



Extremity saving surgery and reconstruction for tumors of the scapula

Skapula tümörlerinde ekstremitte koruyucu cerrahi ve rekonstrüksiyon

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Amaç: Bu çalışmada, skapula tümörü nedeniyle ekstremitte koruyucu cerrahi ve skapular protezle rekonstrüksiyon uygulanan hastalarda tedavi sonuçları değerlendirildi.

Çalışma planı: Skapula kemik veya yumuşak doku tümörü bulunan yedi hastaya (1 kadın, 6 erkek; ort. yaş 53; dağılım 39-75) parsiyel veya total skapulektomi ve rekonstrüksiyon uygulandı. Rekonstrüksiyonda bir hastada fibular otograft, altı hastada skapula protezi kullanıldı. Yumuşak doku rekonstrüksiyonu latissimus dorsi kas flebi ile yapıldı. Ameliyat sonrasında primer patolojiye bağlı olarak adjuvan kemoterapi ve/veya radyoterapi uygulandı. Hastaların üst ekstremitte değerlendirmeleri MSTS (Musculoskeletal Tumor Society) fonksiyonel skorlamasına göre yapıldı. Takip süresi ortalama 35 ay (dağılım 18-53 ay) idi.

Sonuçlar: Hastalarda ameliyat sonrası erken dönemde cerrahi komplikasyon gözlenmedi. Total skapulektomi uygulanan hastalardan ikisi uzak metastaz nedeniyle kaybedildi. Bir hasta ikinci yılda takip dışı kaldı. Unconstrained protez kullanılan ilk olguda omuz instabilitesi görüldü. Hastalarda omuz hareketlerinde kısıtlılık (aktif omuz abduksiyonu 20°-90°) bulunmasına karşın, dirsek ve el fonksiyonları normale yakındı. Fonksiyonel açıdan ortalama MSTS skoru 22 (dağılım 18-25) bulundu; dört hasta iyi veya çok iyi olarak değerlendirildi. Primer hastalığı kontrol altına alınanlarda ve "constrained" protez uygulamalarında sonuçlar daha başarılı (abduksiyon 45°-90°, ort. MSTS skoru 24) idi.

Çıkarımlar: Skapula tümörlerinde ekstremitte koruyucu cerrahi ile birlikte skapular üçgen yapının protezle oluşturulması ve rezeksiyonda korunabilen kasların buraya bağlanmasıyla stabilite ve fonksiyonlar artırılabilir

Anahtar sözcükler: Kemik neoplazileri/cerrahi; protez ve implant; hareket açıklığı, eklem; rekonstrüktif cerrahi prosedür; sar kom/cerrahi; skapula/cerrahi; omuz eklemi.

Objectives: The aim of this study was to evaluate the results of extremity saving surgery and reconstruction with a scapular prosthesis in patients with scapula tumors.

Methods: Seven patients (1 woman, 6 men; mean age 53 years; range 39 to 75 years) underwent partial or total scapulectomy followed by reconstruction with fibular autograft (n=1) or a scapular prosthesis (n=6) for bone or soft tissue scapular tumors. Latissimus dorsi muscle flap was used for the reconstruction of soft tissues. Postoperative adjuvant chemotherapy and/or radiotherapy were used depending on the primary pathology. Functional evaluations were made using the scores of the Musculoskeletal Tumor Society (MSTS). The mean follow-up period was 35 months (range 18 to 53 months).

Results: No major surgical complications occurred in the early postoperative period. Two patients died due to distant metastasis. One patient was lost to follow-up in the second year. The first patient of the series in whom an unconstrained prosthesis was used had severe instability. Overall, despite some limitation in the movements of the shoulder (active shoulder abduction: 20°-90°), elbow and hand functions were near-normal. The mean MSTS functional score was 22 (range 18 to 25); four patients had good or very good results. The results were more satisfactory (abduction: 45°-90°, mean MSTS score 24) in patients with well-controlled primary disease and in whom a constrained prosthesis was used.

Conclusion: Stability and function can be increased with limb salvage surgery, reconstruction of the scapular triangle with a prosthesis, and re-attachment of preserved muscles to the new scapular body.

Key words: Bone neoplasms/surgery; prostheses and implants; range of motion, articular; reconstructive surgical procedures; sarcoma/surgery; scapula/surgery; shoulder joint.

