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The Importance of the Multidisciplinary Approach to Surgical Treatment of Extremity Soft-Tissue Sarcomas

Eurico Cleto Ribeiro de Campos[1], Marcos Gonçalves Adriano Júnior[1], Diego Sanches[2], Marcus Rivabem Winheski[2], Robson Menezes Leal[2], Ricardo Poroski[2], Guataçara Salles Júnior[3], Renan Martins[4], Franciele Soares Pott[5]

[1]Department of Melanoma and Soft Tissue Sarcoma from Prevent Senior São Paulo Group, São Paulo, Brasil
[2]Oncology Surgical Department of Evangélico Mackenzie University Hospital, Curitiba, Paraná
[3]Plastic Surgery of São Vicente Hospital, Curitiba, Paraná
[4]Ponta Grossa State University, Paraná, Brasil
[5]Paraná Military State Hospital, Curitiba, Paraná, Brazil
Email: euricocrcampos@gmail.com, marcos.adriano@preventsenior.com.br, diegosanches10@gmail.com, mrivabem@yahoo.com.br, rob-leal10@hotmail.com, guatajr@yahoo.com.br, martinsrenanmd@gmail.com, franciele.pott@gmail.com

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Abstract

Soft tissue sarcomas (STS) are rare neoplasm with frequencies around 1% of all neoplasms. Although it consists of a high heterogeneous group of tumors, surgery is the mean treatment. The STS surgery is still challenging and complex procedure is usually required: this is because STS requires different types of resection and reconstruction due to various tissue-commitments (nerve, arteries, skin and muscle). So, a multidisciplinary team must be prepared for STS approach to obtain the maximum local control and a limited extremity functional impairment. We, here, showing our experience, wish to introduce some technical contrivances in STS surgery, with special reference to tissue reconstruction. This may illustrate the necessity of a multidisciplinary team approach in this surgery.

Keywords

Limb-Sparing Surgery, Musculoskeletal Oncology, Sarcoma, Soft-Tissue Sarcoma

1. Introduction

The Soft-tissue sarcomas (STS) make up about 1% of all diagnosed neoplasms. They arise more frequently in the extremities, and less commonly in the trunk,

head, and neck. Today, due to advances in molecular diagnostics, associated with a better molecular knowledge and recognition of the Soft-tissue sarcomas, the histopathological characterization became more precise, with more than fifty subtypes of these tumors. Moreover, we now have better prognostic statements and a clearer response to the treatment with monoclononal antibodies, assuring a precision approach to therapy [1].

Surgery remains the main modality of treatment, through tridimensional resections, compartmental excision, with or without reconstruction [2]. The most common surgical reconstructions are the ones that involve arteries, nerves and the closure of the surgical wound with musculocutaneous flap, fasciocutaneous flap, free flap or microsurgical reconstructions [3] [4] [5] [6].

2. Objectives

We here describe the recent advance of STS surgery. In the latter half, we will describe our experience by showing the surgery technique/contrivance for some patients, highlighting the importance/characteristics of each modality/contrivance. Emphasis was paid on reconstruction of various tissues.

3. Case Presentation

Case 1: Patient 23-year-old, male, student. Pain and palpable mass in a left proximal genus with 3 months of evolution. Diagnosis of osteoblastic osteosarcoma. Subjected to neoadjuvant therapy. Due to bone destruction and intraoperative lytic area without bone stock, reconstruction with endoprosthesis was chosen. In these cases, the patient tends to evolve with reduced function of the shoulder. Previous history of destructive lytic lesion with cortical rupture, periosteal reaction and formation of an osteoid matrix (**Figure 1**).

Case 2: Patient 32 years old, male, jiu-jitsu fighter. Pain and swelling in the midfoot with 6 months of evolution. Biopsy resulting from an aneurysmal bone cyst/giant cell tumor. Previously treated in another service with curettage and synthetic graft. Tumor recurrence. We chose to start the denosumab protocol with reduced mass. Due to the extent of involvement, we opted for reconstruction with vascularized fibula and fixation (**Figure 2**).

Case 3: Patient 23 years old, male, complaining pain and swelling for 2 months. Biopsy with diagnosis of osteosarcoma of the distal femur. Patient submitted to neoadjuvant chemotherapy. Biological reconstruction with autologous graft recycled in liquid nitrogen. This technique uses autologous bone for freezing at −196˚ Celsius for femur reconstruction of the femur (**Figure 3**).

Case 4: 51-year-old male with differentiated liposarcoma, on a third relapse, that have been treated in the past (2013) with adjuvant radiotherapy after the first surgery (2013) and received adjuvant chemotherapy (2018) after the second relapse surgery (2017). There were no comorbidities. By the way, using complementary follow-up tests, local recurrence was detected on the topography of the previous surgical scar, with a tumoral mass (>10 cm) attached to the femoral vessels (**Figure 4**).

