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Shoulder function after deltoid muscle removal

Postoperative function and muscular strength of the shoulder joint were studied in five patients who had undergone extirpation of the deltoid muscle because of a soft tissue tumor. No patient had significant functional impairment but all had a slightly limited range of active abduction and flexion. The strength reduction did not exceed 40 per cent in any position.

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The deltoid muscle is a common location for both benign and malignant soft tissue tumors. We have not found any description in the literature of the functional impairment and muscle strength reduction that can be expected after removal of this muscle. Such knowledge is of interest from both a clinical and a theoretical point of view.

We have studied function and muscle strength in five patients in whom the deltoid muscle has been removed because of tumor. We have also tried to estimate the force contribution of the deltoid muscle to different motions of the shoulder joint.

Patients and methods

Five patients were operated for soft tissue tumor in the deltoid muscle between 1979 and 1983 (Table 1). In Case 1, only the posterior and lateral parts of the deltoid muscle were removed, but the remaining part was denervated. In the four other cases, the whole deltoid muscle was removed from origin to insertion along with the tumor, and in Case 4, the lateral parts of the acromion and clavicle were included in the resection. No patient had local recurrence or signs of distant metastasis.

The functional impairment was assessed by interview.

The active and passive range of motion of the shoulder joint was tested.

With the patient in a supine position, the isometric muscle strength generated around the shoulder was measured by a Cybex-II dynamometer, fixed with straps over the chest and pelvis. The rotation center of the dynamometer was aligned to the axis of rotation of the actual movement. The strength of abduction was measured in 0, 45, and 90 degrees of abduction. The strength of flexion and extension was measured in 0, 45, and 90 degrees of flexion. The best of three maximal isometric performances in each position was used. The strength on the operated side was calculated in relation to that on the non-operated side (per cent). The strength reduction was analyzed statistically, using a paired t-test.

Results

Functional impairment. No patient had pain at rest, but Case 1 had weak pain after heavy exertion, and she could not put her hand on her back and also had some difficulties in dressing herself. The other patients had no limitation on their everyday activities. All patients had returned to their previous work, even those who were doing heavy work such as industrial cleaning and forest work. Spare-time activities

Table 1. Descriptive data of five patients who have had the deltoid muscle removed for intramuscular tumor

Case	Sex	Age	Follow-up time (years)	Diagnosis
1	F	54	0.5	Lipoma
2[a]	F	53	3	Lipoma
3	F	62	4	Myxofibrosarcoma
4[a]	M	79	3.5	Leiomyosarcoma
5[a]	M	72	4.5	Leiomyosarcoma

a. Dominant side operated.

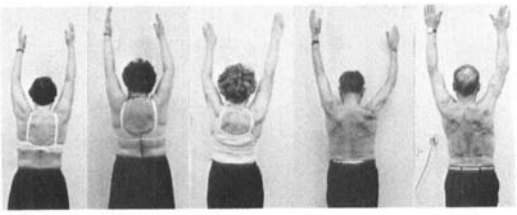

Figure 1. Five patients operated on with removal of the deltoid muscle because of tumor; from left to right, Cases 1 to 5.

were not affected, even in those who had taken regular exercise.

Clinical examination. All patients had a slightly limited (5–15 degrees) range of active abduction and flexion (Figure 1). Case 1 had a slight limitation of internal rotation, so that she could not reach the contralateral scapula. The passive range of motion was unlimited in all patients.

Muscle strength measurements (Figure 2)

Case 3 was weak in all movements on both sides (<10 Nm); no difference was found between her operated and non-operated sides, however. Because of the low absolute values of the muscle strength, comparison between the two sides became uncertain, and this patient is not included in the calculations below.

