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ORIGINAL ARTICLE

BURKHART AND KARAS METHODS OF OPERATIVE TREATMENT OF MASSIVE ROTATOR CUFF TEARS

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Summary

The most complex topic is represented by operative treatment of type IV lesions of rotator cuff. Palliative arthroscopic resection of rotator cuff did not produce optimal results. We thus intend to evaluate the newly implemented surgical techniques at our department.

Fifty-six patients with type IV rotator cuff lesions were treated surgically between October 2007 and December 2010. In 6 patients, combined operations had to be performed because of their pathology, and these were not included in detailed evaluation. The population selected for detailed evaluation of new surgical techniques included 50 patients (mean age: 59 years, range: 41–73 years). The patients were randomized into two subpopulations, each formed by 25 people. Both subpopulations can be considered representative and comparable.

All operations were performed in the "beach-chair" position in general anesthesia or/and in interscalenic block. After type IV lesion was diagnosed, the prespecified surgical procedure followed – partial muscle transfer of subscapularis muscle tendon (Karas) or partial non-anatomic rotator cuff reconstruction (Burkhart). The results were evaluated after 6 months using the modified Constant Functional Score. The following parameters were assessed: sex, age, side of the operation, dominance of the limb, Constant Functional Score pre-operatively and post-operatively, subjective and objective evaluation, pain, activities, movement and muscle strength, Constant Score improvement, improvement in its individual items and subitems, pain pre-operatively and post-operatively.

In older patients with type IV lesions, we have good experience with Karas method while in younger and more active patients, Burkhart method seems to be more useful.

Key words: shoulder arthroscopy; rotator cuff lesions; classification; subacromial decompression; open surgery; muscle transfer; partial reconstruction; Constant Functional Score

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INTRODUCTION

In our department, we have been performing arthroscopies of the shoulder joint and treating the impingement syndrome and rotator cuff lesions for more than 10 years. The frequency of rotator cuff lesions in the shoulder joints examined arthroscopically has forced us to sort these findings and

to contemplate the possibilities of their surgical treatment in more details.

This article was preceded by our previous ones about arthroscopic subacromial decompression (published in 2004; 34) and about arthroscopic palliative rotator cuff resection (published in 2007; 35). We have also published some work about the influence of rotator cuff lesions on the classification of health status in professional soldiers (33). The classification of rotator cuff lesions and their surgical repair are being dealt with in our last article from 2011 (36).

We wish to introduce our own, simplified and intuitive classification of rotator cuff lesions (tables 1 and 2), based on the popular original Gschwend classification (12). The complexity of type IV lesions and unsatisfactory results of available treatment methods have led us to trying and evaluating surgical methods not used in our country so far – of the partial subscapularis muscle tendon transfer according to Karas (14) and of the partial non-anatomic reconstruction of the rotator cuff according to Burkhart (7).

Table 1. My own modification of lesion classification

I	< 1 cm (including non-transmural)
II	1 – 3 cm
III	3 – 5 cm
IV	> 5 cm
V	Inveterate massive rupture with the presence of moderate to severe arthrosis and with cranial subluxation of the humeral head

Table 2. Modified classification as a therapeutic guide

I	Arthroscopic subacromial decompression
II	Arthroscopic reconstruction of the rotator cuff
III	Arthroscopically assisted reconstruction of the rotator cuff
IV	Partial transfer of the subscapularis muscle, open partial reconstruction of the rotator cuff
V	Arthroscopic palliative resection of the rotator cuff remnants

PATIENTS AND METHODS

Patient's population

The population selected for detailed evaluation of new surgical techniques included 50 patients (mean age: 59 years, range: 41–73 years). These were 33 men and 17 women. The right upper limb was affected in 33 patients. In 36 patients, the dominant upper limb was affected.

The half-population created for evaluation of the Karas method (14) consisted of 25 patients whose mean age was 61 years (range: 44–73 years). These were 15 men and 10 women. The right upper limb was affected in 17 cases, the dominant upper limb in 19 cases.

The second half-population intended for evaluation of the Burkhart method (7) consisted of 25 patients whose mean age was 57 years (range: 41–73 years). These were 18 men and 7 women. The right upper limb was affected in 16 cases, the dominant upper limb in 17 cases.

Both subpopulations can be considered representative and well comparable.

All patients included in the population intended for special evaluation fulfilled the inclusion criteria defined for the entire evaluated population. All patients in whom we expected the possibility of finding a type IV rotator cuff lesion were asked to sign – besides the consent to the operation – also the consent to participate in the clinical study. Ten patients refused to sign this consent and thus could not be included in the population intended for special evaluation. Fortunately, these were patients with lesions of a different type.

Another condition for inclusion in the population intended for special evaluation was the presence of an arthroscopic finding of type IV rotator cuff lesion according to my own classification (i.e. lesion ≥ 5 cm without severe degenerative changes and without a marked cranialization of the humeral head). One of the above new surgical methods had to be used in these patients.

Six patients in whom the combination of both above surgical methods had to be used because of their anatomy and rotator cuff pathology were excluded from the population.

Despite the strict criteria, it was possible to define a population of 50 patients with type IV rotator cuff lesions that could be split in two half-populations, each comprising 25 patients who underwent the operation using the first or the second surgical technique mentioned above.

The indications for operative treatment of type IV rotator cuff lesions were similar for all patients with rotator cuff pathology. We indicated the operation after 6 months of unsuccessful conservative therapy (analgesics – antirevmatics, local anesthetic/corticoid injections, lifestyle changes, and physiatry). In this group, however, the time of conservative treatment was quite often shortened and the indication for operative treatment was formulated earlier based on an unequivocal history of trauma, clear clinical picture or a persuasive finding of a complete rotator cuff rupture on the magnetic resonance imaging.

When type IV rotator cuff lesion was diagnosed arthroscopically and the pathological-anatomical findings were favorable, it was necessary to randomize the patients to one of the subpopulations according to the reconstruction planned.

The envelope randomization method, fulfilling the criteria for the randomization method using random numbers, was used.