5 to 10% of bony sarcomas occur in the scapula. The scapula is a common site for Ewing's sarcoma, chondrosarcoma and renal cell carcinoma. In musculoskeletal oncology over the past 25 years, success rate of limb-sparing surgery for patient with extremity sarcoma is reported as 90 to 95%.^[1,2]

During early limb sparing surgery in shoulder girdle, shoulders were left flail without any reconstruction, and the extremity dangled by the skin and neurovascular bundle. Patients had no active shoulder abduction and the shoulder was unstable. This made it difficult to carry objects and to place the hand in a functional position. Cosmesis was poor, and neuropraxia frequently developed. Patients had chronic pain and motor sensory deficits. Many required an external orthosis.^[1,2]

Surgeons attempted to circumvent some of these problems by stabilizing the proximal humerus or remaining humeral shaft directly to the clavicle. But shoulder motion was not improved, and instability remained a problem. Complications and failures were frequent.

These early methods of reconstruction are attempted to reconstruct the bony structures. The periscapular muscles not used for reconstruction. The scapula is the key link to arm stability. The

scapula attaches to the chest wall through its insertion of the periscapular muscles onto the scapula; from the muscles arising from the scapula to the arm, there is no bony attachment except for the clavicle. This linkage must be reconstructed to obtain a satisfactory upper extremity and a stable shoulder girdle, which are essential for normal elbow and hand function.^[1-5]

Prosthetic reconstruction for scapular tumours in literatures are appeared since 1980. Asavamongkolkul et al reported between 1980 and 1991, 17 patients underwent reconstruction with endoprosthesis after resection of malignant tumour of scapula.^[6]

Wodajo et al had used a scapular endoprosthesis for reconstruction after scapular resection on selected patients since 1981.^[1] Malawer et al reported that after development endoprosthetic scapular prosthesis over the 40 reconstructive procedure had been estimated, they had performed approximately 25 scapular replacement. They had developed several recommendation for indication, reconstruction technique and design of prosthesis.^[4]

Successful limb sparing methods lead us to use this method in some selected patients with scapular and periscapular tumour, who had to treated with

Table 1. Oncologic diagnosis, surgery, reconstruction and complications

Age Sex	Diagnosis biopsy* Postop**	Scapulectomy Reconstruction	Chemotherapy Radiation	Complication
39 F	Chondrosarcoma**	R partial Fibular greft		
52 M	AdenoCa Met.- Malign epitelial tm Mesenchymal chondrosarcoma Ewing**	R total Prosthesis, Latissimus flap	Chemotherapy	Subluxation
47 M	Mesenchymal chondrosarcoma* Ewing**	R total Prosthesis, Latissimus flap	Chemotherapy	
53 M	Epiteloid sarcoma- Malign Undifferential tm Sinovial sarcoma**	R total Prosthesis, Latissimus flap	Radiation	Ex
75 M	Multiple myeloma**	L total Prosthesis, Latissimus flap	Chemotherapy	
63 M	LungCa met**	L total Prosthesis, Latissimus flap	Radiation	
47 M	Sinovyal sarkom**	L total Prosthesis, Latissimus flap	Chemotherapy Radiation	Lung met-Ex

non-surgical or amputation before. In our study , 7 patient with scapular tumors, who follow-up means three years after underwent limb salvage and reconstruction in our clinic, were evaluated with the indications of limb salvage and reconstruction for scapular tumors, technical difficulties in operations and scapular prosthesis design properties and functional results.

Patients and methods

Between Jan-2000 and Jan-2003, seven patients with bone and soft tissue neoplasm in scapula are underwent limb sparing surgery. There were six male patients and one female patient, with a mean age of 53 years. Preoperative findings are palpable mass and pain over the scapula, and axillar nerve pathology (one patient). All patient are examined with routine biochemical test, direct plain radiographic image, MRI, sintigraphy, thorax CT, abdomen ultrasonography and biyopsy. Figure 1 and 2 show some examples of plain radiography and CT . After evaluation and determination about diagnosis, stage and prognosis for each case by musculoskeletal tumour consul , limb sparing surgical treatment was performed as partial or total scapular resection. According to postoperative histologic examinaton, indicated radiation therapy and adjuvant chemotherapy were added . Acknowledge

