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Elbow sarcoma resection and triceps reconstruction with Achilles allograft: an overview, case report, and technique guide

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Soft tissue sarcomas (STS's) are a group of malignancies that originate from mesenchymal tissues, including muscles, tendons, adipose tissue, and blood vessels. Soft tissue sarcomas involving the elbow and forearm are exceedingly rare with the most prevalent forms including synovial sarcoma, myxofibrosarcoma, and undifferentiated pleomorphic sarcoma.[4,6,7,9,19] Soft tissue sarcomas (STS's) frequently present with delayed diagnosis, owing to their gradual growth and potential resemblance to benign lesions, necessitating heightened awareness among practitioners regarding their clinical manifestations. Delayed diagnosis, local biopsy, or unplanned excision of sarcomas lead to an increased potential for disease recurrence and potential metastasis. In the setting of locally advanced disease involving the triceps tendon, several options exist for management including local resection and limb salvage, radiation therapy and amputation.[4,19] It is crucial for clinicians to carefully consider the choice of reconstruction technique and potential risks and benefits. Given the low incidence of soft tissue sarcomas and the potential for delayed detection, multidisciplinary management and advancements in reconstructive treatment modalities are required to improve patient functional outcomes. Given the paucity of reported cases requiring triceps reconstruction in the setting of STS, we present a case involving reconstruction using an Achilles tendon allograft in without cancellous bone.

Case presentation

An 86-year-old left-hand dominant Caucasian female with a history of breast cancer status post lumpectomy and hormonal therapy was referred to our clinic by an outside orthopedic surgeon. She described 5 months of elbow pain in her dominant limb, localized to a growing mass over her olecranon fossa. Initially, she was diagnosed with olecranon bursitis, and multiple aspiration attempts from the outside yielded only minute quantities of bloody aspirate. She then underwent an unscheduled partial resection. Final pathology showed high-grade myxofibrosarcoma. Before this, no advanced imagining was completed. Following our initial evaluation, she was sent for magnetic resonance imagining (MRI) with contrast of the elbow which revealed a 4.4 × 2.8 × 3.9 cm heterogenous soft tissue mass within the posterior soft tissues of the elbow with surrounding perilesional edema and extension into the triceps tendon which enhanced with contrast (Fig. 1).

Metastatic workup was initiated and showed no evidence of metastatic disease on computed tomography (CT) scan chest and whole-body positron emission tomography/CT; Stage: pT2cNocMo, Grade III, Enneking Stage IIb. Outside operative records reported incomplete resection at the time of index surgery with margins positive for high-grade pleomorphic sarcoma predisposing the patient to contamination of the surgical field. Considering the patient's age, functional status, and anticipated morbidity, the patient elected to proceed with limb-sparing surgery, acknowledging that amputation would offer the most significant opportunity for tumor control. Final pathology was consistent with a high-grade pleomorphic sarcoma, and the medial and lateral margins were consistent with a low-grade spindle cell sarcoma that extended

Institutional review board approval was not required for this case report.

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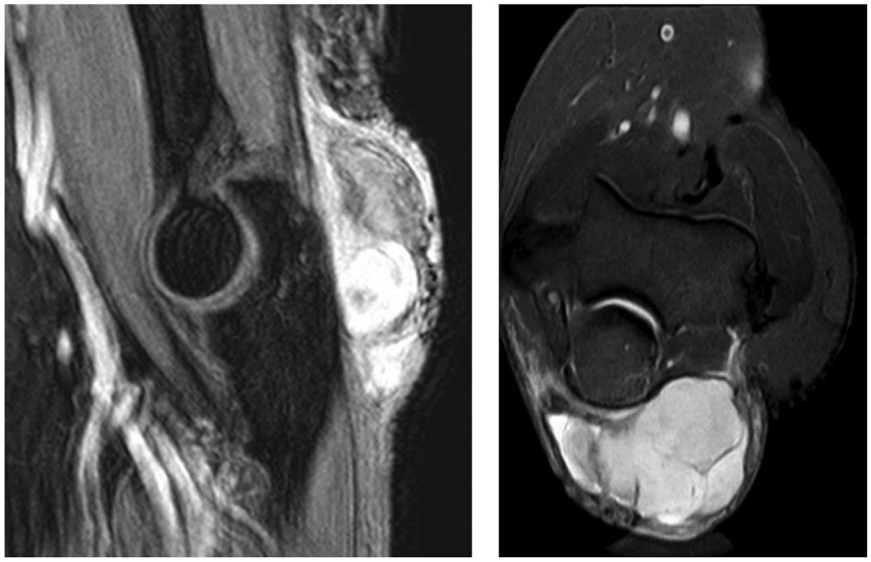