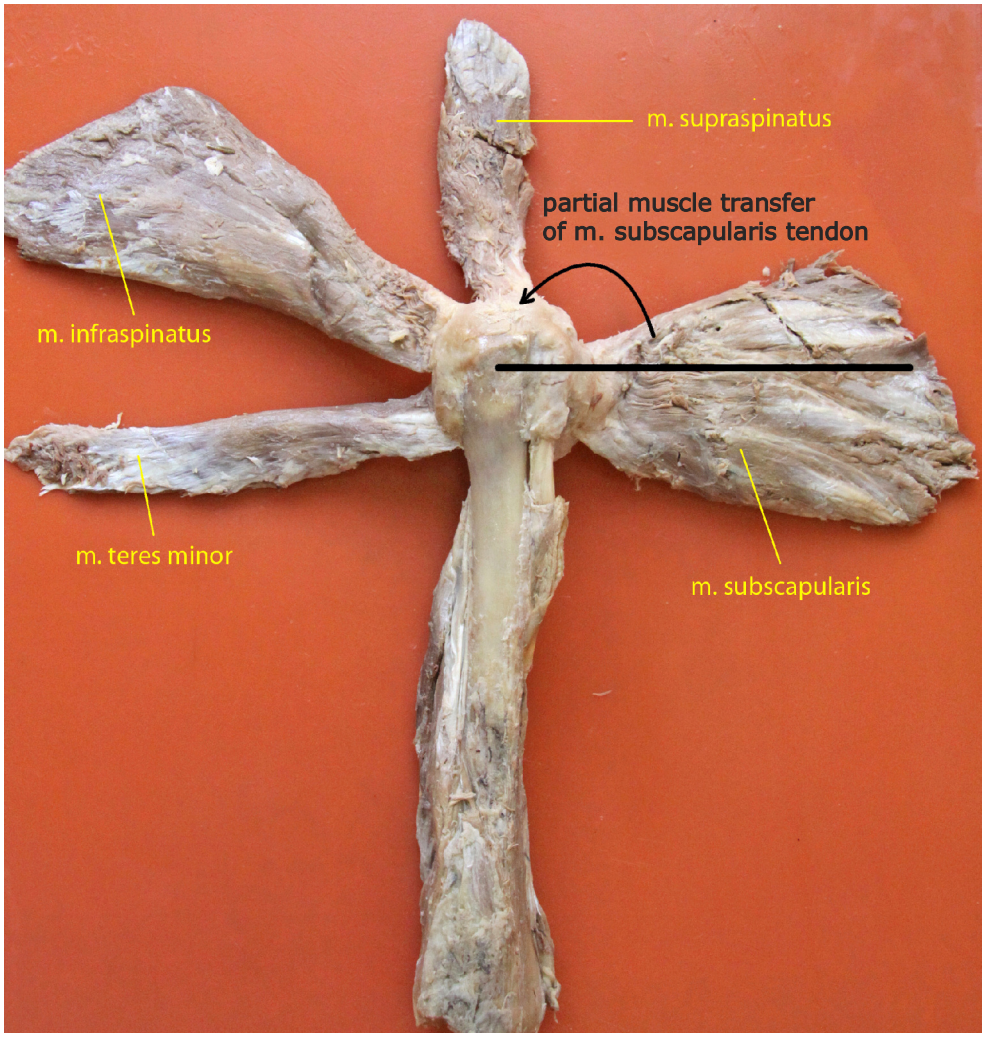


Fig. 1. Scheme of the partial muscle transfer according to Karas using anatomical preparation of the rotator cuff of the shoulder joint.

Method

In patients with chronic complaints, the operation was mostly indicated only after 6 months of unsuccessful conservative treatment. We performed all the operations in the "beach-chair" position which makes the conversion to an open surgery easy. The arthroscope is primarily introduced through the "soft-spot". We always use the continual lavage with an arthroscopic pump. First, we revised the glenohumeral joint, inserting the hook through the ventral port. Then we always performed an arthroscopic visualization of the subacromial space. We evaluated the findings concerning the rotator cuff from both views and we classified its lesion according to my own classification. The complexity of type IV rotator cuff lesions has forced us to try and evaluate some conserving operative approaches that are not used in our country or are used very rarely. After type IV lesion was diagnosed, the given open reconstructive surgery followed.

The operation according to Karas (Fig. 1) consists of splitting the intact subscapularis muscle tendon and of transferring its upper part towards the insertion of the original, severely damaged supraspinatus muscle tendon. This is followed by its fixation to the major humeral tubercle in the location of original supraspinatus muscle tendon insertion, usually using special anchoring elements. This approach can be used in the presence of an intact subscapularis muscle tendon. Of all rotator cuff tendons, this one is fortunately the least prone