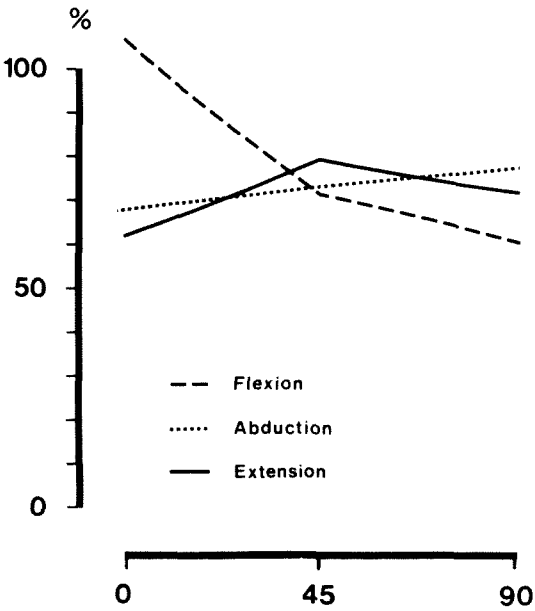

Figure 2. The mean strength reduction in relation to the non-operated side in Cases 1, 2, 4 and 5.

Abduction. Strength was decreased only in the neutral position ($p < 0.05$). The mean strength in relation to the non-operated side was 68, 73, and 77 per cent in 0, 45, and 90 degrees of abduction, respectively.

Flexion. Strength was decreased ($p < 0.05$) at 45 and 90 degrees of flexion. There was no strength reduction in the neutral position. The mean strength in relation to the non-operated side was 107, 71, and 60 per cent in 0, 45, and 90 degrees of flexion, respectively.

Extension. Strength was decreased ($p < 0.05$) in the neutral position and in 90 degrees of flexion. The mean strength in relation to the non-operated side was 62, 79, and 71 per cent in 0, 45, and 90 degrees of flexion, respectively.

Discussion

In our series of 443 benign and malignant soft tissue tumors, 17 were located in the deltoid muscle. A radical removal of a tumor in this muscle means removal of the whole muscle including its fascia (extra-compartmental dissection). If the functional impairment after such an operation is negligible, the operation can be carried out without an incisional biopsy, thereby avoiding the risk of local spread of tumor cells outside the compartment and the possible risk of hematogenous spread of tumor cells. No patient in our small series had any significant loss of function.

The results of the muscular strength measurements are difficult to interpret. Theoretical calculations based on measurements of levers and cross-sectional areas on cadavers (Fick 1911) make the deltoid muscle responsible for 57 per cent of the abduction torque, 49 per cent of the flexion torque, and 15 per cent of the extension torque. The mean abduction strength and flexion strength in our four patients were about 30 per cent higher than those calculated from the work of Fick. The remaining muscles – the rotator cuff muscles, the long head of the biceps, and for flexion also the short head of

the biceps, the coracobrachialis, and the pectoralis major – may have undergone hypertrophy during the follow-up time. In earlier works (Markhede & Nistor 1979, Markhede & Stener 1981), we found surprisingly good function and much remaining strength after removal of different muscles and muscle groups of the lower extremity. In several cases, the most probable explanation for the low strength reduction was a compensatory hypertrophy.

However, in the present study, the woman with only half a year follow-up time was not significantly weaker than the other patients, and our clinical experience is that the patients can elevate their arms against more than gravity a few days after operation. Therefore, another possible explanation of the relatively small loss of strength is that the maximal torque exerted in a given motion is not the sum of the maximal torque that each of the synergistic muscles is capable of. Under normal conditions when the deltoid muscle acts as the prime mover of the humeroscapular joint, the rotator cuff muscles perhaps contribute with less force to the torque than they do after removal of the deltoid muscle.

Theoretically, the deltoid muscle contributes only 15 per cent to the extension torque (Fick 1911). According to our measurements, it seems to contribute about 30 per cent.

To conclude, removal of the deltoid muscle in our five patients resulted in only a slight impairment of function and less loss of abduction and flexion strength than expected from theoretical calculations. Extension strength, however, was more affected than expected, and it seems that the deltoid muscle is equally important to strength in all three directions of motion.

Acknowledgement

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