Figure 1 Magnetic resonance imaging (MRI) images with enhancement taken before surgery (left) sagittal short tau inversion recovery sequence, (right) axial transverse relaxation time MRI, postcontrast, showing heterogenous soft tissue mass with perilesional edema and extension into the triceps tendon with enhancement.

1-5 mm beyond the main tumor mass. Postoperatively, the incision healed without complications, and the patient received radiation therapy in 33 fractions totaling 66.0 Gy.

Surgical technique

The patient was placed in the lateral decubitus position. A wide ellipse shaped incision was made over the posterior elbow soft tissue mass, which fully incorporated the previously healed incision (Fig. 2). The identified mass was discovered in immediate proximity to the triceps tendon. Meticulous attention was taken in dissecting the mass, employing blunt dissection to cautiously mobilize the ulnar nerve without the need for transposition. En bloc excision of the mass, which measured 6.0 × 5.0 × 5.3 cm left a gap of approximately 5 cm gap in the triceps (Fig. 3 *Left* and center). Specimen was sent fresh to pathology intraoperatively exhibiting no remaining residual abnormal appearing tissue.

Following resection, a 2.0-mm drill was used to make 2 bone tunnels in the proximal aspect of the olecranon in a standard fashion. The Achilles allograft was then laid flat over the triceps tendon defect at the level of the myotendinous junction to allow for overlap. A #2 FiberWire (Arthrex Inc., Naples, FL, USA) suture was then used to incorporate the remaining triceps tendon to the Achilles tendon allograft in a Krakow fashion (Fig. 3 *Right* and Fig. 4). Two separate stitches are used along the medial and lateral aspect, creating a total of 4 limbs with the limbs exiting on the deep side of the graft with 2.5 cm of graft remaining. A Hewson suture passer was then used to bring the 2 most medial limbs and lateral limbs through their respective bone tunnels. Next, a free needle was used to pass the limbs back through the graft from deep to superficial through the distal aspect of the graft while maintaining the elbow in a slightly extended position, ensuring optimal alignment, length, and tension, which was confirmed with gentle range of motion (ROM). The graft was subsequently secured with locking knots and redundant allograft was trimmed. A radial forearm fasciocutaneous flap was developed and the elbow was prepared for skin grafting at the direction of the plastic surgery team. Postoperatively, the patient was placed into a posterior mold splint at 30 degrees of flexion and discharged home.

Follow-up and outcome

Multidisciplinary follow-up was provided and successful integration of the fasciocutaneous flap was achieved. At 5 weeks postop, the posterior mold splint was removed, and physical therapy was initiated. Gentle passive ROM was encouraged for 2 weeks followed by progressive strengthening and active ROM. Final pathology showed margins consistent with mainly low-grade spindle cell sarcoma that extended beyond the main tumor mass.

One month postoperatively, radiation therapy was initiated and treatment was completed over a 2-week period (66.0 Gy in 33 fractions). The patient continued to progress with physical therapy and was able to complete most activities of daily living with assistance at home. Three months postop, the patient reported full sensation in the radial and median distribution with subjective decrease in sensation in the ulnar nerve distribution. Passive ROM at elbow was from 0 to 130 degrees with active ROM from 0 to 110. Strength was recorded at 4/5 in the 0-40 degree arc with 3/5 strength for the remainder of the active arc based on the Medical Research Council Scale for Muscle Strength.[14] Despite the patient's inability to fully regain her baseline strength (5/5) on Medical Research Council scale, she effectively utilized her upper extremity to carry out activities of daily living and managed to ambulate with the aid of a platform walker.