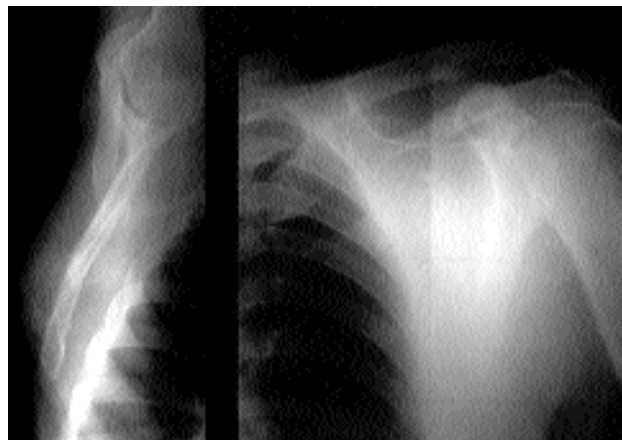


Figure 1. Radiography, Ewing sarcoma in scapula

about patients are summarized in Table-1. Upper extremity function in patients are evaluated according to the functional rating system of the Musculoskeletal Tumor Society (MSTS)for upper extremity.

Follow-up period was mean 35 mounth (ranged 18-53 mounth).

Surgical technique

As surgical procedure; extraarticular partial or total scapular resection and shoulder girdle reconstruction with scapular prosthesis or bone greft. One

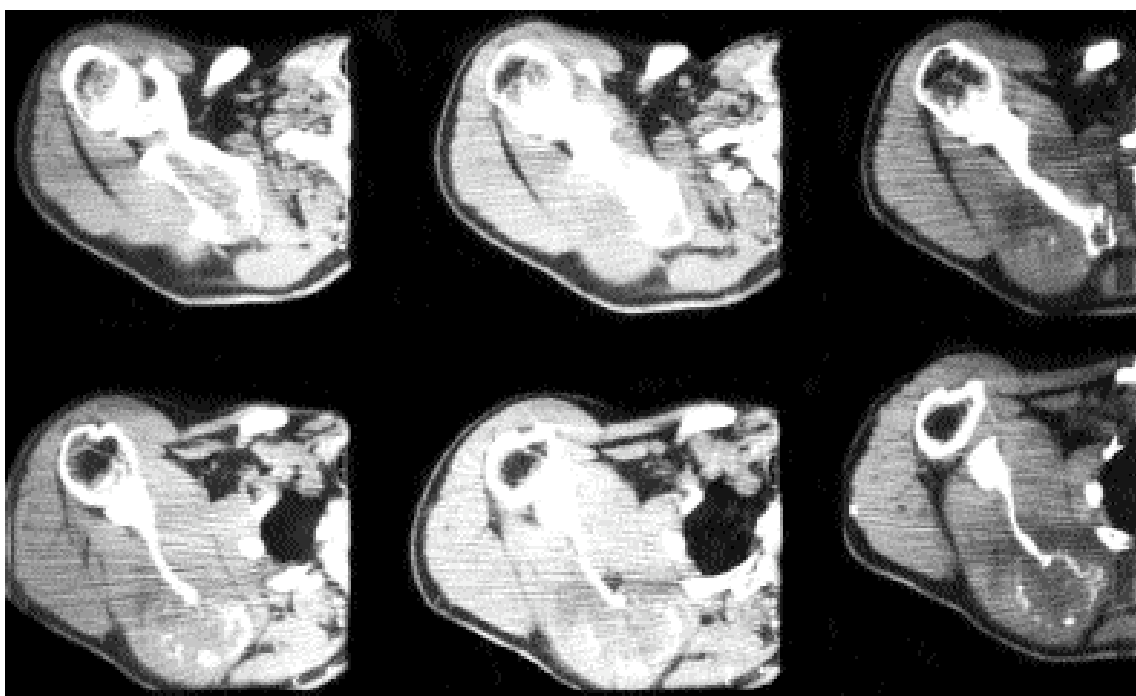


Figure 2. CT scan, Ewing sarcoma in scapula.