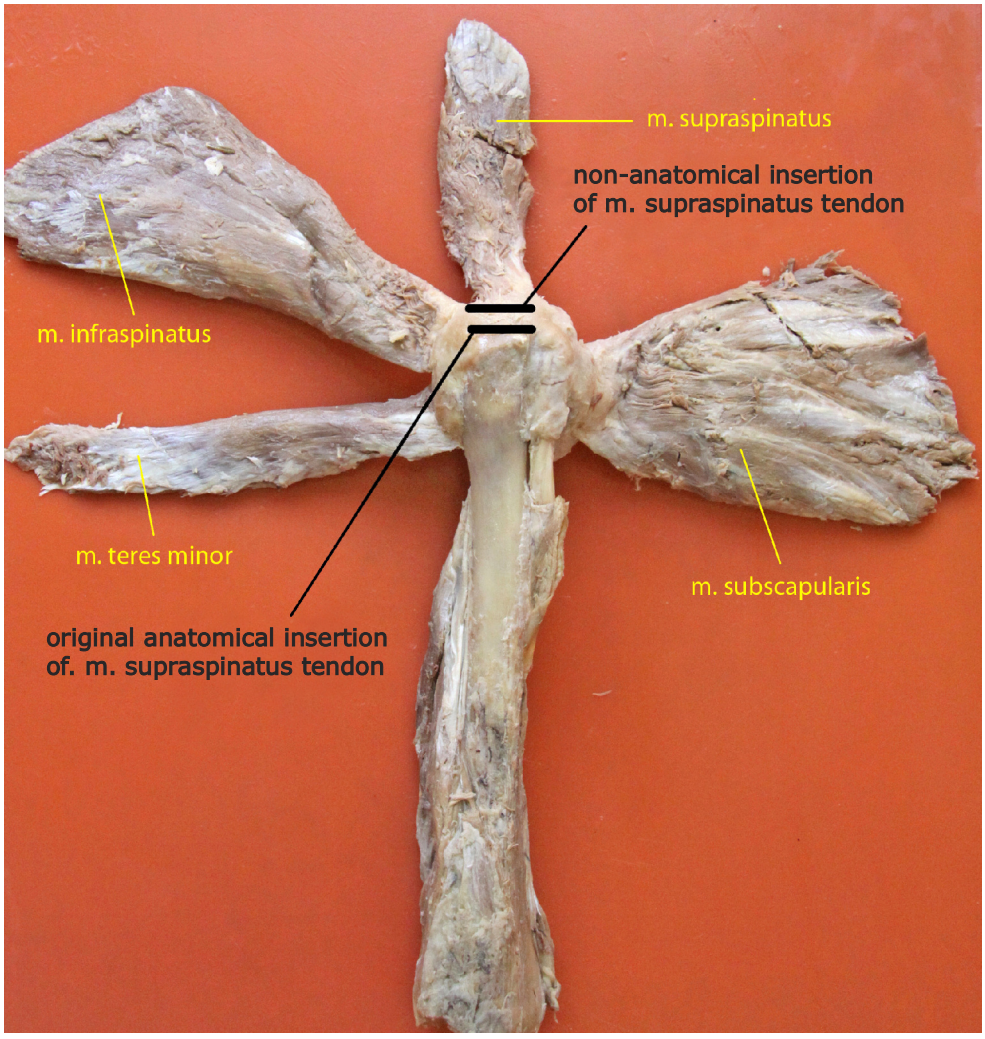


Fig. 2. Scheme of the partial non-anatomic reconstruction according to Burkhart using anatomical preparation of the rotator cuff of the shoulder joint.

to damage. Most often, the supraspinatus muscle tendon is damaged, followed by the infraspinatus muscle tendon.

During the operation according to Burkhart (Fig. 2), no fixation of the mobilized supraspinatus muscle tendon to the original insertion on the major humeral tubercle is performed. The tendon has to be fixed to the base of the major tubercle about 1 cm medially from the original insertion but beyond the border of the hyaline joint cartilage. The tension within the reconstructed tendon is thus minimized. This measure minimizes the risk of reconstruction failure while possibly lowering the mobilized tissue quality.

As for the post-operative care, we always use the fixation in the abduction orthosis for 6 weeks in non-anatomic reconstructions. After the orthosis is removed, sling fixation is still used and only individual gradual limbering-up is recommended for 3 weeks. Intensive rehabilitation is started just after those 3 weeks.

In patients representing the special population who underwent an operation for type IV rotator cuff lesion, no post-operative complications were noted. Possible complications can only be expected based on the rare occurrence of complications seen in other surgeries of the shoulder joint of a similar extent (large amount of blood drained through the Redon drain, necessitating a surgical revision and hemostasis; surface infection of surgical wounds; axillary nerve palsy; rupture of the trachea during endotracheal intubation in the "beach-chair" position with pneumomediastinum, not requiring any other intervention).

The modified initial Constant Score (18) was calculated in all patients prior to the surgery. Detailed clinical examination and also a questionnaire evaluating the patient's subjective complaints were always used.

We saw each patient about 10 days (removal of stitches), 6 weeks and 3 months post-operatively and also after they completed the physiatric treatment, which was relatively long-term in most cases.

The results of surgical treatment were always assessed at least 6 months post-operatively during follow-up outpatient visits using the modified Constant Score. The approach to the evaluation was the same as pre-operatively.

All patients enrolled were followed-up throughout the study.

We had a chance to see more than one half of the patients again more than 2 years post-operatively.

The patient's age, sex, side of the operation and dominance of the operated limb were evaluated. The Constant Score was assessed pre-operatively and 6 months post-operatively

Pain was quantified using the visual analogue scale pre-operatively, 1, 3 (dismissal from the hospital), and 10 days (removal of the stitches on the outpatient basis), 6 weeks (visit preceding the physiatric program initiation) and 6 months post-operatively. Use of analgesics was also monitored during hospitalization and then at home (during outpatient visits).

In all patients representing the special population, the Constant Score was assessed immediately (on the preceding evening or in the morning) before the reconstruction surgery and during an outpatient visit at least 6 months post-operatively. All patients in the special population were thus evaluated not earlier than 6 months and not later than 7.5 months after the surgery. We had a chance to assess about one half of the patients using the modified Constant Score again 2 years after the reconstructive operation on average. This assessment has not been included in the detailed statistical evaluation. Compared with the scores noted 6 months post-operatively, only a minimal worsening was observed.

Pain was another factor examined. It was assessed subjectively, using the visual analogue scale. The assessment took place immediately before the operation and then in prespecified time intervals (1 day, 3, and some 10 days, about 6 weeks and at least 6 months post-operatively).

The last evaluated factor was the use of analgesics during the hospitalization and then at home some 6 months after the surgery. The use of analgesics was always assessed during the outpatient visits. During the last outpatient visit at least 6 months after the reconstruction surgery, the assessment of analgesics use represented a part of questionnaire tapping the subjective satisfaction of patients.

While thinking about how to assess the functional results of surgical treatment of type IV rotator cuff lesions, we contemplated the use of Constant Functional Score (18) and of the UCLA (University of California, Los Angeles) rating scale. The modified Constant Score, accepted by the European Society for Surgery of the Shoulder and Elbow Joints, was eventually chosen because of its apparent simplicity. Beside detailed clinical examination, this evaluation method also uses practical self-reported questionnaires. We also chose this method because it has been used in our department for years. The modification recommended by the European Society for Surgery of the Shoulder and Elbow Joints consists

of alternative muscle strength evaluation, comparing the strength of the operated arm with that of the contralateral (healthy) arm.