Interval screening at 14 months from index procedure with whole body positron emission tomography/CT and MRI of left elbow, revealed nonspecific edema about the ulnar nerve with integration of the graft and a new focal lobulated 2.1-cm lesion in the intertrochanteric region of the left femur (Fig. 5). Subsequent MRI and bone biopsy of the femoral lesion confirmed malignant spindle cell lesion, compatible with high-grade spindle cell sarcoma and consistent with metastatic disease; Enneking Stage III. Given the patients' declining functional status and pain, the decision was made to pursue prophylactic stabilization with

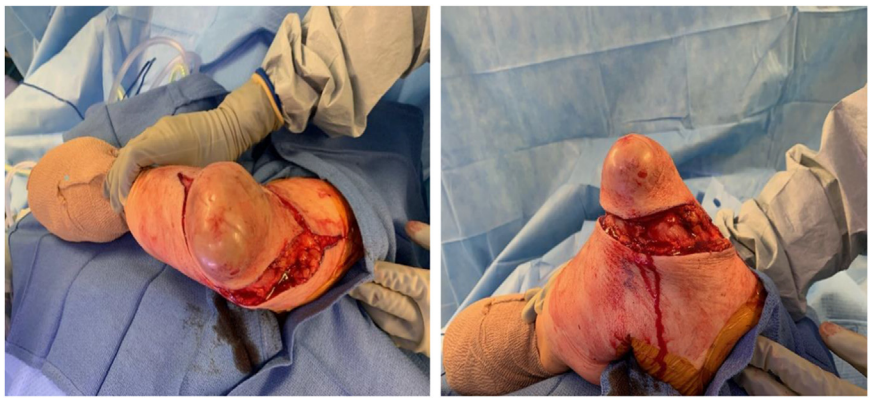

Figure 2 Intraoperative imagining showing wide ellipse incision over the posterior aspect of the elbow overlying the soft tissue mass.

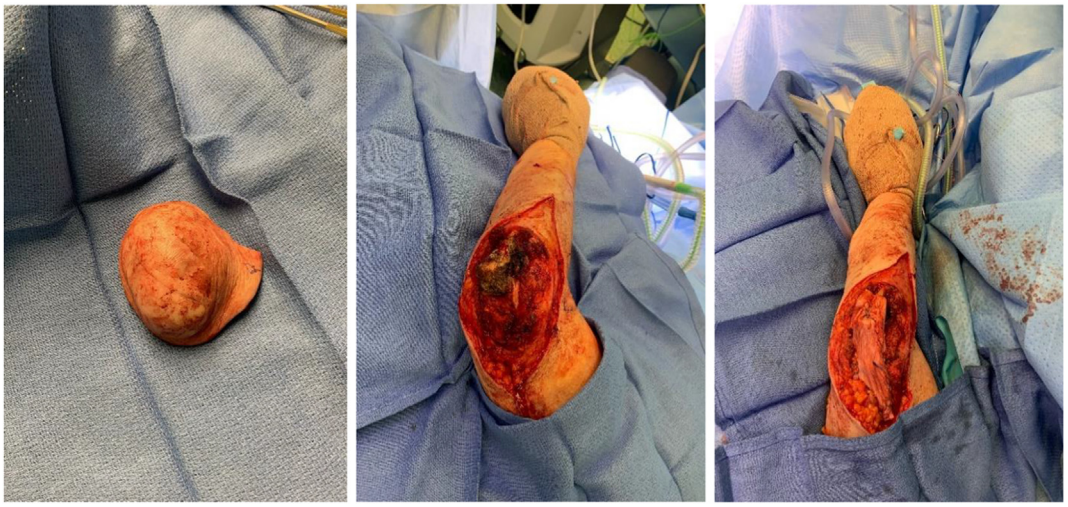

Figure 3 Intraoperative photographs. Excised soft tissue mass (*left*). Post en bloc resection of sarcoma with preparation for allograft implantation (*center*). Postintegration of Achilles tendon allograft with FiberWire and bone tunnel augmentation (*right*).

intramedullary nailing. Following discharge home, the patient decompensated medically, and the decision was made to pursue hospice care.

