanted during that period.

The population included 191 patients (seven bilateral cases). There were 146 women and 45 men for a ratio of 1 man:3 women. The mean age at surgery was 67.5 years old (28—89). The dominant side was involved in 65% of the cases. Etiologies included 85 primary shoulder osteoarthritis 76 rotator cuff arthropathies, 19 avascular necroses and 18 rheumatoid arthritis. Arthroplasties included 104 anatomic TSA including 24 pegged glenoids 80 keeled glenoids, 77 reverse arthroplasties, and 17 hemiarthroplasties. All TSA and hemiarthroplasties were implanted by deltopectoral approach. Reverse arthroplasties were implanted by superior approach in 34 cases. The type of arthroplasty in relation to the etiology is shown in Table 1.

Thirty-three patients (33 shoulders) had died at the final follow-up. The status of the shoulder was unknown in ten of these: the implant had been revised in one patient, and it was still in place in nine others. Fifteen patients (16 shoulders) were lost to follow-up. Nine of the 143 remaining patients (149 shoulders) had had their implant revised or removed. In the remaining 134 in whom the arthroplasty was still in place, 24 (24 shoulders) were found but they could not come to the consultation and 110 patients (116 shoulders) were seen in a final follow-up with the arthroplasty still in place, after a minimum follow-up of 96 months and a mean 112 months (96—135). Ninety-eight of these 116 shoulders underwent a clinical and radiological assessment, the others were contacted by telephone.

Table 1 Distribution of the types of arthroplasties according to etiology.

	Anatomic TSA	Hemiarthroplasty	Reversed	Total
Primary osteoarthritis	82	1	2	85
Cuff arthropathy	2	5	69	76
Avascular necrosis	13	6		19
Rheumatoid arthritis	7	5	6	18
Total	104	17	77	198

TSA: total shoulder arthroplasty

Table 2 Complications and arthroplasty replacements by etiology.

	Number	Complications	Replacement
Primary osteoarthritis	72	8 (11%)	6 (8.3%)
Cuff arthropathies	61	9 (14.7%)	4 (6.5%)
Avascular necrosis w/o RC	11	0	0
Rheumatoid arthritis	15	1 (6.6%)	0
Total	159	18	10

Patients underwent a clinical evaluation at the final follow-up based on the Constant-Murley score [17] and assessment of active range of motion. The radiographic assessment included an AP view in neutral rotation and an axillary lateral view when possible. Radiographic assessment of reverse arthroplasties included evaluation of glenoid loosening and scapular notches. Glenoid loosening was considered to be definitive with there was migration of the component, suspected if there was a complete radiolucency either on AP or lateral views, and to absent in other cases (Fig. 1). Notches in the body of the scapula after reverse arthroplasties were classified as present or absent.

Results were segmented down by etiology or type of arthroplasty in each case. Comparison of pre- and postoperative parameters was performed with the Wilcoxon test for paired data. Comparison of the results of the final Constant-Murley score after more than 8 years of follow-up in relation to the etiology and type of arthroplasty was performed with the help of the U and Mann-Whitney test and the Kruskall Wallis test for unpaired data. $P < 0.05$ was considered to be significant. Analyses were performed with Statview software (Abbacus concepts Inc. Berkeley, CA, USA).

Results

The rate of complications and surgical revisions in relation to the etiology and type of arthroplasty are presented in Table 2. This includes all the arthroplasties that could be assessed or for which information was obtained, or 159 shoulders. In the group of primary shoulder osteoarthritis, there were eight (11%) complications (temporary paralysis of the axillary nerve, compression of the ulnar nerve, five cases of glenoid loosening, one posterior instability). They all involved anatomic TSA: seven required surgical revision including six (8.3%) total or partial implant changes (five loosenings of the glenoid component and one recurrent posterior instability and posterior glenoid wear). There were nine (14.7%) complications in the group of cuff tear arthropathies which only involved reverse arthroplasties: two did not require surgical revision (one acromion fracture and one fracture of the humeral diaphysis), three required surgical revision without implant change (two infections with simple lavage, one reduction of dislocation) and four (6.5%) required changing all or part of the implant (one infection with glenoid loosening, one mechanical glenoid loosening, the glenosphere and one screw was changed due to costal impingement, one glenoid fracture from a fall 7 years after surgery). In the group with rheumatoid arthritis, there was one acromion fracture on a reverse arthroplasty, with no surgical revision. There were no complications in the avascular necrosis group. There were no complications or surgical revisions in the hemiarthroplasty group.