The achieved result of 80–100 points is considered excellent, 65–79 points are good; 51–64 points are acceptable. Fifty points and less correspond to a bad result. This assessment, however, cannot be viewed as fully reliable – the difference between the pre-operative and post-treatment Constant Scores is much more important.

The functional assessment of surgical results has been dealt with by Trsek (32).

Table 3. Modified Constant Functional Score

1.	Subjective assessment (questionnaire) – 35 points a) pain – 15 points b) work, sleep, sport/recreational activities – 20 points
2.	Objective assessment (clinical examination) – 65 points a) range of motion (elevation, abduction, internal rotation, external rotation) – 40 points b) muscle strength (compared with the healthy contralateral side) – 25 points

Table 3 illustrates the evaluation method used.

During statistical assessment of subpopulations formed to evaluate two new surgical methods for treatment of type IV rotator cuff lesions, the following factors were taken into account:

1. Patient's sex, age, side of the operation, dominance of the operated limb.

2. Constant Functional Score – pre-operatively and 6 months post-operatively.

3. Individual items in the Constant Score (subjective and objective assessment) – pre-operatively and 6 months post-operatively.

4. Individual subitems of the Constant Score (pain, activities, movement, muscle strength) – pre-operatively and 6 months post-operatively.

5. Improvement of the Constant Score, in its individual items and subitems.

6. Pain assessment – VAS – pre-operatively, on the 1st, 3rd (dismissal from the hospital) and 10th post-operative days (removal of the stitches), 6 weeks (rehabilitation initiated) and 6 months after the operation.

7. The use of analgesics in both subpopulations.

The following statistical methods were used for statistical evaluation of the results obtained: calculation of averages and of the standard deviations, two-phase analysis of variance (ANOVA) followed by an assessment of contrasts using the LSD method.

RESULTS

The special population was formed by two subpopulations, each of which consisted of 25 patients and was evaluated in detail separately. In the first subpopulation, surgical treatment according to Karas was used – partial muscle transfer of the cranial portion of the well preserved subscapularis muscle tendon (14). The second subpopulation was treated surgically according to Burkhart, using partial non-anatomic reconstruction of the rotator cuff with a medialization of the original supraspinatus muscle tendon insertion (7).

The following factors were evaluated in both subpopulations: the patient's sex and age, lateralization and dominance of the operated upper limb, modified Constant Score (18) assessed pre-operatively and 6 months post-operatively, individual items within the Constant Score (subjective and objective evaluation) pre-operatively and 6 months post-operatively, individual subitems of the Constant Score (pain, activities, movement, muscle strength) pre-operatively and 6 months post-operatively, Constant Score improvement, improvement in its individual items and subitems, pain assessed subjectively using a visual analog scale (pre-operatively, on the 1st, 3rd and 10th post-operative days, 6 weeks and 6 months after the operation).

The results achieved in each subpopulation are listed in Tables 4, 5, 6, and 7.

Table 4. Results obtained in the subpopulation of patients treated with the Karas method (n = 25)

Patient No.	Sex M/F	Age	Limb R/L	Dominance Y/N	Improved Constant	Improved subj.	Less pain	Improved activity	Improved obj.	Improved motion	Improved strength
1	F	68	R	Y	31	5	4	1	25	15	10
2	F	71	R	Y	40	11	6	5	29	17	12
3	M	50	R	N	18	9	6	3	9	5	4
4	M	65	L	Y	13	13	5	8	0	1	-1
5	M	63	L	Y	13	4	3	1	9	4	5
6	F	66	R	Y	29	8	5	3	21	11	10
7	M	59	L	N	24	7	4	3	17	7	10
8	M	53	R	Y	20	10	4	6	10	2	8
9	M	50	R	Y	19	15	7	8	4	1	3
10	M	64	R	Y	23	10	4	6	13	7	6
11	F	73	R	Y	23	4	2	2	19	9	10
12	M	60	R	Y	35	8	5	3	27	15	12
13	M	66	L	N	17	10	3	7	7	3	4
14	F	69	L	Y	17	10	6	4	7	5	2
15	M	48	R	Y	31	8	4	4	23	12	11
16	M	61	R	Y	30	15	6	9	15	9	6
17	M	66	R	Y	29	6	4	2	23	16	7
18	F	53	L	Y	13	15	7	8	-2	0	-2
19	F	72	R	Y	12	10	8	2	2	2	0
20	M	46	L	N	22	10	5	5	10	7	3
21	F	52	L	N	24	11	6	5	13	7	6
22	M	44	R	Y	21	13	4	9	8	1	7
23	M	68	R	Y	25	9	5	4	16	9	7
24	F	71	R	N	18	14	8	6	4	4	0
25	F	68	R	Y	28	12	6	6	16	9	7

Legend: No. – number, M – male, F – female, R – right, L – left, Y – yes, N – no, subj. – subjectively, obj. – objectively

Table 5. Results obtained in the subpopulation of patients treated with the Burkhart method (n = 25)

Patient No.	Sex M/F	Age	Limb R/L	Dominance Y/N	Improved Constant	Improved subj.	Less pain	Improved activity	Improved obj.	Improved motion	Improved strength
1	M	61	R	Y	26	6	3	3	20	15	6
2	M	57	R	Y	24	7	5	2	17	13	4
3	F	54	R	Y	23	9	7	2	14	10	4
4	M	53	L	Y	28	10	7	3	18	13	5
5	M	65	L	N	27	5	2	3	22	17	5
6	F	63	R	Y	29	12	4	8	17	13	4
7	M	48	R	Y	25	7	3	4	18	11	7
8	M	41	R	Y	26	6	2	4	20	11	9
9	M	69	R	Y	22	12	4	8	10	8	2
10	M	58	L	N	30	9	6	3	21	13	8
11	M	53	R	Y	28	9	4	5	19	12	7
12	F	67	L	N	24	7	4	3	17	11	6
13	M	59	R	N	26	9	6	3	17	11	6
14	M	56	R	Y	26	7	4	3	19	15	4
15	M	62	R	Y	26	10	4	6	16	13	3
16	F	69	R	Y	20	6	3	3	14	13	1
17	M	65	R	Y	25	9	3	6	16	10	6
18	M	46	L	N	27	8	1	7	19	17	2
19	M	43	R	Y	32	10	4	6	22	18	4
20	F	66	L	N	26	11	4	7	15	10	5
21	F	55	R	Y	26	12	6	6	14	12	2
22	M	51	L	N	29	5	2	3	24	20	4
23	F	73	R	Y	19	14	6	8	5	4	1
24	M	46	L	Y	31	7	3	4	24	24	0
25	M	56	L	N	23	7	2	5	16	10	6

