Clinical Decision Making for a Soft Tissue Hand Mass: When and How to Biopsy

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Evaluation of a hand mass and subsequent surgical treatment is a frequent clinical encounter for the practicing hand surgeon. The clinical evaluation of benign and malignant hand tumors has traditionally focused on diagnosis, surgical excision, and reconstruction. There is a paucity of literature discussing the determining factors for a hand mass biopsy, its appropriate technique, and postbiopsy preparation and handling. This review discusses the approaches of the hand surgeon and orthopedic oncologist to a soft tissue mass in the hand and clarifies the term biopsy. Special attention is focused on preoperative decisions and indications for core needle, incisional, and excisional biopsies of hand masses. In addition, we include a discussion of surgical technique for obtaining a specimen, processing a specimen, and sending a specimen for pathological evaluation. This highlights specimen labeling and type of fixative utilized for pathological evaluation. This review features a section detailing clinical strategies to reduce morbidity associated with evaluation and treatment of benign and malignant hand masses and is based on recommendations from a synopsis of expert opinion and literature review. *(J Hand Surg Am. 2018;43(12):1123–1129. Copyright © 2018 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Biopsy, hand mass, mass excision.

Proper diagnosis and treatment of a soft tissue hand mass is an integral aspect of any hand surgery practice. Although the overwhelming majority of hand masses encountered are benign, identifying the estimated 3% to 6% of malignancies is of utmost importance.[1] The essential steps in evaluating a mass involve a comprehensive clinical evaluation including a detailed history, thorough physical examination, and proper imaging. This evaluation combined with an understanding of most likely and most serious diagnoses should guide subsequent treatment decision making.

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As part of the diagnostic workup, the decision to utilize the biopsy as a diagnostic and therapeutic treatment is a critical step. When a biopsy is indicated, proper technique in retrieving, handling, and sending a specimen is essential to obtaining accurate results that guide care of the patient. Hand soft tissue tumors are unique with respect to other extremity and axial located tumors because biopsies here simultaneously represent the last stage of the diagnostic workup and first stage of treatment.[2]

INDICATIONS AND CONTRAINDICATIONS

The biopsy's goals are to generate a tissue sample for accurate pathological analysis and begin the therapeutic treatment of the tumor that is causing pain or a disruption in cosmesis or function. Before surgery, hand soft tissue masses must be clinically categorized into determinate and indeterminate masses.[3] Table 1 lists the common clinical determinate masses based on history, physical examination, and imaging. Lesions categorized as

determinate can generally be accurately diagnosed prior to tissue analysis. However, malignant masses can be mistaken as determinate lesions by fulfilling benign criteria, including size limits less than 3 to 5 cm, no increase in size, and pain-free history. In addition, masses that are firm, solid, and nonmobile on examination should be approached with heightened awareness.[4] A common technique for identifying translucency utilizes passage of light through a cystic structure. Figure 1 demonstrates a technique for assessment of transillumination. In the digit, the light source can be placed on the volar aspect of the digit. In the palm or dorsum of the hand, the light source can be placed adjacent to the mass for evaluation.

All hand mass evaluations should include at least biplanar radiographs. Clinical decision making based on history and examination determines need for advanced imaging. A low threshold for advanced imaging (magnetic resonance imaging [MRI] with and without gadolinum) and input from a musculoskeletal radiologist and pathologist facilitates evaluation with a team-based approach and helps better identify sarcomatous lesions.[5,6] An ultrasound evaluation is often a complementary test to the MRI and is helpful for determination of solid or cystic tissue. No specific guidelines or evidence-based data exist for which hand soft tissue masses require a biopsy. A biopsy is indicated whenever a mass has biological activity or causes symptoms in the patient.[7]

Indeterminate masses do not have a clear diagnosis based on nontissue mass evaluation and range from benign to malignant. Atypical features of benign pathologies include painful lesions (especially at night) and those with progressive size. Physical examination noting size, shape, mobility, consistency, exact location, and changes to overlying skin may alert the clinician to a malignant process as well as any neurovascular symptoms from tumor or mass effect. Regional lymph nodes in the antecubital fossa and axilla should be included in the assessment. If systemic symptoms are reported, workup can be initiated in conjunction with the primary physician.