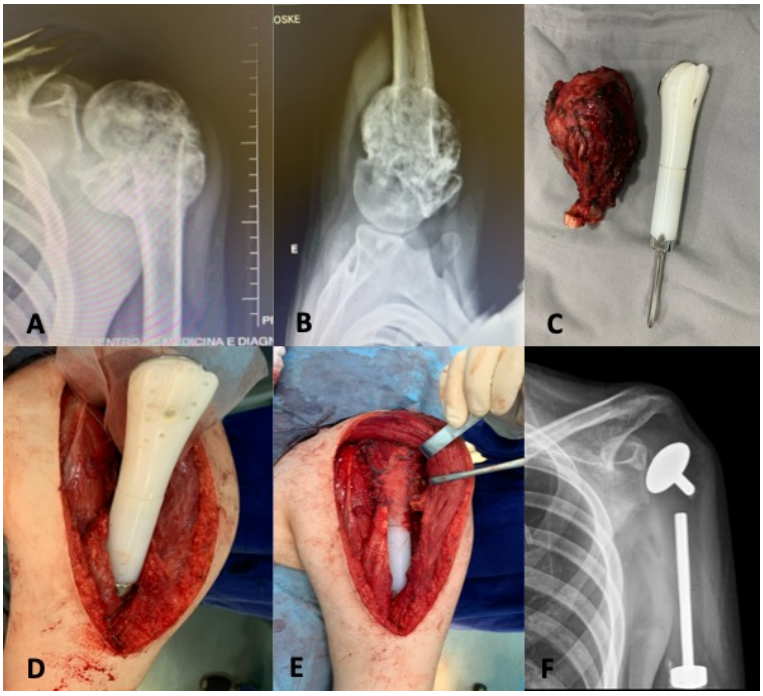

Figure 1. (A) and (B) X-ray; (C) Tumor resection and polyethylene endoprosthesis; (D) Reduction and fixation of the endoprosthesis with marlex mesh support; (E) Position endoprosthesis; (F) X-ray reconstruction.

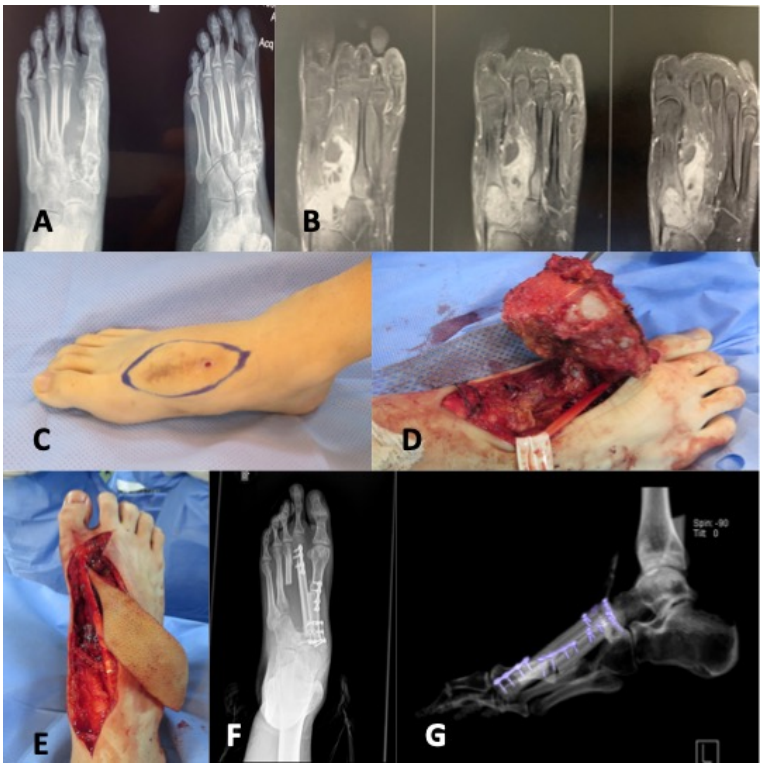

Figure 2. (A) X-ray shows aggressive, destructive bone litic lesion at midfoot; (B) Aggressive lesion with destruction of cuneiforms and first 3 proximal metatarsal; (C) Pre-operative planning; (D) E-bloc ressection; (E) Vascularized fibular graft reconstruction; (F) X-ray reconstruction; (G) CT reconstruction.