Legend: No. – number, M – male, F – female, R – right, L – left, Y – yes, N – no, subj. – subjectively, obj. – objectively

Table 6. Subjective assessment of pain in the subpopulation of patients treated with the Karas method (n = 25)

Patient No.	VAS before	VAS Day 1	VAS Day 3	VAS Day 10	VAS Week 6	VAS Month 6
1	6	8	6	4	1	0
2	8	9	7	5	2	0
3	9	10	9	6	4	1
4	7	9	8	5	0	0
5	4	8	8	6	3	0
6	8	9	6	4	2	2
7	6	7	6	5	3	0
8	7	9	8	6	2	1
9	8	10	9	7	5	0
10	9	10	10	9	6	4
11	5	8	8	5	3	1
12	7	9	7	4	1	0
13	6	9	8	6	2	1
14	5	8	7	3	1	0
15	7	10	7	5	3	0
16	8	10	9	6	4	2
17	7	9	8	5	2	0
18	10	10	10	7	4	3
19	9	10	10	6	3	0
20	8	10	9	5	4	2
21	9	10	10	9	5	2
22	9	10	10	8	7	5
23	8	10	8	4	2	0
24	10	10	10	7	3	1
25	8	9	9	8	4	0

Legend: No. – number, VAS – visual analog scale

Table 7. Subjective assessment of pain in the subpopulation of patients treated with the Burkhart method (n = 25)

Patient No.	VAS before	VAS Day 1	VAS Day 3	VAS Day 10	VAS Week 6	VAS Month 6
1	6	8	6	5	2	1
2	7	9	8	7	3	1
3	8	9	8	6	4	1
4	6	9	7	5	4	0
5	9	9	9	8	7	5
6	8	9	6	6	6	3
7	7	9	7	5	4	2
8	8	10	9	8	6	4
9	6	9	6	4	3	1
10	7	8	6	3	1	0
11	5	7	5	3	2	0
12	8	10	8	5	4	3
13	9	10	7	4	3	2
14	7	10	8	4	2	1
15	8	8	5	3	1	0
16	7	10	7	6	4	3
17	9	9	8	5	3	2
18	8	10	9	8	6	5
19	9	9	7	6	5	4
20	7	8	5	3	1	0
21	8	8	6	4	3	1
22	5	8	6	4	2	0
23	6	9	7	6	3	0
24	4	7	6	4	1	0
25	7	9	9	8	5	4

Legend: No. – number, VAS – visual analog scale

The last evaluated factor was the use of analgesics in individual subpopulations, linked with the subjective pain assessment. Heavier use of analgesics in the entire post-operative period (during hospitalization, during fixation and during rehabilitation) was noted in the subpopulation operated according to Burkhart.

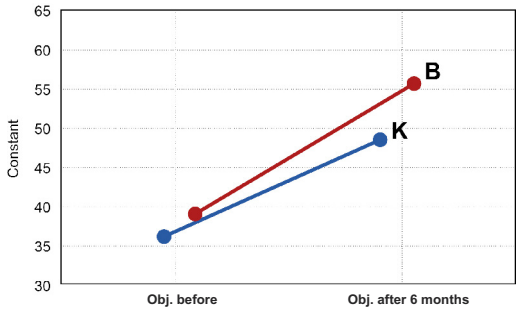
The following methods were used for statistical evaluation of the special population and both its subpopulations: calculation of averages and of the standard deviations, two-phase analysis of variance (ANOVA) followed by an assessment of contrasts using the LSD method.

Data were listed as averages and standard deviations in continuous random variables and as percents in discrete random variables. The temporal influence of the two methods (according to Karas and Burkhart, respectively) on X, Y … and Z was quantified using the two-factor analysis of variance followed by an assessment of contrasts using the LSD method. P values < 0.05 were considered statistically significant. The statistical analysis was carried out using the Statistica program, version 9.1.

Further workup of the above results (of the two-factor analysis of variance followed by an assessment of contrasts using the LSD method) has led to the conclusions presented below.

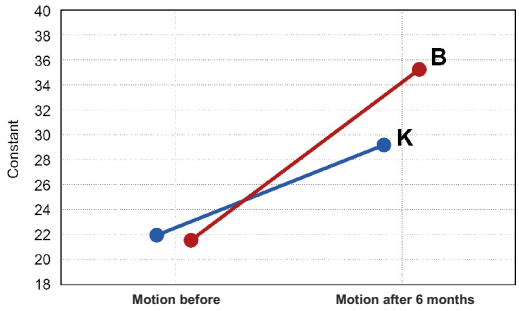
The differences between the results of the surgical treatments according to Burkhart and Karas, respectively, concerning the objective improvement and improvement of the range of motion are statistically highly significant, favoring the former method ($p < 0.01$ for both comparisons). These variables were expressed also graphically (Graphs 1 and 2).