SURGICAL ANATOMY

The hand is a complex anatomical region with close proximity to many different organ systems: vessels, nerves, musculotendinous units, and bone. Fine motor coordination and dexterity require interplay between systems and the hand is considered a specialized compartment, with many subcompartments organizing distinct structures into anatomical areas. An MRI with and without gadolinium is the study of choice for defining soft tissue relationships and mass characteristics. Axial MRI images are the workhorse for surgical planning. Computed tomography provides excellent resolution of tumor bone relationship.

The location of a mass plays a critical role during treatment. Lesions distal to the metacarpophalangeal joint are nearly always treated with excisional biopsies. More proximal lesions in the hand often involve or are in close proximity to adjacent compartments containing important functional structures. Judicious preoperative decision making involves determination of incisional or needle biopsy to rule out a malignancy. Complications of incomplete excisional biopsy of a malignant lesion can be devastating compared with more proximal locations in forearm and brachium.[4] In addition, reports of incomplete excisions or biopsies can be the first indication of malignancy in 38% to 95% of cases.[6] However, Sluijmer et al[8] described a series of patients undergoing an excisional biopsy of suspected benign soft tissue tumor and found that preoperative diagnosis differed from pathological diagnosis in only 21% of cases. They concluded that a surgeon's preoperative diagnosis is usually correct when a strategic approach to a soft tissue tumor is utilized and discrepant diagnoses are usually benign and do not alter treatment.

The relatively compact area of the hand compartments often leads to tumors discovered and evaluated at smaller sizes than tumors found in other proximal extremity locations owing to subcutaneous location or mass effect on neurovascular structure. In other regions of the body, soft tissue lesions greater than 5 cm represent worrisome masses, but in the hand, sizes greater than 3 cm can be a concern for a malignant lesion. Brien et al[4] found 78% of the soft tissue sarcomas in the hand were less than 5 cm. In addition, the hand is unique owing to the lack of local soft tissue coverage.[6] No local expendable flaps for coverage exist for larger resections with the exception of forearm flaps including the radial forearm flap, lateral arm flap, or posterior interosseous flap. Masses less than 2 cm in size are generally treated with excisional biopsy because at this size, reexcision does not cause the same morbidity as a larger tumor and closed techniques may be more challenging.

TABLE 1. Clinical Characteristics of Common Hand Soft Tissue Determinate Masses

Diagnosis	History	Physical Examination	Imaging
Ganglion cyst	Waxing and waning symptoms and size, may cause pain with ADLs	Soft mass, typical location over dorsum and radial volar wrist, + transillumination test	X-rays without signal, MRI with round smooth lesion dark (muscle equivalent) on T1-, bright on T2-weighted imaging, periphery enhances with gadolinum—not the lesion itself
Lipoma	Slow growing, typically painless, exceptions include atypical location with resulting symptoms based on location (Guyon canal—ulnar neuropathy)	Rubbery texture, mobile, − transillumination test	X-rays with lucency of mature fat, variable location: subcutaneous, intramuscular, or in deep space of hand, MRI with similar uniform appearance of subcutaneous fat (T1 bright signal, T2 moderate to bright signal) suppression on fat saturation sequences, well circumscribed
Giant cell tumor of tendon sheath	Painless, slow-growing volar mass, may become symptomatic with impact during ADLs	Small (1−2.5 cm), firm palpable mass around tendon sheath with uneven surface on palpation, nontranslucent	X-rays may show erosion into bone, soap bubble appearance, MRI well circumscribed, with nodular or lobulated pattern, low signal intensity on both T1 and T2 (hemosiderin)
Schwannoma	Firm, slow-growing nodule adjacent to site of peripheral nerve, paresthesias distal to mass	May produce local pain or accompanying paresthesias of local nerve, + Tinel sign	X-rays without signal, MRI with isointense to muscle on T1, brighter than muscle T2 signal, + gadolinum diffuse enhancement, string sign or target sign
Glomus Tumor	Subungual location, pain associated with cold exposure	Bluish-purple hue subungual mass, may cause nail changes, pinpoint tenderness, cold intolerance pain may be reproduced by ethyl chloride vapocoolant spray	X-rays may show scalloping of distal phalanx, MRI with bright signal under nail bed on T2, low signal on T1
Hemangioma	Female predominance, may or may not be painful, can have periodic symptoms; if superficial, can ulcerate and bleed	May demonstrate bluish hue, size can be dependent on position and may fluctuate	X-rays frequently shows phleboliths, MRI shows marginated lipomatous tissue that is bright with isointense T1 background, vascular formations, gadolium enhancement (heterogeneous bright T1- and T2-weighted images)
Pyogenic granuloma	Rapidly growing, typically following traumatic wound, friable and bleeds easily	Red beefy pedunculated solitary cutaneous lesion	Typically not required during diagnostic process

ADLs, activities of daily living.