Discussion

Soft tissue sarcomas involving the elbow are uncommon. In 2018, STS accounted for 0.8% of all cancers in the United States with 20% of STS occur in the upper extremity.[4,6] Of those, 30%-40% arose in the elbow and forearm.[4] Typically, individuals manifest with nonpainful, gradually enlarging masses. Individuals who are exposed to ionizing radiation, experience lymphedema or are afflicted with conditions such as neurofibromatosis and Li-Fraumeni syndrome, may exhibit a predisposition towards the development of soft tissue sarcoma.[6,9] Emori et al reviewed the Japanese tumor registry during 2006-2017 and identified 114,286 individuals who were diagnosed with sarcoma; of which only 219 (0.19%) were found to have STS of the elbow, with a median age at onset of 63 years and tumor size an independent risk factor for poor prognosis.[5] In cases with locally advanced disease, it may be imperative to consider reconstructive intervention to restore functionality and mitigate the potential for metastasis.

In conjunction with tumor control, resection and reconstruction may allow surgeons to optimize the functional and biological viability of the limb. With reduced surgical time and donor site morbidity, allograft is an appealing option. Molenaars et al completed a systematic review which highlighted the role of allografts and the propensity to use Achilles tendon allografts in reconstructive surgery involving the elbow.[12] However, it is not without associated risks, including infectious disease transmission, host rejection, and increased cost.[13,17] Bennett and Mehlhoff described a technique for triceps reconstruction with Achilles tendon allograft to augment and bridge the triceps tendon.[2] Case reports have presented alternatives including, autologous semitendinosus, gracillis allograft, and fascia lata grafts.[3,7,12,20,21] While these studies have presented alternatives, no study has compared the biomechanical differences specifically in the setting of triceps grafts. In 2010, Petre et al studied the biomechanical properties of an intact triceps tendon and showed a load to failure (LTF) of 1741.1 N (1705.3-1777.5) and liner stiffness (LS) of 83.7 (71.5-96.0), with directly repaired tendons LTF of 317.4 N (304.1-330.7) LS 12.8 (11.5-14.1) and augmented repairs LTF of 593.1 N (573.7-612.6) and LS 24.9 (22.1-27.8).[15] A systematic review completed by Malige et al evaluated the biomechanical properties of Achilles, tensor fascia lata, iliotibial band, hamstring, quadriceps, peroneus longus, and tibialis anterior and posterior grafts. These were predominantly used as anterior cruciate ligament allografts, illustrating graft characteristics similar to those of the native triceps tendon with respect to stiffness and LTF.[11] Mabe et al specifically looked at Achilles tendon grafts and noted a maximum LTF of 915 N ± 326

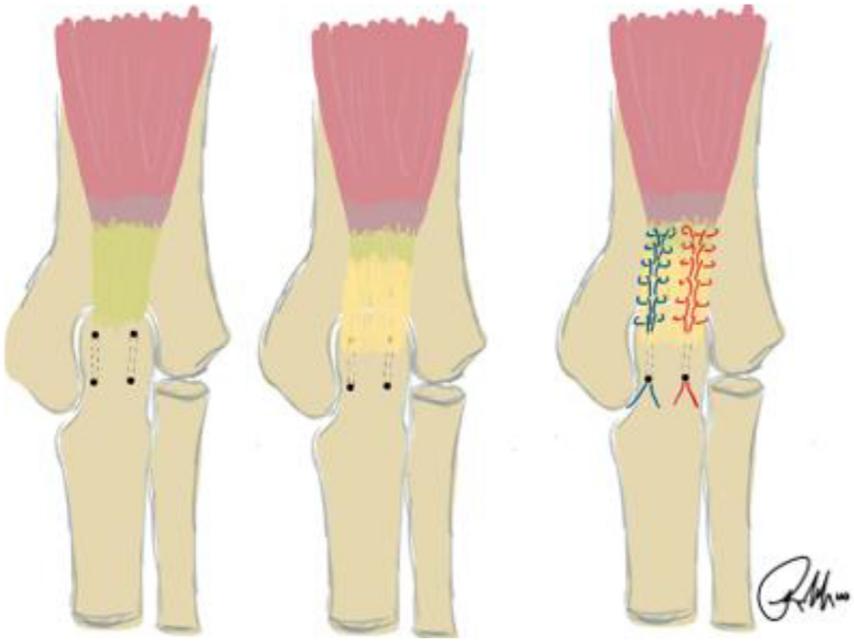

Figure 4 *Left*: Location of trans-osseous tunnels. *Center*: Placement of Achilles tendon allograft starting distal to the myotendinous junction. *Right*: Medial and lateral Krackow sutures limbs were utilized to incorporate Achilles tendon allograft which were passed through the trans-osseous tunnels and tied.