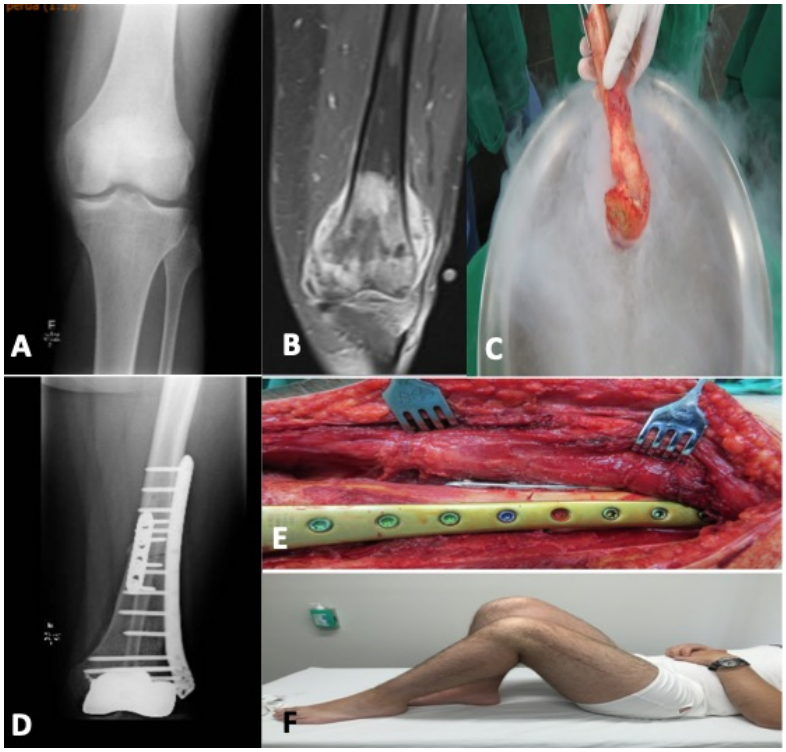

Figure 3. (A) Pre-operative osteosarcoma of distal femur; (B) Liquid nitrogen reclycling bone; (C) 1y. pos-op. x-ray; (D) Black arrow shows perfect-fit reduction; (E) Bone reconstruction; (F) Flexion knee 100^0.

Figure 4. (A) Soft tissue sarcoma relapsed of right thigh and groin; (B) Compartment resection of the main muscles of anterior groin and femoral artery; (C) Product of soft tissue sarcoma resection of right thigh and groin.

Nerve reconstruction

Case 5: 73-year-old upper extremity STS female patient, high grade disease, submitted to a neoadjuvant treatment with chemotherapy and radiotherapy, evolving with partial response and surgical treatment by compartmental resection with median nerve resection and reconstruction with a flap from the sural

nerve. She had a satisfactory evolution on the postoperative period. Also, it was observed a good regaining on the motor effects of the median nerve in the anterior and flexor compartment (Figure 5).

Caso 6: STS female patient with the disease affecting the left medial compartment of the thigh. She was treated with neoadjuvant chemotherapy and subsequent medial compartment resection, extended to the skin. Considering that the patient presented to the service with a clear cell sarcoma, a subtype that is associated with the commitment of regional lymph node, a search for sentinel lymph node was made at the left side. With the resection of the adductor muscles and adjacent skin, by local injection, a reconstruction of the was made utilizing an anterior compartment fasciocutaneous flap based on reverse flux of the superior genicular artery, after ligation of the descendent branch of lateral circumflex femoral artery (Figure 6, Figure 7).

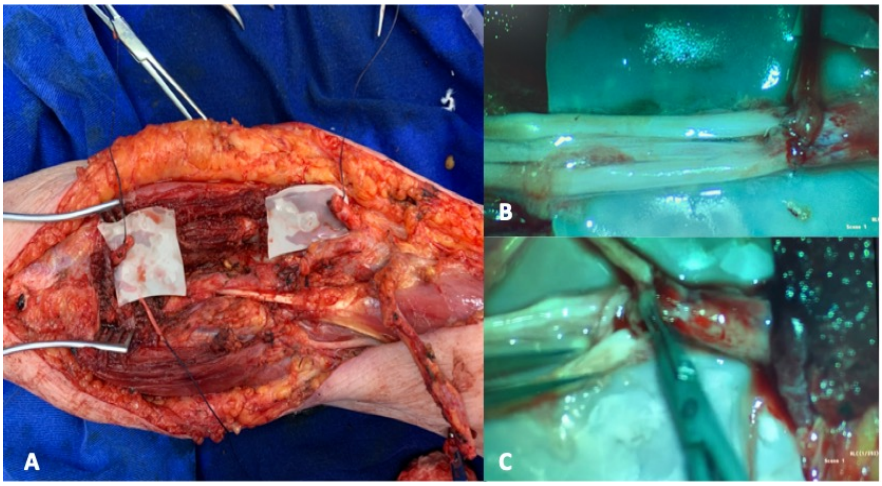

Figure 5. Tridimensional STS resection of anterior forearm. Median nerve microsurgical reconstruction employing fibers of sural nerve.