BIOPSY TECHNIQUE

To reiterate, surgical biopsy of a soft tissue tumor is the last step of the complex diagnostic process and the first step of treatment. Its goal reflects the simultaneous removal of symptomatic tissue and tissue diagnosis.[2]

Biopsies can be performed by various techniques and are traditionally categorized as closed or open techniques. Closed techniques do not involve an incision but instead use either fine-needle aspiration or core needle biopsy, such as a trephine, to obtain a sample for pathological evaluation. Fine-needle aspiration has been demonstrated to have the lowest percentage of obtaining an accurate diagnosis (~70%−90%) and is generally reserved for radiologists using imaging (ultrasound or computed tomography guidance) supplementation.

Core needle biopsies are often preferred owing to their more accurate tissue sampling (80%−96%), low probability of tissue misdiagnosis, low cost, minimal

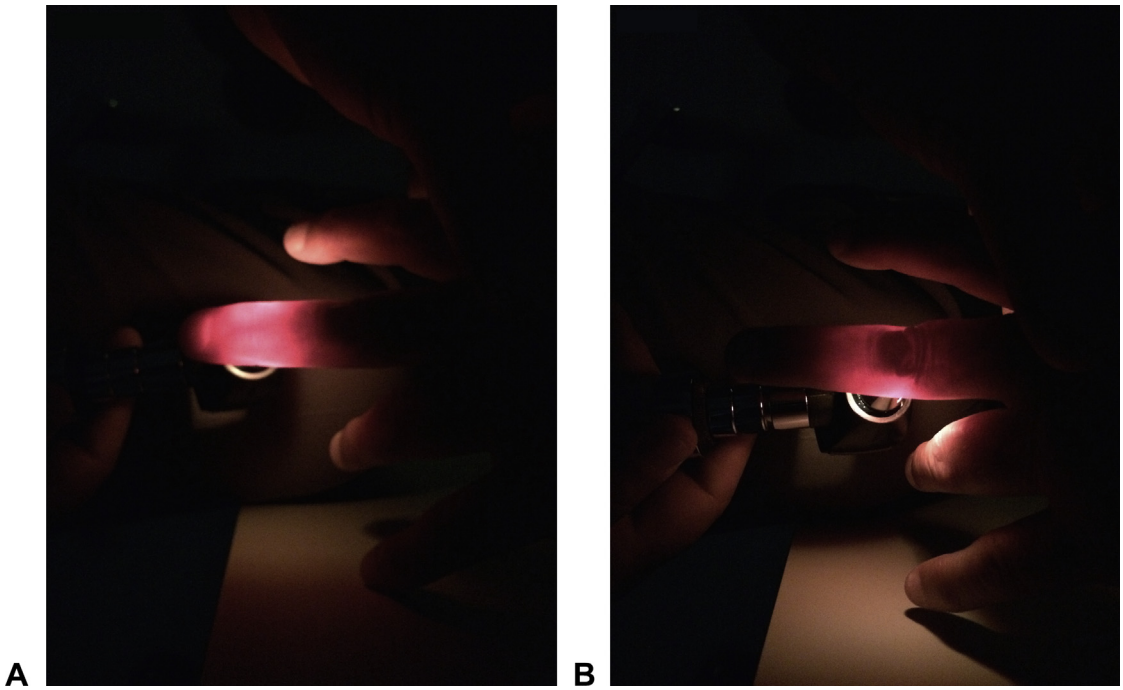

FIGURE 1: **A** Passage of light through the digit in the absence of mass. **B** Solid mass at the level of the proximal interphalangeal joint that does not allow passage of light through the mass.

invasiveness, and small area of contamination (limited to the needle tract).[9] This can be performed as an outpatient by the treating surgeon or in conjunction with an interventional radiologist, but may not be suitable for all cases. Case discussion and technical suggestions are encouraged for optimal sampling and are based on location of subsequent incision and mass resection. For example, sampling through a single muscle limits needle tract morbidity versus an intermuscular approach.[10] Core needle biopsies yielding nondiagnostic tissue may be repeated.