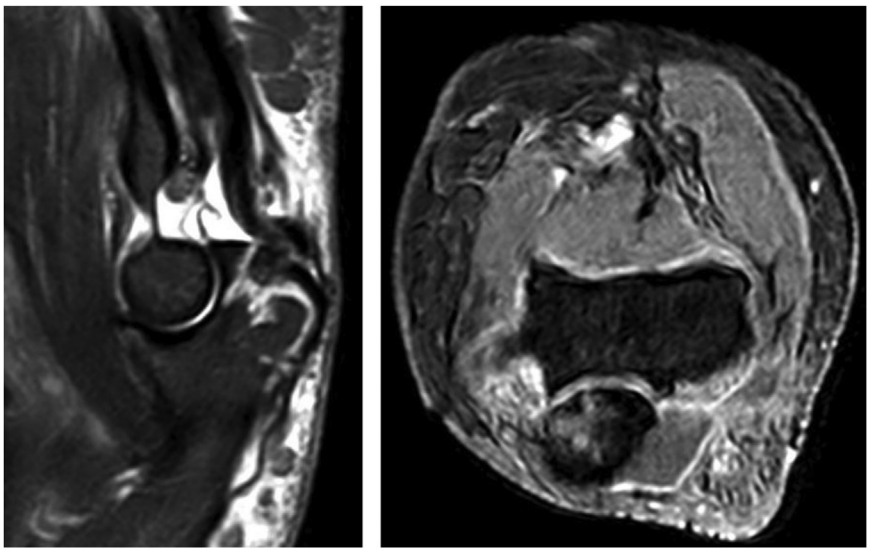

Figure 5 Sagittal short tau inversion recovery MRI left and postcontrast axial view right 14 months from index procedure with evidence of postsurgical changes and without evidence of nodular enhancement within the surgical bed to suggest recurrent tumor. *MRI*, magnetic resonance imaging.

and stiffness of 217 N/mm ± 45.[10] This was below the native intact tendon but within the range of augmented repairs.

There are a variety of techniques available in orthopedic oncology that have been utilized in the past for reconstruction following en bloc resection for soft tissue sarcoma. Clancy et al used a fascia lata autograft fixed through a combination of bone tunnels at the olecranon and proximal ulna and a 0-ethibond suture through the distal remnant muscle and fascia.[3] Alternatively, Weistroffer et al reported a technique which used a hamstring tendon autograft woven through the triceps tendon in a Bunnell fashion and secured to bone via Krakow sutures into bone tunnels.[20] In the setting of chronic triceps insufficiency, Aunon-Martin et al employed a technique combining Achilles tendon allograft in combination with a BicepsButton (Arthrex Inc., Naples, FL, USA) Aand interferon screw distally to secure the allograft at the olecranon and incorporated it proximally into the allograft with a suture tendon allograft band and a pulvertaft-type technique.[1] Pilih and Kozic reported a case in which an Achilles tendon allograft, without a calcaneal bone fragment, was utilized in triceps reconstruction. It resulted in successful tendon integration, improved functional outcome, strength recovery, pain reduction, and ROM measured with goniometric measurements and isokinetic testing.[16] Similarly, Sanchez-Sotelo and Morrey reported normal or slightly decreased power with extension and little or no pain with restoration of a functional arc in 3 patients managed with a tendo Achillis reconstruction with calcaneal fragment[18] The allograft was

fashioned to the olecranon via a V-shaped osteotomy and fixed in a chevron manner with a 6.5-mm partially threaded cancellous screw.[18]

Alternative graft options have also shown promise with similar reported outcomes. Clancey et al reported a functional recovery comparable to the patient's predisease state with fascia-lata autograft, whereas Weistroffer et al had an excellent return of function with ROM from 5 to 140 and 5/5 strength, allowing their patient to resume weightlifting with hamstring autograft.[3,20] While these findings are favorable, the ages of these 2 patients were 59 and 49, respectively, making them significantly younger.