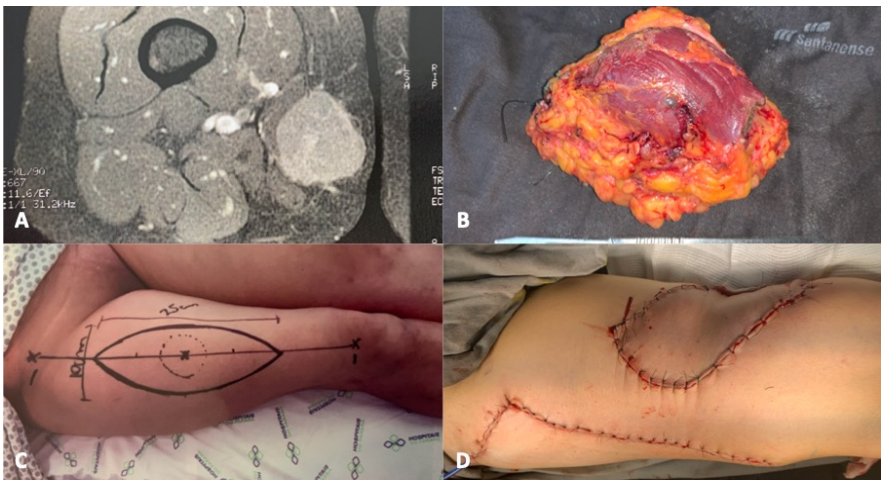

Figure 6. (A) STS affecting the left medial compartment of the thigh; (B) Tridimensional resection; (C) The pre operation anterolateral thigh flap mark; (D) Reconstruction of soft tissue structure with anterolateral fasciocutaneos flap.

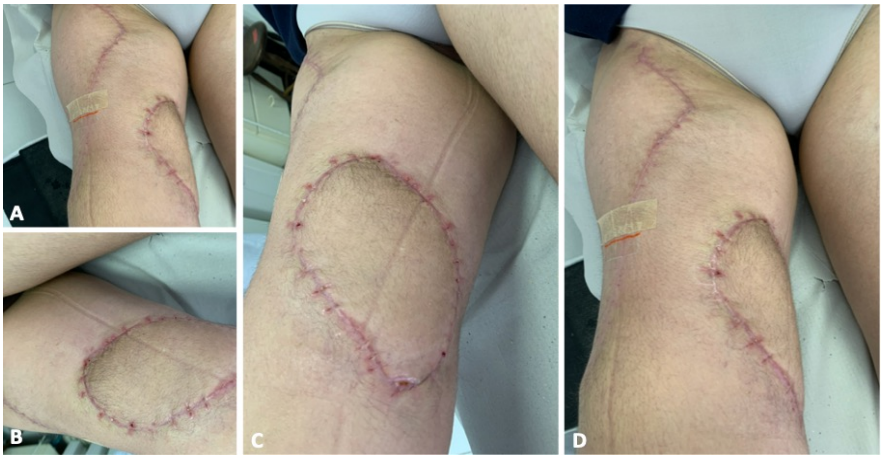

Figure 7. The anterolateral thigh flap aspect, forty days after surgery.

4. Experience and Discussion

The Soft-tissue sarcomas are a rare group of tumors, corresponding to almost 1% of all malignant neoplasms. Surgery, inside the global multidisciplinary team management is the best choice of treatment, bringing up large resections, depending on local, regional or microsurgical reconstructions [2] [3] [5].

Until the 80's, the most applied surgery in the treatment of STS was the amputation surgery of the affected extremity, but many of these patients, submitted to mutilating procedures, were affected by cancer recurrence at a metastatic foci [2].

A work of Rosenberg *et al.*, especially, and other important studies [2], suggests that the limb-sparing surgery, combined with radiotherapy, had overall survival rates similar to the ones of amputation. In this study, all the patients were submitted to adjuvant chemotherapy treatment. The presentation of histologically compromised surgical margins was the major risk factor for local recurrence [2]. Therefore, the Soft-tissue sarcomas of the lower extremity and those with higher histopathological grade started to be treated differently, with limb-salvage surgery in integration to chemotherapy and radiotherapy [7] [8].

The combination of chemotherapy and radiotherapy treatments in a close relation with more advanced imaging techniques, allowed an increase on the limb-salvage preservation rates compared to amputation surgery. Despite the higher local recurrence rate in the limb-salvage surgery, the survival rate is very similar in both procedures [2] [3] [9].

Lymphadenectomies are not routinely employed because these types of tumors are derived from mesenchymal tissues, usually presenting with low potential for lymphatic dissemination, which can reach up to 7%.

Some histological subtypes are more likely to spread to regional lymph nodes, like clear cell sarcoma, epithelioid sarcoma, rhabdomyosarcoma, the synovial type and angiossarcoma [10].

The sentinel lymph node technique appears as promising when applied to this group of a higher risk, considering the lower morbidity and the potential bene-

fits of lymph node staging on treatment [11].

The surgical treatment of STS, at many times implicates extensive resections to bone, muscular, nervous and vascular structures. Complex reconstruction techniques regarding bone substitution, use of vascular prostheses, microsurgical nervous reconstructions and dermal, fasciocutaneous, musculocutaneous or free flaps may be necessary for the appropriate closure of the surgical wound [12] [13].