Open biopsy techniques of extremity masses are governed by established principles of orthopedic oncology. Hemostasis is of utmost importance and maintained with a pneumatic tourniquet during the surgery and with meticulous use of intraoperative electrocautery. The extremity should be held in elevation for exsanguination and Esmarch exsanguination is contraindicated.[2] Postoperative hematomas can track in subcutaneous or intermuscular planes, leading to intercompartmental contamination.[3] Regardless of specific technique, direct visualization of the tumor can aid in diagnosis. This is performed through longitudinal incisions that parallel neurovascular tracts and avoidance of vital structures. Excisional and incisional biopsies represent open biopsy techniques.

Excisional or marginal biopsy is reserved for soft tissue lesions with determinate status, lesions less than 2 cm, those located distal to the metacarpophalangeal joints, or those with low risk of malignancy. This technique employs an incision directly over the mass and dissection is performed until the mass can be seen. The tumor is shelled out from its surrounding soft tissue attachments. The reactive zone is typically violated and tumor cells may remain in the surgical bed despite removal of the pseudocapsule. This technique is rarely used for indeterminate lesions owing to inadequate resection of an unexpected malignant lesion with positive margins. Increased morbidity is related to tumor bed reexcision requiring greater size of excision, possible resection of vital structures, and lower rates of successful tumor removal.[9]

In hand surgery, incisional or intralesional biopsy is reserved for indeterminate soft tissue lesions with high probability of malignancy, which is rare. Incisional biopsy is a sampling of the tissue from the tumor itself under direct visualization. This is performed through the tumor bed and used to determine the diagnosis before proceeding with wide margin treatment of a suspected sarcomatous lesion. It may be indicated after a failed or nondiagnostic closed biopsy.[9] Generally, less tissue dissection is required compared with an excisional biopsy because circumferential visualization is not utilized. The technique involves directly incising the tumor in its periphery with a scalpel. Incisional biopsy is the most

accurate and reliable form of biopsy and has long been considered the gold standard for soft tissue tumors, yielding a diagnostic accuracy of 94% to 100%.[2]

Wide margin resection includes tumor excision with negative margins and a cuff of normal tissue around the reactive zone and pseudocapsule. Typically, a 1- to 3-cm periphery of normal tissue is removed but is dictated by relationship of the tumor to nearby structures, especially neurovascular tissues. Radical excision is defined as resection through an adjacent compartment with the affected compartment removed in its entirety. This technique is of limited utility in the hand owing to proximity of important functional structures. Amputation is performed when digit, ray, or limb salvage is not warranted because the resected margins should not be abbreviated in lieu of more function.

BIOPSY PREPARATION

All biopsies involve tissue for pathological diagnosis that can be sent as fresh, frozen, and or permanent (formalin) sections. Different specimens require different sections. The most common method of sending a specimen that before surgery is a determinant lesion is permanent section in formalin. This preserves the specimen's morphological features to permit the pathologist's histopathological evaluation. Indications for fresh sections include the need for cytogenetic analysis and immunohistochemistry to characterize the mass. Fresh sections are also used for evaluation of infection with tissue culture. Frozen section analysis is performed to evaluate for an infectious process and ensure adequate diagnostic tissue has been obtained, but should not be relied upon to diagnose malignant lesions.[7] An adequate biopsy confirms the tissue is a representative sample of the proposed biopsy, is a sufficient specimen for additional studies, and is viable for select studies.[2] It is in the patient's and surgeon's best interest that the surgical team is informed of fixation choice prior to obtaining the biopsy. Errors may occur in surgical preliminary fixation, mishandling, and prolonged transit time when surgical teams are unprepared.

Prior to sending a specimen, it is advantageous to label a specimen when margins are important for treatment. The technique involves marking orientation with suture identification of proximal and distal, as well as superficial and deep if the skin cannot be seen. If feasible, the surgeon delivers the tumor to the pathologist directly with discussion of intraoperative findings, although not readily available at all institutions.[2] Figure 2 represents images of a biopsy with correct labeling technique demarcating specimen orientation. However, labeling of excisional biopsies is generally not performed owing to small size and no utility for benign lesions.

POSTOPERATIVE MANAGEMENT

The postoperative treatment of biopsied lesions is based on pathological diagnosis. Benign masses can be followed routinely with patient surveillance for recurrence. In the occurrence that a mass is consistent with malignancy, the patient should be informed of the diagnosis with a proposed treatment plan based on the pathology report. Margins should be evaluated, with high likelihood of positive margins with an excisional biopsy. Referral to an orthopedic oncologist is recommended for complete workup including metastatic staging as well as reimaging the tumor bed. An unplanned excision increases risk of local recurrence.[6] However, survival may be independent of initial positive margins, but may depend on size and grade of tumor if repeat wide margin excision obtains negative margins.[6]

OTHER IMPORTANT SURGICAL CONSIDERATIONS

The physician's ability to make a clinical diagnosis is imperative. However, many masses can only be reliably diagnosed on tissue analysis. This leaves the surgeon and patient without preoperative certainty of a benign mass prior to surgical intervention. Empathic concern, communication, and adjunct imaging, such as an MRI with and without gadolinum, help bridge this gap with a discussion of the patient's fears or concerns, the differential diagnosis, and the planned interventions based on tissue analysis.