Graph 1: Statistically significant difference between both subpopulations concerning the objective improvement (favoring the Burkhart subpopulation), $p < 0.01$



Legend: Obj. – objective assessment, B – Burkhart, K – Karas

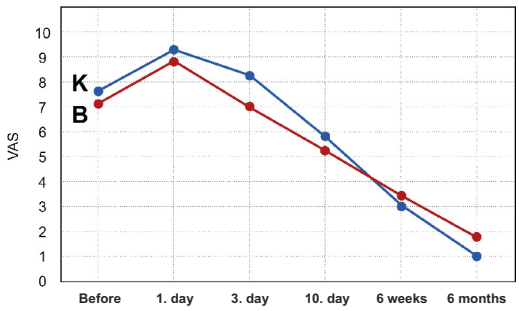
Graph 2: Statistically significant difference between both subpopulations concerning the motion range improvement (favoring the Burkhart subpopulation), $p < 0.01$



Legend: Motion range improvement, B – Burkhart, K – Karas

The Burkhart method was statistically significantly better than the Karas method when the improvements in the entire Constant Score and improvement in muscle strength were compared ($p < 0.05$ for both comparisons). The differences between these two methods concerning other factors seem to be statistically insignificant.

Graph 3: Subjective pain assessment using the visual analog scale



Legend: VAS – visual analog scale, B – Burkhart, K – Karas

The subjective assessment of pain using the visual analogue scale has been expressed graphically (Graph 3) at individual time points (pre-operatively, on the 1st, 3rd, and 10th post-operative days, 6 weeks and 6 months post-operatively).

Globally better results were thus obtained treating the type IV rotator cuff lesions with the Burkhart method. Worse results achieved with the Karas method are, however, outweighed by shorter duration of pain and lower use of analgesics.

DISCUSSION

In our experience, rotator cuff lesions are quite prevalent.

As for the world literature, the arthroscopy of the shoulder joint has been described in detail by Peterson (25). Rotator cuff lesions have been dealt with in detail by Matsen (17).

Most of the rotator cuff lesions seem to be clearly chronic and always associated with impingement syndrome. Acute lesions are rare and according to our experience, they are usually superimposed on previous degenerative changes.

Diagnostically, ultrasonography is less useful since it can only yield good results in the hands of an experienced and skilful examiner. Magnetic resonance imaging provides better results when evaluated by an experienced radiologist. Unequivocal classification of the lesion type can, however, be based on arthroscopic findings only. We checked the correctness of our classification on cadavers and also by agreement/disagreement of the classification after the conversion to open operations.

Type I lesion can be managed satisfactorily in the long-term with arthroscopic subacromial decompression, removing the irritation of rotator cuff in the narrow subacromial space. This method is a good replacement of the original open acromioplasty according to Neer (20). We have already published its favorable results (34). The arthroscopic and open techniques of subacromial decompression are being compared by Pillai (27).

In type II lesions, reconstruction or suture of the rotator cuff that can quite easily be performed arthroscopically is indicated.

The situation is similar in type III lesions where the reconstruction can be simplified technically by a mini-incision intended for knot tying. Laterally located lesions often have to be managed with special fixation implants.

Since type IV lesions are clearly the most complex, they are being managed by using more operative treatments than the other lesion types, the spectrum of outcomes comprising rather worse (often just satisfactory or even unsatisfactory) results. Failures of the attempts at anatomical reconstruction of such large lesions were described by Karas (15). Arthroscopic palliative resection of rotator cuff remnants in the presence of minimal degenerative changes cannot be found satisfactory by the surgeon (1, 35). As the description of this method implies, it only alleviates the pain but does not offer any functional reconstruction of the rotator cuff. Of the many methods described, most hope concerning the restoration of function seems to be associated with muscle transfers and partial non-anatomical reconstructions. The most common muscle transfers are those of subscapularis (5, 14, 22) and latissimus dorsi (11, 13, 16, 26) muscles. “Inlay-flaps” from the deltoid (10), teres minor (22), and teres major (26) muscles are also used. The most technically feasible and

the least burdening (concerning the extent of the surgery) is probably the partial muscle transfer of the subscapularis muscle according to Karas (14). Karas, however, describes very good outcomes only in a very small group of patients. Quite good results were publshed for the latissimus dorsi muscle transfers but this surgery requires larger surgical approach and is more burdening to the patient. Latissimus dorsi muscle transfer always needs to be indicated with caution because of its extent; we don't perform this type of surgery. Non-anatomic partial reconstruction of the rotator cuff described by Burkhart (6, 7) undoubtedly also has its place here. Even in this case, however, good outcomes achieved with this method were published in a relatively small patient sample. New surgical "double-layer" (19) and "double-row" (31, 38) techniques are becoming increasingly popular, yielding still better and better results. The use of allomaterials – carbon filaments (27) and synthetic replacements (24, 30, 37) – is much less successful. Unsatisfactory results were also described using the cadaverous graft (21). Variable and mostly unsatisfactory outcomes were noted with cutaneous xenografts (2, 29), differently augmented grafts (3, 9) or the bovine pericardium (8). The development of biosynthetic and biological replacements using the cultivation of pluripotent stem cells is very fast (23). These methods are still mostly a matter of scientific research and scarce outcomes of their clinical use have to be viewed as very preliminary.

Attempts at anatomical reconstruction of type IV lesions often fail because of lack of tissues enabling the reconstruction. When high tension in the tissues after the anatomical reconstruction ensues, failure can occur. The quality of tissues (fibrillation, fat infiltration) available for reconstruction also has to be assessed. My experience clearly supports the so-called non-anatomical reconstructions. Attempts at arthroscopic realization of the reconstruction in these cases lead to significant increases in the surgical time and the cosmetic effect is debatable at best, provided the higher number of arthroscopic ports needed. At our department we clearly prefer the conversion of the arthroscopic operation to an open procedure, enabling wide digital mobilization of the rotator cuff. It needs to be stressed, however, that in large lesions (more than 5 cm), not even this mobilization often makes it possible to close these defects without critical tension.