Since the surgery is the most crucial modality on the multidisciplinary approach of sarcomas and seeing that sometimes it results in extensive resections on limb-sparing surgery, there is a questioning about the most suitable and more appropriate time for reconstruction, immediately or later.

The moment when the reconstruction was made, on retrospective studies, seems to be the great determining factor of morbidity on the functional long-term result and on the reconstructions [14].

Zhou *et al.* [14] analyzed 32 patients, immediately submitting them to reconstructions at the lower extremities after the sarcoma surgery or later, with the mean average of 3.6 weeks after the surgery. In the later reconstruction group, a more frequent number of complications was detected, such as seroma, surgical wound dehiscence, venous thromboembolism, infection and partial or total loss of the flap. Only surgical wound haematoma was statistically significative, being less common in the group of patients treated with immediate reconstruction [14]. Thus, we understand that the extremity Soft-tissue sarcomas which receive extensive resections are related to lower rates of complications when the immediate reconstruction is done [14] [15].

5. Technical/Procedural Details of Important Procedures

5.1. Bone Reconstruction (Cases 1, 2 and 3)

Until 1970, sarcomas that affected the bone were treated through amputation or just following the patient. Most died as a result of disease progression. In the 1980s, with the advent of chemotherapy, there was an increase in the survival of patients, consequently, improvement of treatment in the affected area needs to be better. Currently, osteosarcoma and Ewing's sarcoma have an average survival of 50% - 70% in 5 years when the disease is localized [16].

Surgery is a fundamental step in multimodal treatment of bone sarcomas. Enneking described the principles of resection in bone neoplasms, in which the treatment of tumor resection with wide margins is the goal [17].

The surgical methods of reconstruction can be subdivided into 3: substitute methods, biological and composite methods (composing the two previous methods).

Substitute techniques (case 1)

1) Endoprostheses (substitute method)

In the last 40 years, endoprostheses (megaprostheses) replace part of the resected bone. In resections of both primary and metastatic tumors to the bone,

endoprostheses are an excellent option. Responsible for a significant reduction in the number of amputations, the substitute method has the advantage of maintaining the limb, recovering partial or complete function early and improving quality of life (pain/hygiene/displacement) [18]. In elderly patients, advanced primary cancer disease and low performance, endoprostheses are choices in the treatment of pathological fractures or bone injuries with a high risk of fracture.

In primary diseases such as osteosarcoma, ewing's sarcoma, pleomorphic sarcomas of the bone, the case should be individually assessed, as the main complications of using endoprostheses are 4:

a) function: score lower than biological methods for reducing areas of tendon insertion and origin.

b) Infection: infection resulting from the implant material in the literature makes an average of 10% (capanna). Place with the highest risk of infection occurs around the knee.

c) Aseptic loosening: the largest series show 5-year survival of the endoprosthesis ranging from 20% - 85% [19]. In the last 30 years, there has been a great development of bioengineering to reduce the risks of loosening. There are materials with increased porosity to create a stable bone/prosthesis interface. Endoproteses with rotational component combined to reduce implant overload. However, the greatest risk is still the use of an endoprosthesis in children, as there is a high life expectancy with a high burden on the implant itself of the later productive age and the child's growth potential, creating problems of limb discrepancy. Expandable endoprostheses are a choice in the treatment of primary sarcomas in children, but the same risks remain described.

2) Partial or total prostheses (substitute method) (case 2)

In patients with bone involvement in the hip or knee, the choice is replacement with conventional or revision prostheses. We must remember to keep bone stock and musculotendinous structures for better function. When a pathological fracture of the femoral neck occurs without trochanteric involvement, prostheses with long and cemented femoral components should be chosen. This stems from the need to protect the entire bone segment (e.g., the femur). In injuries around the knee, revision implants with long medullary components should also be chosen to protect bone tracking.

3) Biological methods (case 3)

Biological reconstruction methods use homologous or autologous grafts. Homologous grafts (allografts) can be used to fill spaces (crushed grafts) or mass grafts to reconstruct large defects.

Among biological methods, the vascularized graft (fibula, rib) and recycled autologous (irradiation and freezing in liquid nitrogen) are the most used. have the advantage of increasing function, reducing complications such as loosening, implant failure [20] [21].

The recycled liquid nitrogen graft has the advantage of maintaining anatomi-

cal press-fit, reducing HLA incompatibility, and cryoimmunogenicity (case 3). This technique described by the Kanazawa group preserves bone stock, increasing the possibility of functional and long-term success [20].

5.2. Vascular Reconstruction (Case 4)

The case four demonstrates a relapsing soft-tissue sarcoma of the anterior compartment of thigh adhered to the femoral vessels, femoral artery and femoral vein, making necessary to perform an arterial shunt and posterior arterial vascular reconstruction with Dacron Vascular Prosthesis.