The unexpected malignancy is the major concern of any mass resection that does not meet clinical criteria of the diagnosed mass. If a mass does not fit the visual profile of suspected diagnosis, stop the surgical procedure and send a frozen section of the mass to ensure a representative sample is obtained and send a fresh specimen as well. Intraoperative management can proceed with feedback from a pathologist. If a malignancy is suspected, then meticulous hemostasis should be performed and prompt referral to a provider or center specializing in malignant lesions should be made after confirmation of malignancy on frozen and fresh sections.

Physicians must also remember to obtain an infectious workup of a mass because infections can masquerade as benign or malignant tumors. "Culture

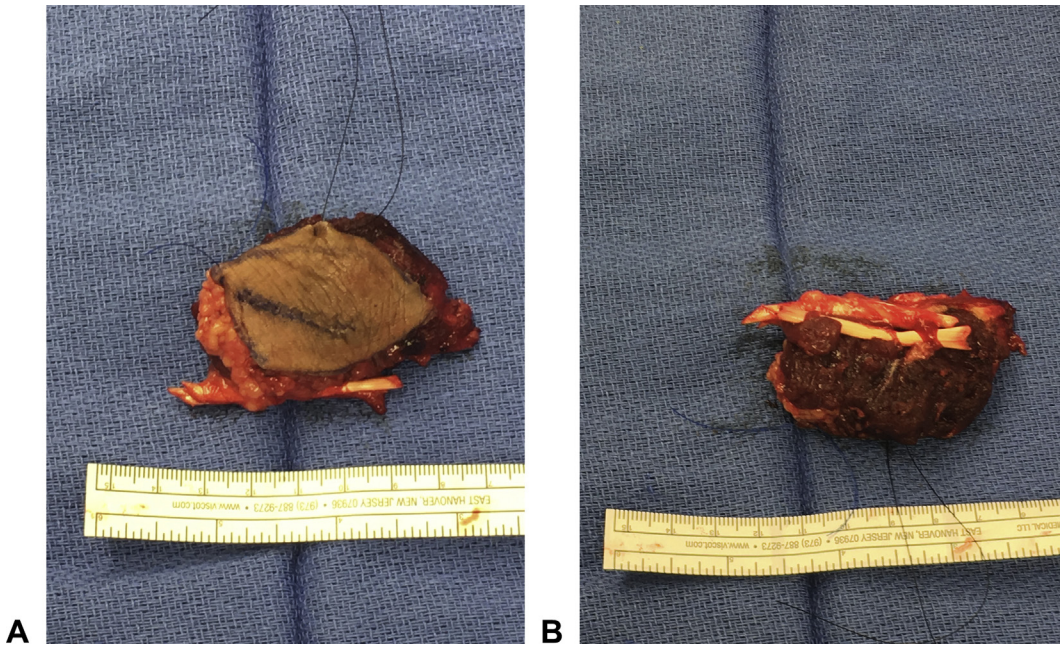

FIGURE 2: Images of a biopsy demonstrating **A** superficial and **B** deep surface of the biopsy specimen. Note that orientation is marked by different sutures demarcating radial and distal aspects.