The complexity of type IV rotator cuff lesions, failure of attempts at anatomical reconstruction and just satisfactory results of arthroscopic palliative resection of rotator cuff remnants have led me to trying and evaluating new surgical methods scarcely used in our country so far. The results achieved with both methods justify my continued use of both above surgical approaches. In exceptional cases of large defects, both approaches had to be combined. The necessity became apparent during the course of the operation. We could not, however, include these cases in the special population. Given the smaller prevalence of type IV lesions, the total number of 50 patients in the special population (2 subpopulations with 25 patients in each) is relatively high. We did not find larger patient populations in the available literature. The surgical method according to Karas yielded relatively worse functional results using the Constant Score but these are outweighed by shorter duration of pain, lower use of analgesics and faster rehabilitation. This method seems to be suitable rather for older patients with lower functional demands. In younger patients with higher functional demands, the surgical method according to Burkhart is likely to be preferred, in which longer duration of pain, higher use of analgesics and slower rehabilitation are outweighed by better functional outcomes based on the final Constant Score.

Reconstruction surgeries are contraindicated in type V lesions. Severe degenerative changes of the bone in the subacromial space render any reconstructions useless within a short time. Good outcomes were described in arthroscopic palliative resection of rotator cuff remnants according to Apoil (1). In our experience, this effect does not have to be just temporary in many patients. We have already published the satisfactory results achieved with this method (35). Resurfacing after failure of previous therapy is suitable for selected older patients – this procedure is not much burdening and provides substantial pain relief. Clear functional improvement, however, cannot be expected in this case. Younger and more active patients with complete and large rotator cuff defects and degenerative changes thus require another suitable endoprosthetic solution, including especially reverse TEP.

Larger chronic rotator cuff lesions can be associated with a central motor deficit affecting the deltoid muscle (4).

Functional assessment of results has been published by Trsek (32). In our department, we clearly prefer the established modified Constant Functional Score (18), which seem to be easier and more useful than the UCLA evaluation.

CONCLUSION

Rotator cuff impairment is a frequent cause of complaints concerning the shoulder girdle. Great majority of these lesions are chronic and are associated with the impingement syndrome. Acute problems often arise even after a small trauma in the presence of degenerative changes.

Considerations concerning the management of individual lesion types are based on abundant practical experience, the classification used being a therapeutic guide.

In type IV lesions affecting older patients, we have good experience with a partial transfer of the intact subscapularis muscle tendon according to Karas (14). The same lesions in younger and more active patients seem to be more effectively managed with partial non-anatomic reconstruction according to Burkhart (7). In rare cases, both of the above methods had to be combined because of specific anatomical situations.

The results achieved so far are reassuring; our study has confirmed the benefit offered by new surgical methods to carefully selected patients.

REFERENCES

1. Apoil, A.; Dautry, P.; Koechlin, P. The surgical treatment of rotator cuff impingement. In: Bayley, I.; Kessel, L. (eds.): Clinical disorders of the shoulder. Springer, Berlin **1982**, p 22–26.
2. Badhe, T. G.; Lawrence, T. M.; Smith, F. D.; Lunn, P. G. An Assessment of Porcine Dermal Xenograft as an Augmentation Graft in the Treatment of Extensive Rotator Cuff Tears. *J. Shoulder Elbow Surg.* **2008**, 17, 35–39.
3. Barber, M. A.; Herbert, M. A.; Coons, D. A. Tendon Augmentation Grafts: Biomechanical Failure Loads and Failure Patterns. *Arthroscopy*. **2006**, 22, 534–538.
4. Berth, A.; Pap, G.; Awiszus, F.; Neumann, W. Central Motor Deficits of the Deltoid Muscle in Patients with Chronic Rotator Cuff Tears. *Acta Chir. Orthop. Traum. čech.* **2009**, 76, 456–461.
5. Bicanic, G.; Trsek, D.; Klobucar, H.; Cicak, N. Comparison of Subscapularis Tendon Transfer Technique and Direct Suture Technique for Massive Rotator Cuff Tears. *Acta Chir. Orthop. Traum. čech.* Supplement 1. **2004**, 71, 46.
6. Burkhart, S. S. Arthroscopic treatment of massive rotator cuff tears. *Clin. Orthop. Rel. Res*, **1991**, 267, 45–46.
7. Burkhart, S. S.; Nottage, W. M.; Ogilvie-Harris, D. J. Partial Repair of Irreparable Rotator Cuff Tears. *Arthroscopy*. **1994**, 10, 363–370.
8. Ciampi, P.; Vitali, M.; Fraschini, G. Reconstruction of Massive Rotator Cuff Tears with a Bovine Pericardium Patch. 22nd Congress of the European Society for Surgery of the Shoulder and the Elbow. Abstract Book. Mozart, Madrid **2009**, p 119.
9. Coons, D. A.; ALAN, B. F. Tendon Graft Substitutes – Rotator Cuff Patches. *Sports Med. Arthroscopy*. **2006**, 14, 185–190.
10. Dierickx, C.; Vanhof, H. Massive rotator cuff tears treated by a deltoid muscular inlay flap. *Acta Orthop. Belg*. **1994**, 60, 94–100.
11. Gerber, C. Latissimus dorsi transfer for the treatment of irreparable tears of the rotator cuff. *Clin. Orthop. Rel. Res*. **1992**, 275, 152–160.
12. Gschwend, N.; Ivoševič-Radovanovič, D.; Patte, D. Rotator Cuff Tear – Relationship between Clinical and Anatomorphological Findings. *Archives of Orthop. and Trauma Surg.* Volume 107. **1987**, 1, 7–15.
13. Kany, J.; Valenti, P. Arthroscopic Assisted Humeral Fixation for Latissimus Dorsi Transfer. 22nd Congress of the European Society for Surgery of the Shoulder and the Elbow. Abstract Book. Mozart, Madrid **2009**, p 120.
14. Karas, S. E.; Giachello, T. A. Subscapularis Transfer for Reconstruction of Massive Tears of the Rotator Cuff. *J. Bone Jt. Surg*. **1996**, 78-A, 239–245.
15. Karas, E. H.; IANNOTI, J. P. Failed repair of the rotator cuff. *J. Bone Joint Surg*. **1997**, 79-A, 784–793.
16. Lichtenberg, S.; Magosch, P.; Frikech, H.; Kircher, J.; Habermayer, P. Are there Advantages of the Combined Latissimus Dorsi Transfer according to L'Episcopo compared to the Isolated Latissimus Dorsi Transfer according to Herzberg after a Long Term Follow-up? 22nd Congress of the European Society for Surgery of the Shoulder and the Elbow. Abstract Book. Mozart, Madrid **2009**, p 74.
17. Matsen, F. A. III.; Craig, T. A.; Steven, B. L. Rotator Cuff. In.: Rockwood, Ch. A. Jr.; Matsen, F. A. III. (eds.): The Shoulder. Second Edition. Volume 2. W. B. Saunder's Company, London **1998**, p 755–839.
18. Matsen, F. A. III.; Smith, K. L. Effectiveness Evaluation and the Shoulder (Constant´s Scoring System, UCLA). In: Rockwood, Ch. A. Jr.; Matsen, F. A. III. (eds.): The Shoulder. Second Edition. Volume 2. W. B. Saunder's Company, London **1998**, p 1313–1319.