The vascular reconstruction can be made with synthetic material or autologous saphenous vein graft. On occasions, the major veins undergo ligations. This can result in an increased number of thrombotic syndrome and the postoperative period can exhibit edema, hyperpigmentation, and varicous veins, However, these complications are clinically easier to handle [22] [23].

Prior investigations of Nishiari *et al.* [22], analyzing 44 cases of STS of lower extremities who have undergo vascular reconstructions, evaluates that there are no differences on the complications rate between arterial or nerve reconstruction, although the usage of the saphenous vein graft in the arterial reconstruction implicates in a low number of occlusion complications when compared with the synthetic material [22].

5.3. Nerve Reconstruction (Case 5)

The STS, the upper extremity sarcomas, in particular, usually require extensive resections with a loss in cutaneous, muscular and nervous tissue. The reconstruction, when made simultaneously to the main procedure, allows a great functional postoperative recovery as well as a more rapid return to work activities. When applied at the second moment of time, some difficulties can appear, like the formation of fibrosis and a delay in surgical wound healing, slowing the process of reconstruction and the adjuvant radiotherapy treatment [14].

According to Frasca *et al.* [24], the portion of STS that have undergone large resections, extended to nerve structures, must be reconstructed at the same operative act, optimizing postoperative rehabilitation.

This paper, explains that a sinovial sarcoma bilaterally affecting the phrenic nerve, undergone a procedure consisting of sacrificing the left phrenic nerve, making a reconstruction of the right nerve with left nerve fibers. The technique that was utilized was the microsurgical, concurrent with the application of fibrina glue. The authors consider, as an option, the neurotization of the phrenic nerve with the trapezius branch of the ipsilateral spinal accessory nerve or reconstruction of the phrenic nerve employing fibers of sural nerve.

In addition to the application of nerve grafts for reconstruction, another possibility is the intra-plexular or extra-plexular neurotization technique that constitutes a transfer of a nerve classified as non-fundamental to rearrange a fundamental nerve. Usually, in these situations, there is not a proximal stump [15]

[25].

This type of surgical methods is frequently used on brachial plexus reconstructions after trauma, but can be applied on the extremities, looking for improvement on the neuromuscular function, after resecting the Soft-tissue sarcoma.

In the STS, nerve grafts are commonly made with sural nerve and the neurotization procedure with the transfer of the ulnar nerve motor fascicle, paying attention to the level of the reconstruction, avoiding the risk of denervation on the intrinsic muscles of the hand [25].

5.4. Reconstruction of Skin and Soft Tissues (Case 6)

STS resections constantly result in cutaneous defects, implicating more complex reconstructions for the wound closure, impairing the achievement of free surgical margins [26].

The anterolateral thigh flaps are the most appropriated for reconstruction of thigh defects, because they allow reconstruction at sites presenting important tissue loss, associated with a long vascular pedicle and ensuring more amplitude on the defect's coverage. The pedicle can reach up to 16 cm, assuring the surgical team the ability to reconstruct large defects and free of tension. In this case, two teams can work simultaneously on the tumour resection and obtaining tissue for the adequate reconstruction [27] [28].

The fasciocutaneous flaps permit a proper local reconstruction, proportional and adjusted to the surgical defect generated, as well as enabling different orientations, to guarantee a precise positioning at the resection site [27]. Resections on hand, wrist and shoulder topographies can be done using skin flaps, local flaps, regional or at a distance pediculated musculocutaneous flaps and microsurgical reconstructions utilizing free flaps [4] [15]. On occasions, the selected reconstruction will depend on the clinical status of the patient and competence to perform the postoperative rehabilitation.

There are a few articles in literature reporting the approach of STS surgical wound closure with local reconstruction or the employment of distance flaps associated with tendinous transposition. This procedure, when achievable, has to be done in the same time of the mean surgical procedure, considering that immediate reconstructions result in greater functional recovery, a low number of surgical procedures, a more rapid return to work activities, avoiding fibrosis, with possible local anatomic distortion and possible radiotherapy effect, when indicated as adjuvant treatment [13].

Elswick *et al.* [4] have shown that in 159 thigh sarcoma patients that have been operated, the most frequently used form of reconstruction was based on local or regional pediculated muscular flaps, as well as the fasciocutaneous flaps. In 4% of the cases, free microsurgical flaps were utilized.

The free microsurgical flaps are indicated in the case of large extensive resections, mainly when the amputation of the limb is considered as the principal

surgical modality, in consequence of a large soft tissue loss and consequent functional impotence of the limb. The study of Barner *et al.* 2009, defines a 95% success rate with the application of free microsurgical flaps in 73 patients operated, suffering from lower extremity STS. Most of these patients were able to normally deambulate, or with a minimum grade of alteration in the postoperative period.