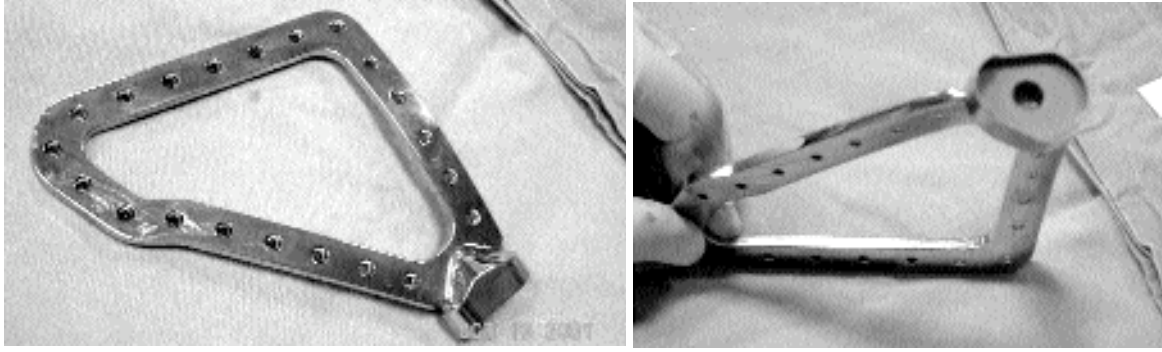


Figure 3. Unconstrained scapula prosthesis.

patient was treated by partial scapulectomy and reconstructed scapular frame with fibular greft and re-attached muscles so that shoulder stability and function are saved. After total scapulectomy, scapular reconstruction was obtained with custom-made scapular prosthesis. Due to wide excisional surgery, soft tissue defect over scapula and shoulder girdle were resulted many difficulties of soft tissue coverage to the prosthesis and besides functional failure. Gleno humeral stability was established with Dacron greft(Intergard) and prolen mesh (Trex) which wrapped up the humeral head and glenoid. When the periscapular muscles were not enough for reconstruction, prosthesis was hung its medial side to costal bone by wire or suture material. While the scapular stabilization was intended, we paid attention to less limitation of shoulder abduction.

Prosthesis

For prevent to morbidity related the defect on the upper extremity alignment due to partial or total scapulectomy, custom-made prosthesis was designed. Prosthesis was designed resemble glenoid and scapu-

lar alar component for establish functional gleno-humeral joint movement and reconstruction of scapula thoracic relationship to support shoulder and arm.

Custom-made scapular prosthesis were templated using scapular CT examination for each patient, and produced from cobalt-chrome material. Prosthesis included glenoid component and triangular scapular body frame. Triangular frame had some holes for sutur application (Figure 3). After wide resection of tumour, some reserved muscles were able to reattached to the prosthesis and so functional outcomes would be increased. First prosthesis didn't include any process except glenoid, but for reduce to secondary instability, acromial component and clavicular attachment ability were added second generation of prosthesis. Three dimensional correction on prosthesis was achieved as 12° convexity in frontal plane, glenoid angulated 7° retroversion and 5° superior (Figure 4). When the static and dynamic stabilizer weakness or failure at the gleno-humeral joint due to massive soft tissue defect in shoulder girdle, more constrained prosthesis for glenohumeral reconstruc-

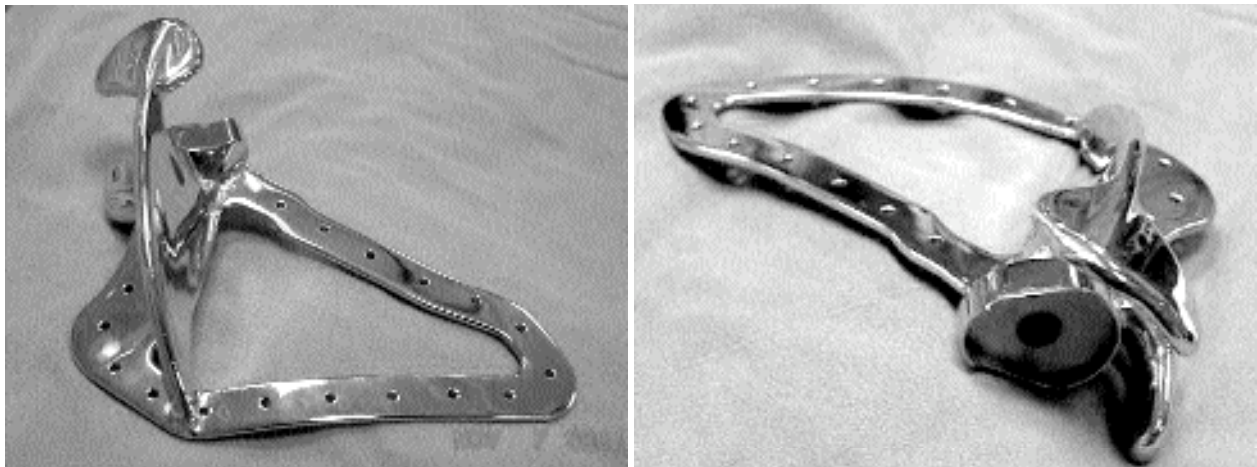


Figure 4. Constrained scapula prosthesis

tion is required, so our study about improvement of prosthesis is continued.