In more advanced cases, soft tissue sarcoma may require osteoarticular reconstruction. Kharrazi et al performed a retrospective case series examining osteoarticular allograft reconstruction in patients with periarticular elbow bone loss secondary to tumor or trauma. Patients underwent either hemiarticular allograft or total elbow osteoarticular allograft. All patients who underwent total elbow allograft reconstruction developed degenerative changes and 66.7% allografts failed, while 87.5% of patients with hemiarticular allograft were able to return to preoperative level of function.[8] Management of tumor burden is crucial for giving patients with oncologic malignancies the best chance of remission. While amputation above the level of the lesion offers the best probability of long-term remission, patient preference and functional requirements must also be considered. Through performing an en bloc resection and triceps reconstruction, we were able to provide our patient with a favorable and functional outcome.

Conclusion

The use of an Achilles allograft for triceps tendon reconstruction provides intrinsic biomechanical benefits as well as the ability to integrate with surrounding tissues without donor site morbidity.[10,15] Achilles allograft tissue is a robust and durable choice for tendon reconstruction and it allows the treatment of larger defects.[11,18] Several case studies have demonstrated that a wide range of Achilles allograft reconstruction methods produce good to excellent patient outcomes, but no method has been established to guide treatment.[1,18,19] Our decision to utilize an Achilles allograft was a combination of defect size, decreased donor site morbidity and enhanced biomechanical properties, affording our patient the greatest chance for functional recovery of her dominant limb. Surgical reconstruction of the triceps poses a considerable technical challenge. In the field of orthopedic oncology, it is imperative for every surgeon to thoughtfully exercise their clinical judgment to discern the most suitable approach and surgical methodologies to utilize. This judgment must consider various factors, including the patients themselves and the potential surgical interventions that may be required, such as triceps reconstruction. This case report may serve as a valuable resource in aiding them in their decision-making process and contribute to the limited body of information available, thereby offering guidance for treatment.