6. Conclusions

The bone and Soft-tissue sarcoma patients, especially those affected by Soft-tissue sarcoma of the extremities, undergoing limb-sparing Surgeries, compose the group that has a more required need for reconstruction and rehabilitation, highlighting the importance of the multidisciplinary team approach. The reconstructions are complex and microsurgical in many moments.

So, for a more successful multidisciplinary approach, including the surgical treatments, patients demand specialized referral centers, and hospital facilities having a higher number of sarcoma patients under treatment by year. Also, psychossocial aspects must be considered together with the motor and functional rehabilitation process.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Katz, D., Palmerini, E. and Pollack, S.M. (2018) More than 50 Subtypes of Soft Tissue Sarcoma: Paving the Path for Histology-Driven Treatments. *American Society of Clinical Oncology Educational Book*, **38**, 925-938. https://doi.org/10.1200/EDBK_205423

[2] Rosenberg, S.A., Tepper, J., Glatstein, E., *et al.* (1982) The Treatment of Soft-Tissue Sarcomas of the Extremities: Prospective Randomized Evaluations of (1) Limb-Sparing Surgery plus Radiation Therapy Compared with Amputation and (2) the Role of Adjuvant Chemotherapy. *Annals of Surgery*, **196**, 305-315. https://doi.org/10.1097/00000658-198209000-00009

[3] Endo, M. and Lin, P.P. (2018) Surgical Margins in the Management of Extremity Soft Tissue Sarcoma. *The Chinese Clinical Oncology*, **7**, 37. https://doi.org/10.21037/cco.2018.08.10

[4] Elswick, S.M., Wu, P., Arkhavan, A.A., *et al.* (2019) A Reconstructive Algorithm after Thigh Soft Tissue Sarcoma Resection Including Predictors of Free Flap Reconstruction. *Journal of Plastic, Reconstructive & Aesthetic Surgery*, **72**, 1304-1315. https://doi.org/10.1016/j.bjps.2019.04.016

[5] Barner-Rasmussen, I., Popov, P., Böhling, T., Tarkkanen, M., Sampo, M. and Tukiainen, E. (2009) Microvascular Reconstruction after Resection of Soft Tissue Sarcoma of the Leg. *British Journal of Surgery*, **96**, 482-489. https://doi.org/10.1002/bjs.6581

[6] Lin, C.T., Wang, C.H., Ou, K.W., *et al.* (2017) Clinical Applications of the Pedicled Anterolateral Thigh Flap in Reconstruction. *ANZ Journal of Surgery*, **87**, 499-504. https://doi.org/10.1111/ans.12973

[7] Baldini, E.H., Le Cesne, A. and Trent, J.C. (2018) Neoadjuvant Chemotherapy, Concurrent Chemoradiation, and Adjuvant Chemotherapy for High-Risk Extremity Soft Tissue Sarcoma. *American Society of Clinical Oncology Educational Book*, **38**, 910-915. https://doi.org/10.1200/EDBK_201421

[8] Pervaiz, N., Colterjohn, N., Farrokhyar, F., Tozer, R., Figueredo, A. and Ghert, M. (2008) A Systematic Meta-Analysis of Randomized Controlled Trials of Adjuvant Chemotherapy for Localized Resectable Soft-Tissue Sarcoma. *Cancer*, **113**, 573-581. https://doi.org/10.1002/cncr.23592

[9] Lim, Z., Strike, S.A. and Puhaindran, M.E. (2019) Sarcoma of the Lower Limb: Reconstructive Surgeon's Perspective. *Indian Journal of Plastic Surgery*, **52**, 55-61. https://doi.org/10.1055/s-0039-1688101

[10] Keung, E.Z., Chiang, Y.J., Voss, R.K., *et al.* (2018) Defining the Incidence and Clinical Significance of Lymph Node Metastasis in Soft Tissue Sarcoma. *European Journal of Surgical Oncology*, **44**, 170-177. https://doi.org/10.1016/j.ejso.2017.11.014

[11] Andreou, D., Boldt, H., Werner, M., Hamann, C., Pink, D. and Tunn, P.U. (2013) Sentinel Node Biopsy in Soft Tissue Sarcoma Subtypes with a High Propensity for Regional Lymphatic Spread-Results of a Large Prospective Trial. *Annals of Oncology*, **24**, 1400-1405. https://doi.org/10.1093/annonc/mds650

[12] McGoldrick, N.P., Butler, J.S., Lavelle, M., Sheehan, S., Dudeney, S. and O'Toole, G.C. (2016) Resection and Reconstruction of Pelvic and Extremity Soft Tissue Sarcomas with Major Vascular Involvement: Current Concepts. *World Journal of Orthopedics*, **7**, 293-300. https://doi.org/10.5312/wjo.v7.i5.293

[13] Siegel, G.W., Kuzon, W.M., Hasen, J.M. and Biermann, J.S. (2016) Staged Soft Tissue Reconstruction Following Sarcoma Excision with Anticipated Large Cutaneous Defects: An Oncologically Safe Alternative. *Iowa Orthopedic Journal*, **36**, 104-108.