Results

There was no complication about neurovascular tissue and infection after surgery.

Two patient with underwent total scapulectomy due to scapular and soft tissue tumour, were exitus with malignant disease progression as distant metastasis. One patient was out of follow-up in second years. Follow-up period is mean 35 month (range, 18 to 53 month). Patients shoulder (active abduction range, 20° to 90°) range of motion were limited (Figure 5a,5b,5c show a radiography of patient treated with constrained scapular prosthesis, and his shoulder neutral position and active abduction), elbow and hand function were normal. Patient MSTS functional scoring is mean 22 (range, 18 to 25), four patient evaluated as good and very good. When we re-evaluated this patient related malign prognosis, well controlled group show more active abduction range 45° to 90° and MSTS score is mean 24(range, 23 to 25).

Discussion

In the past, reconstruction after extra-articular resection of the scapula and glenohumeral joint (“Tikhoff-Linberg” procedure, developed in 1928) consisted of suspension of the remaining humerus from the clavicle or chest wall. This leads to limited

stability of the shoulder and the upper extremity.^[1] Recovery of shoulder function with prosthetic and soft tissue reconstruction are come together improving limb sparing methods for 25 years. Studies for improvement endoprosthetic design have been intense in especially lower extremity contrary to upper extremity. Major advances have been made in endoprosthetic design and surgical technique for scapular reconstruction recently. Wodajo et al.^[1] and Witting et al.^[5] help to come a better understanding of the indications and requirements for this procedure.

High grade scapular tumour, lesion may be take part of scapula as glenoid, body and extend extraosseously anterior or posterior side of scapula. It is important, many bone sarcomas extent anteriorly to subscapularis muscle, posteriorly to infraspinatus muscle. If the deltoid and trapezius muscle couldn't be protected, shoulder abduction ability is diminished. Wide suprascapular tumour couldn't be treat with endoprosthesis.^[1]-5]

It is recommended for scapulohumeral stability, that periscapular muscle such as trapezius, rhomboid and latissimus dorsi save and make tenodesis, in addition to deltoid and axiller nerve must be protected. In our study, because of some patient had been oparedted previously and lost soft tissue and have to gone wide resection, latissimus dorsi flap has major importance to coverage over the prosthesis. Latissimus dorsi and pectoralis major flaps are often