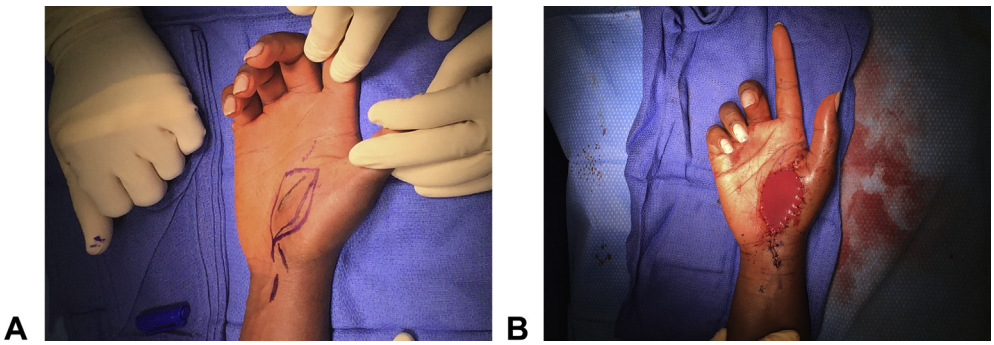

FIGURE 3: **A** Preoperative image of a tumor bed reexcision of a malignant mass in the thenar eminence. **B** Postoperative image of the reconstruction of tumor bed excision. Note the **A** initial incision in the thenar eminence with the planned wide margin treatment and **B** greater morbidity seen on the postoperative image.

what you biopsy and biopsy what you culture" is a mantra to govern practice. Tissue cultures should be sent for aerobic, anaerobic, fungal, and mycobacterium. Crystal analysis from fresh tissue can be an adjunct if suspecting soft tissue tophaceous gout or pseudogout.

COMPLICATIONS

Hand mass excisional biopsies are generally benign procedures, but these may be fraught with complications particularly because no single technique can be applied to the vast array of tumors and locations. Complications from a closed biopsy are mostly related to nondiagnostic procedures. The worst complication includes contamination and interference with future surgical treatment, such as wound hematoma and local tumor spread by passing the needle through the far side of the tumor into normal tissue during the closed biopsy passes.[10]

Excisional biopsy and open incisional biopsy can have several complications relating to sampling of surgical tissue, which include infection, wound dehiscence, hematoma, tumor spread, and contamination of an uninvolved compartment, neurovascular injury, inadequate tissue collection, inadequate margins.[4] Figure 3 is an example of preoperative and postoperative images of a tumor bed reexcision.

CONCLUSIONS

The vast majority of soft tissue tumors encountered in the hand are benign and can be treated with excisional biopsy. Defining the lesion as determinate or

indeterminate based on clinical and radiographic criteria will mitigate the risk of an unplanned marginal excision of a malignancy. Maintaining a high index of suspicion and approaching hand mass evaluation systematically will prevent complications and optimize patient care. We recommend classification of a mass based on clinical features and advanced imaging: determinate lesions can be treated with an excisional biopsy and indeterminate lesions may be treated with needle, incisional, or excisional biopsy.

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REFERENCES

1. Puhaindran ME, Athanasian EA. Malignant and metastatic tumors of the hand. *J Hand Surg Am*. 2010;35(11):1895–1900.
2. Trigg SD. Biopsy of hand, wrist, and forearm tumors. *Hand Clin*. 2004;20(2):131–135.
3. Papp DE, Khanna AJ, McCarthy EF, Carrino JA, Farber AJ, Frassica FJ. Magnetic resonance imaging of soft-tissue tumors: determinate and indeterminate lesions. *J Bone Joint Surg Am*. 2007;89(Suppl 3):103–115.
4. Brien EW, Terek RM, Geer RJ, Caldwell G, Brennan MF, Healey JH. Treatment of soft-tissue sarcomas of the hand. *J Bone Joint Surg Am*. 1995;77(4):564–571.
5. Frassica FJ, Khanna JA, McCarthy EF. The role of MR imaging in soft tissue tumor evaluation: perspective of the orthopedic oncologist and musculoskeletal pathologist. *Magn Reson Imaging Clin N Am*. 2000;8(4):915–927.
6. Pradhan A, Cheung YC, Grimer RJ, et al. Soft-tissue sarcomas of the hand. *J Bone Joint Surg Br*. 2008;90(2):209–214.
7. Rougraff BT, Aboulafia A, Biermann JS, Healy J. Biopsy of soft tissue masses: evidence based medicine for the Musculoskeletal Tumor Society. *Clin Orthop Relat Res*. 2009;467(11):2783–2791.
8. Sluijmer H, Becker S, Bossen J, Ring D. Excisional biopsy of suspected benign soft tissue tumors of the upper extremity: correlation between preoperative diagnosis and actual pathology. *Hand (N Y)*. 2014;9(3):351–355.
9. Marvogenis AF, Panagopoulos GN, Angelini A, et al. Tumors of the hand. *Eur J Orthop Surg Traumatol*. 2017;27(6):747–762.
10. Okada K. Points to notice during the diagnosis of soft tissue tumors according to the Clinical Practice Guideline on the Diagnosis and Treatment of Soft Tissue Tumors. *J Orthop Sci*. 2016;21(6):705–712.