Glenoid loosening was evaluated in 92 TSA in which radiographic assessment was performed (Table 3). There were 28.5% migrations and 17.4% suspected loosenings in the group of anatomic TSA, with no significant difference between pegged and keeled glenoids. The mean Constant-Murley score (61.2) in patients with loosening was not significantly different from that of patients without loosening (60.8). In the reverse arthroplasty group the rate of migrations was 3.4% and of suspected loosenings was 10%. The difference in the rate of definite and suspected loosenings between reverse arthroplasties and anatomical TSA was highly significant ($P < 0001$). A humeral loosening was identified in 1.5% of anatomic TSA and 3.6% of reverse arthroplasties. A scapular notch was identified in 55% of reverse arthroplasties.

Functional results were studied in the in 98 shoulders of patients whose implant was still in place, who were reviewed after a minimum follow-up of 96 months (96—134 months), and who underwent a clinical assessment. The preoperative Constant-Murley score was 30 ± 12 (0—66) and there was no significant difference among the etiologies. Anterior active elevation was $88.7 \pm 27.6^{\circ}$ (8—150). The postoperative Constant-Murley score was 58.4 ± 16.7

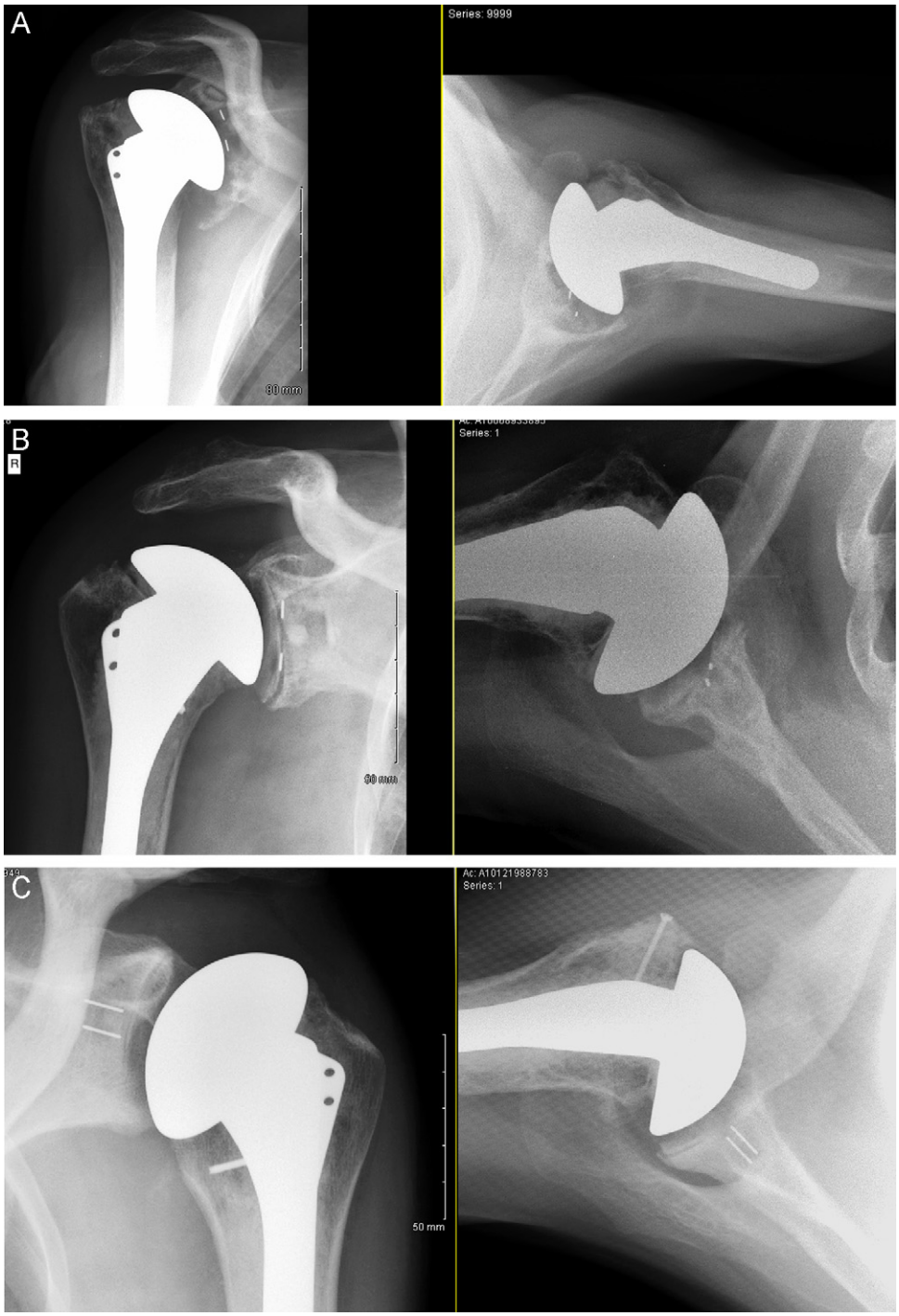

Figure 1 A. Example of definite loosening with migration due to subsidence of the glenoid component in the glenoid cavity. B. Example of suspected loosening with a complete radiolucency on lateral view. C. Example of glenoid without loosening.

(25—94). It was significantly improved ($P < 0.0001$) as were each of the parameters. Active anterior elevation was $119.1 \pm 34.7^{\circ}$ (11—180).

The results of the Constant-Murley score in relation to etiology are found in Table 4. The score was higher in patients with primary shoulder arthritis and cuff tear arthropathies than in those with other etiologies and was significantly different from those with rheumatoid arthritis ($P = 0.008$). There was significantly less improvement in patients with rheumatoid arthritis than in those with other etiologies ($P = 0.02$).