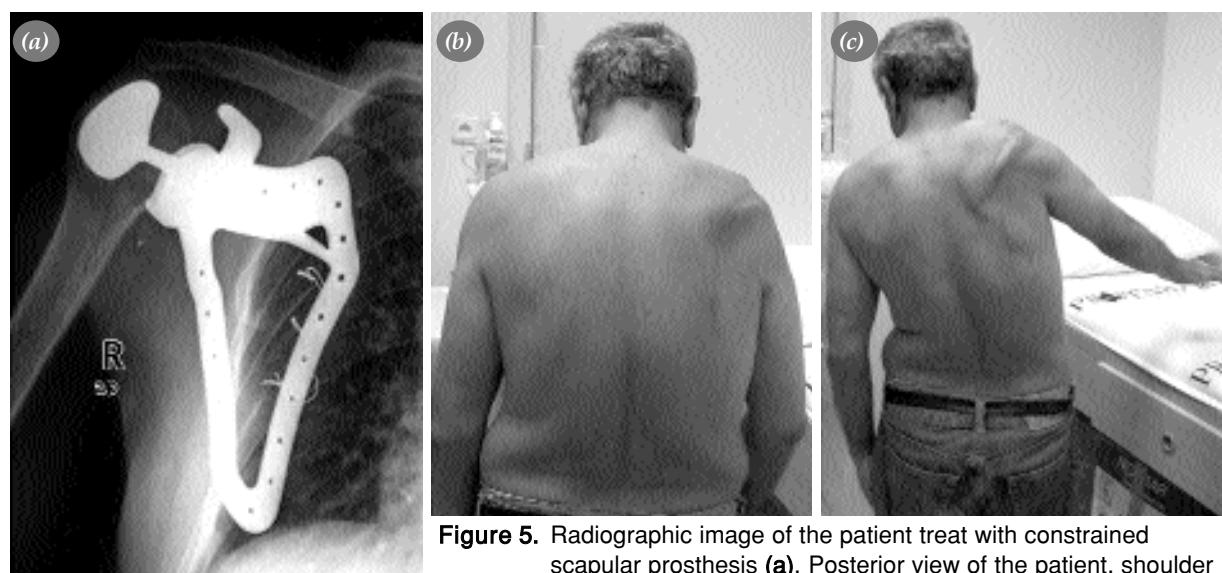


Figure 5. Radiographic image of the patient treat with constrained scapular prosthesis (a), Posterior view of the patient, shoulder neutral position (b), active shoulder abduction range (c).

used to obtain soft tissue coverage, but their addition to stability is little.^[7]

At the first prosthetic reconstruction, unconstrained custom-made prosthesis was used and glenohumeral stability was re-established with Prolen mesh. But, humeral head was shown superior subluxation at the radiographic follow-up. For prevent this problem, constrained prosthesis design was developed for subsequently application. Wodajo et al. reported good results with constrained prosthesis against same instability problem.^[1,5]

In our study, to establish scapulo thoracic relationship, periscapular muscles were attached holes on prosthesis. If there was insufficient muscle mass, prosthesis was connect with costal bone using wire and suture material. With this connection as hanging form, not tightly, able to keep to right more abduction movement, while scapular stability was increased and humeral head was supported.

Voggenreiter et al. reported that 19 patient underwent Tikhoff-Linberg procedure and reconstructed with shoulder prosthesis had a high complication rate but had a superiority against amputation.^[8]

Witting et al. Preliminary results of three patients, At latest followup, MTST functional score was 24 to 27 of 30 (80%–90%) with painless shoulder and functional hand and elbow. Forward flexion and abduction ranged from 25° to 40°.^[5]

Wodajo et al. compared with patients with no endoprosthesis, patients with endoprosthetic reconstruction had higher average MSTTS scores (86% vs. 62%), a larger arc of active abduction (60–90% vs. 10–20%), and improved cosmesis.^[1]

In our study, 2 of 7 patient underwent limb-sparing surgery related primary and secondary malignancy, were exitus secondary to progression of malignancy, so functional results were observed as lower than the others. It is commented that these patient be worsen with progression of illness, complication of medical and surgical treatment, and inadequate rehabilitation.

Unconstrained prosthesis practise was resulted subluxation and the other following problem, consequently functional scores was found low in our results accordingly literature.

Patients who treated with constrained prosthesis or partial scapulectomy and otograft and under controlled main disease, long term follow-up and functional evaluation: although active shoulder abduction is limited 45° to 90°, elbow and hand function is nearly full (MSTS scores mean 24). Because of the own control group was not established, our result comparing with literature, is find similar prosthesis application groups and better than no prosthesis groups. Our clinical experience related only one patient that underwent scapulectomy, abduction can be achieved merely with orthosis.

In literature, except prosthetic application for metastatic tumour of humerus, especially for scapula prosthetic reconstruction for selected metastatic scapular tumour is uncommon.^[9]

Whenever soliter metastatic tumoral lesion is found after main treatment or unknown origin, tumour resection can be performed for histological diagnosis and treatment for prolong patient survival. Two patient like this had lived two and three years after scapulectomy. For prevent morbidity and increase life quality of these patient, choosing scapular prosthesis application alternative, related necessity should be tried to regain functional properties. In our first case, instability problem is arised for non-constrained scapular prosthesis, than constrained design was preferred at subsequent cases. With indication of the total shoulder prosthetic reconstruction, constrained prosthesis usage results to increase shoulder stability besides decrease tension over the soft tissue.

Scapula acts as bridge between body and shoulder, so its function should be saved with endoprosthetic reconstruction in its malignant disease. On the contrary the other prosthetic reconstruction, scapula prosthesis is covered and stabilized with soft tissue, we expect good result with bioactive light and flexible material, establishing much more attachment by muscle and soft tissue.

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