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References

1. Aunon-Martin I, Prada-Canizares A, Jimenez-Diaz V, Vidal-Bujanda C, Leon-Baltasar JL. Treatment of a complex distal triceps tendon rupture with a new technique: a case report. Arch Trauma Res 2016;5:e32221. https://doi.org/10.5812/atr.32221.
2. Bennett JB, Mehlhoff TL. Triceps tendon repair. J Hand Surg Am 2015;40:1677-83. https://doi.org/10.1016/j.jhsa.2015.05.016.
3. Clancy R, Lim Z, Ravinsky RA, O'Neill A, Ferguson P, Wunder J. Use of a fascia lata autograft to reconstruct a large triceps tendon defect after en bloc resection of a soft-tissue sarcoma: a case report. JBJS Case Connect 2020;10:e0390. https://doi.org/10.2106/JBJS.CC.19.00390.
4. Duran-Moreno J, Kontogeorgakos V, Koumarianou A. Soft tissue sarcomas of the upper extremities: maximizing treatment opportunities and outcomes. Oncol Lett 2019;18:2179-91. https://doi.org/10.3892/ol.2019.10575.
5. Emori M, Iba K, Murahashi Y, Shimizu J, Sonoda T, Wada T, et al. Oncological and prognostic analysis of soft tissue sarcoma of the elbow: report using the bone and soft tissue tumor registry in Japan. Jpn J Clin Oncol 2021;51:1608-14. https://doi.org/10.1093/jjco/hyab119.
6. Gage MM, Nagarajan N, Ruck JM, Canner JK, Khan S, Giuliano K, et al. Sarcomas in the United States: recent trends and a call for improved staging. Oncotarget 2019;10:2462-74. https://doi.org/10.18632/oncotarget.26809.
7. Gupta RK, Soniet A, Malhotra A, Masih GD. Triceps tendon reconstruction using autologous semitendinosis graft in professional kabaddi player—a rare case report. J Clin Orthop Trauma 2017;8:S38-40. https://doi.org/10.1016/j.jcot.2017.05.007.
8. Kharrazi FD, Busfield BT, Khorshad DS, Hornicek FJ, Mankin HJ. Osteoarticular and total elbow allograft reconstruction with severe bone loss. Clin Orthop Relat Res 2008;466:205-9. https://doi.org/10.1007/s11999-007-0011.
9. Lohman RF, Nabawi AS, Reece GP, Pollock RE, Evans GRD. Soft tissue sarcoma of the upper extremity. Cancer 2002;94:2256-64. https://doi.org/10.1002/cncr.10419.
10. Mabe I, Hunter S. Quadriceps tendon allografts as an alternative to Achilles tendon allografts: a biomechanical comparison. Cell Tissue Bank 2014;15:523-9. https://doi.org/10.1007/s10561-014-9421-5.
11. Malige A, Baghdadi S, Hast MW, Schmidt EC, Shea KG, Ganley TJ. Biomechanical properties of common graft choices for anterior cruciate ligament reconstruction: a systematic review. Clin Biomech 2022;95:105636. https://doi.org/10.1016/j.clinbiomech.2022.105636.
12. Molenaars RJ, Schoolmeesters BJA, Viveen J, The B, Eygendaal D. There is a role for allografts in reconstructive surgery of the elbow and forearm. Knee Surg Sports Traumatol Arthrosc 2019;27:1840-6. https://doi.org/10.1007/s00167-018-5221-y.
13. Mundinger GS, Prucz RB, Frassica FJ, Deune EG. Concomitant upper extremity soft tissue sarcoma limb-sparing resection and functional reconstruction: assessment of outcomes and costs of surgery. Hand (N Y) 2014;9:196-204. https://doi.org/10.1007/s11552-013-9567-9.
14. Paternostro-Sluga T, Grim-Stieger M, Posch M, Schuhfried O, Vacariu G, Mittermaier C, et al. Reliability and validity of the medical research council (MRC) scale and a modified scale for testing muscle strength in patients with radial palsy. J Rehabil Med 2008;40:665-71. https://doi.org/10.2340/16501977-0235.
15. Petre BM, Grutter PW, Rose DM, Belkoff SM, McFarland EG, Petersen SA. Triceps tendons: a biomechanical comparison of intact and repaired strength. J Shoulder Elbow Surg 2011;20:213-8. https://doi.org/10.1016/j.jse.2010.08.017.
16. Pilih KA, Kozic M. Partial triceps tendon avulsion delayed reconstruction using Achilles tendon allograft, a case report. Trauma Case Rep 2022;42:100701. https://doi.org/10.1016/j.tcr.2022.100701.
17. Robertson A, Nutton RW, Keating JF. Current trends in the use of tendon allografts in orthopaedic surgery. J Bone Joint Surg Br 2006;88-B:988-92. https://doi.org/10.1302/0301-620X.88B8.17555.
18. Sanchez-Sotelo J, Morrey BF. Surgical techniques for reconstruction of chronic insufficiency of the triceps. Rotation flap using anconeus and tendo achillis allograft. J Bone Joint Surg Br 2002;84:1116-20. https://doi.org/10.1302/0301-620x.84b8.12902.
19. Savvidou OD, Koutsouradis P, Bolia IK, Kaspiris A, Chloros GD, Papagelopoulos PJ. Soft tissue tumours of the elbow: current concepts. EFORT Open Rev 2020;4:668-77. https://doi.org/10.1302/2058-5241.4.190002.
20. Weistroffer CJK, Mills WJ, Shin AY. Recurrent rupture of the triceps tendon repaired with hamstring tendon autograft augmentation: a case report and repair technique. J Shoulder Elbow Surg 2003;12:193-6. https://doi.org/10.1067/mse.2003.15.
21. Wolf JM, McCarty EC, Ritchie PD. Triceps reconstruction using hamstring graft for triceps insufficiency or recurrent rupture. Tech Hand Up Extrem Surg 2008;12:174-9. https://doi.org/10.1097/BTH.0b013e31817da1ba.