The results of the Constant-Murley score in relation to the type of arthroplasty were 60.9 ± 17.7 for anatomic TSA, 56 ± 19.1 for reverse arthroplasties and 54.5 ± 13.1 for hemiarthroplasties. The differences were not significant. Mean improvement was 30.6 for anatomic TSA, 29 for reverse arthroplasties and 19.6 for hemiarthroplasties. There was less improvement with hemiarthroplasties, but the few

Table 3 Loosening according to type of arthroplasty.

	Number	Suspected	Definite
Anatomic	63	11	18
Reversed	29	3	1
Total	92	14	19

number of cases made it impossible to confirm the significance of these results.

Discussion

The indications for glenohumeral arthroplasties in glenohumeral arthropathies depend mainly upon the etiology of the disease [9]. Hemiarthroplasties are indicated when the glenoid cartilage is intact, reverse arthroplasties for rotator cuff tears, and anatomic TSA when the rotator cuff is intact and in the presence of glenoid wear. These indications were respected in our study with nearly all cases of primary osteoarthritis treated with anatomic TSA, nearly all cuff tear arthropathies with reverse arthroplasties, and a more variable distribution for avascular necrosis and rheumatoid arthritis. Nevertheless, each of these types of arthroplasties has its own specific complications: glenoid wear for hemiarthroplasties, scapular notches and instability for reverse arthroplasties and glenoid loosening for anatomic TSA. Our study with a minimum follow-up of 8 years in a population of glenohumeral arthropathies confirms that the risk of glenoid loosening is significantly higher with anatomical TSA (28.5% of migrations and 17.4% of suspected loosenings) than with reverse arthroplasty. The rate of surgical revision for loosening was 8.3% for anatomic TSA and 6.5% for reverse arthroplasty. The rate of scapular notches with reverse arthroplasty was 55%. Functional results were similar for anatomic TSA (CM = 60.9 ± 17.7) and reverse arthroplasty (CM= 56 ± 19.1). On the other hand, although the functional results of hemiarthroplasty were poorer, there were no surgical revisions or infections.