[14] Zhou, S., Azzi, A.J., Safran, T. and Zadeh, T. (2020) A Comparison of Delayed Versus Immediate Reconstruction Following Lower-Extremity Sarcoma Resection. *Archives of Plastic Surgery*, **47**, 49-53. https://doi.org/10.5999/aps.2019.00780

[15] Oh, J., Ahn, H.C. and Lee, K.H. (2018) Simultaneous Reconstruction of the Forearm Extensor Compartment Tendon, Soft Tissue, and Skin. *Archives of Plastic Surgery*, **45**, 479-483. https://doi.org/10.5999/aps.2017.01802

[16] Misaghi, A., Goldin, A., Awad, M. and Kulidjian, A.A. (2018) Osteosarcoma: A Comprehensive Review. *SICOT-J*, **4**, 12. https://doi.org/10.1051/sicotj/2017028

[17] Enneking, W.F., Spanier, S.S. and Goodman, M.A. (1980) A System for the Surgical Staging of Musculoskeletal Sarcoma. *Clinical Orthopaedics and Related Research*, **153**, 106-120. https://doi.org/10.1097/00003086-198011000-00013

[18] Unwin, P.S., Cannon, S.R., Grimer, R.J., *et al.* (1996) Aseptic Loosening in Cemented Custom-Made Prosthetic Replacements for Bone Tumours of the Lower Limb. *The Journal of Bone and Joint Surgery. British Volume*, **78**, 5-13. https://doi.org/10.1302/0301-620X.78B1.0780005

[19] Mittermayer, F., Krepler, P., Dominkus, M., *et al.* (2001) Long-Term Follow-Up of Uncemented Tumor Endoprostheses for the Lower Extremity. *Clinical Orthopaedics and Related Research*, **388**, 167-177. https://doi.org/10.1097/00003086-200107000-00024

[20] Tsuchiya, H., Wan, S.L., Sakayama, K., Yamamoto, N., Nishida, H., Tomita, K., *et al.* (2005) Reconstruction Using an Autograft Containing Tumour Treated by Liquid Nitrogen. *The Journal of Bone and Joint Surgery. British Volume*, **87**, 218-225. https://doi.org/10.1302/0301-620X.87B2.15325

[21] KorompilIas, A.V., Paschos, N.K., Lykissas, M.G., Kostas-Agnantis, I., Vekris, M.D. and Beris, A.E. (2011) Recent Updates of Surgical Techniques and Applications of Free Vascularized Fibular Graft in Extremity and Trunk Reconstruction. *Microsurgery*, **31**, 171-175. https://doi.org/10.1002/micr.20848

[22] Nishinari, K., Krutman, M., Aguiar Junior, S., *et al.* (2015) Surgical Outcomes of Vascular Reconstruction in Soft Tissue Sarcomas of the Lower Extremities. *Journal of Vascular Surgery*, **62**, 143-149. https://doi.org/10.1016/j.jvs.2015.02.004

[23] Sheehan, S., Dudeney, S. and O'Toole, G.C. (2016) Resection and Reconstruction of Pelvic and Extremity Soft Tissue Sarcomas with Major Vascular Involvement: Current Concepts. *World Journal of Orthopedics*, **7**, 293-300. https://doi.org/10.5312/wjo.v7.i5.293

[24] Frasca, L., Longo, F., Tacchi, G., *et al.* (2020) Importance of Muldisciplinary Management of Giant Mediastinal Sarcoma: A Case Report with Phrenic Nerve Reconstruction. *Thoracic Cancer*, **11**, 1734-1737. https://doi.org/10.1111/1759-7714.13452

[25] Caetano, E.B., Vieira, L.A., Andrade, A.M., *et al.* (2016) Transferência de nervos (neurotizações) no tratamento das lesões traumáticas do plexo braquial. *RFCMS*, **18**, 129-132. https://doi.org/10.5327/Z1984-4840201626410

[26] Weschenfelder, W., Gast-Froehlich, S., Spiegel, C., Vogt, M. and Hofmann, G.O. (2020) Factors Influencing Quality of Life, Function, Reintegration and Participation after Musculoskeletal Tumour Operations. *BMC Cancer*, **20**, 351. https://doi.org/10.1186/s12885-020-06837-x

[27] Song, Y.G., Chen, G.Z. and Song, Y.L. (1984) The Free Thigh Flap: A New Free Flap Based on the Septocutaneous Artery. *British Journal of Plastic Surgery*, **37**, 149-159. https://doi.org/10.1016/0007-1226(84)90002-X

[28] Landuyt, K.V. (2006) The Anterolateral Thigh Flap for Lower Extremity Reconstruction. *Seminars in Plastic Surgery*, **20**, 127-132. https://doi.org/10.1055/s-2006-941720