19. Meier, S.: Rotator Cuff Tears and Tendon Delamination: Performing Anatomic Repairs and Solving Fixation Issues. 22nd Congress of the European Society for Surgery of the Shoulder and the Elbow. Abstract Book. Mozart, Madrid **2009**, p 72.
20. Neer, S. C. II. Anterior Acromioplasty for the Chronic Impingement Syndrome: A Preliminary Report. *J. Bone Jt. Surg*. **1972**, 54-A, 41–50.
21. Neviaser, J. S.; Neviaser, R. J.; Neviaser, T. J. The repair of chronic massive rupture of the rotator cuff of the shoulder by use of a freeze-dried rotator cuff. *J. Bone Joint Surg*. **1978**, 60-A, 681–684.
22. Neviaser, R. J.; Neviaser, T. J. Transfer of subscapularis and teres minor for massive defects of rotator cuff. In: Bayley, I.; Kessel, L. (eds.): Shoulder surgery. Springer, Berlin **1982**, p 60–63.
23. Nicholson, G. R.; Breur, G. J.; Van, S. D.; Yao, J. Q.; Kim, J.; Blanchard, C. R. Evaluation of a Cross-linked Acellular Porcine Dermal Patch for Rotator Cuff Repair Augmentation in an Ovine Model. *J. Shoulder Elbow Surg*. **2007**, 16, S184-S190.
24. Ozaki, J.; Fujimoto, S.; Masuhara, K. Repair of chronic massive rotator cuff tears with synthetic fabrics. In: Bateman, J. E.; Welsh, R. P. (eds.): Surgery of the shoulder. Decker, Philadelphia **1984**, p 185–191.
25. Peterson, Ch. A. II.; Altchek, D. W.; Warren, R. F. Shoulder Arthroscopy. In: Rockwood, Ch. A. Jr.; Matsen, F. A. III. (eds.): The Shoulder. Second Edition. Volume 1. W. B. Saunder's Company, London **1998**, p 290–335.
26. Phipps, G. J.; Hoffer. M. M. Latissimus dorsi and teres major transfer to rotator cuff for Erb's palsy. *J. Shoulder Elbow Surg*. **1995**, 4, 124–129..
27. Pillai, A.; Nimon, G. A. Acromioplasty. Outcome Measurement after Arthroscopic and Open Procedures. *Acta Chir. Orthop. Traum. čech*. Supplement 1. **2004**, 71, p 55.
28. Post, M. Rotator cuff repair with carbon filament: A preliminary report of five cases. *Clin. Orthop. Rel. Res*. **1985**, 196, 154–158.
29. Proper, A. G.; Aladin, A.; Lunn, P. G. Evaluation of Porcine Dermal Xenograft in the Treatment of Chronic Massive Rotator Cuff Defects. *J. Bone Jt. Surg*. Supplement 1. **2003**, 85-B, p 69.
30. Soler, S. J.; Gidwani, S.; Curtis, M. J. Early Complications from the Use of Porcine Dermal Collagen Implants (Permacol) as Bridging Constructs in the Repair of Massive Rotator Cuff Tears. A Report of 4 cases. *Acta Orthop. Belg*. **2007**, 73, p 432–436.
31. Toussaint, B.; Goberie, E.; Schnaser, E.; Bosley, J.; Shishani, Y. The Clinical Outcome and Structural Integrity of Arthroscopic Rotator Cuff Repair with the Use of the Double-row Transosseous Equivalent Technique. 22nd Congress of the European Society for Surgery of the Shoulder and the Elbow. Abstract Book. Mozart, Madrid **2009**, p 96.
32. Trsek, D.; Bicanic, G.; Klobucar, H.; Cicak, N. Shoulder Function after Open Rotator Cuff Repair. *Acta Chir. Orthop. Traum. čech*. Supplement 1. **2004**, 71, 46.
33. Urbánek, L.; Jícha, Z. The Influence of the Rotator Cuff Lesions on the Health Classification of the Professional Soldiers. Military Medical Science Letters. 2008, 77, 135–139.
34. Urbánek, L.; Karjagin, V. Arthroscopic subacromial decompression – Personal Experience and Results. *Acta Chir. Orthop. Traum*. Čech. **2004**, 71, 45–49.
35. Urbánek, L.; Vaněček, V.; Vašek, P.; Kubela, R. Arthroscopic Palliative Resection of the Rotator Cuff in Patients with Unreconstructible Lesions. *Acta Chir. Orthop. Traum. čech*. **2007**, 74, 268–272.
36. Urbánek, L.; Vašek, P.; Tuček, M. Arthroscopic Findings Concerning Rotator Cuff Lesions and Their Operative Management. *Acta Chir. Orthop. Traum. Čech*. **2011**, 78, 237–243.
37. Yao, J. Q.; Blanchard, C. R.; Bloor, S. Zimmer Collagen Repair Patch for Rotator Cuff Tendon Repair. **2006**. (UnPub)
38. Zumstein, M. A.; Bugnas, B.; Brassart, N.; Boieleau, P. Arthroscopic Double-row Rotator Cuff Repair: Is the Technique a Predictive Factor of Better Clinical and Anatomical Results? 22nd Congress of the European Society for Surgery of the Shoulder and the Elbow. Abstract Book. Mozart, Madrid **2009**, p 97.