There are certain limitations to our study. This was a multicenter, retrospective study, in which each surgeon decided on his indications, surgical technique, and postoperative follow-up. Nevertheless, all of the arthroplasties performed in the different centers during the study period were included. They are representative of the surgical activity during this period in western France. The percentage of patients who were alive and reviewed was 70%. This was because the minimum follow-up was 8 years and the population included some elderly patients in poor general condition who were unable to attend the clinical and radiological examination. Finally, even though the differences of certain results seemed important, their significance could not be confirmed because of the uneven distribution of the various etiologies and the different types of arthroplasties. Assessment of glenoid loosening was subjective and the definition was simplified into three groups: obvious migration defined as definite loosening, a continuous radiolucency without migration defined as suspected loosening, and no continuous radiolucency defined as no loosening. The most common method used to evaluate loosening is the Molé score [18]. However among the different mechanisms of loosening analyzed by Walch et al. [19], progressive subsidence of the component in the glenoid cavity (Fig. 1) was shown to be true migration, although a clearly visible radiolucency was not necessarily found, which does not confirm the Molé classification. We therefore decided to use our very simple classification.

Etiology and type of arthroplasty

Sperling et al. [20] showed that long-term results for pain supported the use of anatomic TSA for rheumatoid arthritis, but not for cuff tear arthropathies. Implant survival was also better for anatomical TSA with a rate of surgical revision of 5.6% for failure of a glenoid component compared to 7.4% for painful glenoid wear with hemiarthroplasties. On the other hand, the survival curve was stable for hemiarthroplasties after the fifth year while it decreased for anatomic TSA to cross that of hemiarthroplasties after between 15 and 20 years. However, many series of anatomic TSA also report a high rate of loosening; from 42% for Sojbjerg et al. [21] to 87% for Betts et al. [22]. These studies usually show that there is no relationship between component deterioration and functional results.

In our series, the Constant-Murley score and functional improvement were significantly poorer in cases of rheumatoid arthritis than for other etiologies. As previously reported by Gadea et al. [23], pain was markedly improved while there was very little improvement in range of motion.

Table 4 Constant-Murley (CM) score results.

		Pain	Activity	ROM	Force	CM	Gain
Primary osteoarthritis	Preoperative	4	9.4	15.1	5.1	33.5	30.6
	Postoperative	12.6	16	27.3	7.9	62.8	
Cuff arthropathy	Preoperative	3.4	7.9	14.3	2	26.6	30.4
	Postoperative	13.2	14.7	23.4	6.4	57.2	
	Preoperative	3	7.4	10.8	3.3	24.3	25.3
	Postoperative	9.8	13.8	23	8	53.8	
Rhematoid Arthritis	Preoperative	5	7.2	13.7	1.8	27.8	18
	Postoperative	13.1	13.3	18	3.2	47.5	
Total	Preoperative	3.8	8.6	14.3	3.7	30	28.6
	Postoperative	12.5	15	24.6	6.9	58.4	

Moreover, treatment of this etiology was nearly evenly distributed among the three types of arthroplasties, showing that the three different types of implants should be chosen according to different criteria. The first is age, because rheumatoid arthritis often involves young patients, in whom TSA is associated with an inevitable risk of glenoid loosening during long-term follow-up [22] either because of loss of function of the rotator cuff or because of bone lesions. Thus, we feel that hemiarthroplasty should be indicated in young patients, especially because according to Sperling et al. [20], there is very little difference between the long term results of hemiarthrplasty and TSA after more than 15 years of follow-up, and because the survival rate of hemiarthroplasties is excellent (100%) according to Gadea et al. [11]. On the other hand, there is a risk of glenoid loosening with TSA so that it should be reserved for older patients with functional rotator cuffs. Although reverse arthroplasties certainly have a place in the treatment of older patients with rotator cuff deficiences, complications due to bone lesions should be expected [24] as shown in our study with one fatigue fracture of the scapular spine.

Although the Constant-Murley score and functional improvement were not as good for avascular necrosis as results for primary shoulder osteoarthritis or rotator cuff arthropathies, the difference was not significant. After a mean follow-up of 8.9 years, Hattrup and Cofield [25] reported functional results that were comparable for TSA and hemiarthroplasty with better implant survival with anatomic TSA. With a short mean follow-up (4.8 years), Feeley et al. [26] did not find any clinical difference between the two types of arthroplasty, but reported a higher complication rate with anatomic TSA (22% versus 8%). For Gadea et al. [11] the survival rate was 94% at 10 years while it was 95% at 15 years for Smith et al. [4]. The good results for this etiology with hemiarthroplasty were especially important since this was a young population. They confirm that avascular necrosis is a reliable indication for hemiarthroplasty with good long-term glenoid tolerance.

There was a significant improvement in the Constant-Murley score and its parameters for primary osteoarthritis and cuff tear arthropathies. Most rotator cuff arthropathies were treated with reverse arthroplasty, while primary osteoarthritis was treated with anatomical TSA, which corresponds to the usual recommendations. There was no significant difference between the two groups for the Constant-Murley score or for functional improvement. Complications were more frequent with reverse arthroplasty, in particular with three infections but this rate was similar to that in other studies [12]. On the other hand, there was only one case of instability and one case of surgical revision for mechanical loosening. Indeed, one out of three cases of loosening was due to infection, one was from a fall with a glenoid fracture 7 years after arthroplasty and the third was purely mechanical. On the other hand, there were five surgical revisions for mechanical loosening in the group with primary osteoarthritis. If these cases of mechanical loosening were taken into account as well as the cases of true loosening defined by radiologically confirmed migration, the rate of mechanical loosening in the group with primary osteoarthritis was 32% compared to 5% in the group with rotator cuff arthropathies. Thus, although the results of anatomic TSA for primary glenohumeral osteoarthrtitis are globally good with a marked improvement in function, the long term results are concerning because of the high rate of surgical revision for loosening, and especially, the high potential risk of loosening. Young et al. [27] reported a 94.5% 10-year and 79.4% 15-year implant survival rate without surgical revision of the glenoid component, but an 80.3% ten year and only a 33.6% fifteen year survival rate without loosening showing an important increase in the potential risk of surgical revision after 10 years. This was not found for rotator cuff arthropathies which nevertheless undergo greater stress than anatomic TSA, suggesting that the quality of cementless fixation of the glenoid is markedly better than the fixation of a polyethylene implant. The unresolved problem is therefore the cementless anatomic glenoid component, which would be ideal because all of the long-term experiences with metal-back fixation have been failures.

Conclusion

Glenohumeral arthropathies can be treated by arthroplasty with a certain amount of success. Nevertheless, results are less good with hemiarthroplasty, although there are fewer complications, the use of reverse arthroplasty, especially in rotator cuff arthropathies is associated with a high risk of complications, and finally, the rate of surgical revision of TSA for mechanical glenoid loosening and the high rate of radiologically confirmed loosening suggests that the use of cemented polyethylene components should be avoided, especially in young patients.

Disclosure of interest

At least one of the authors (LF) has a conflict of interest: invited as a speaker by the company Tornier.

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