Skeletal Radiology (2019) 48:499–501
https://doi.org/10.1007/s00256-018-3127-x

PERSPECTIVE

Revisiting tract seeding and compartmental anatomy for percutaneous image-guided musculoskeletal biopsies

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Received: 20 June 2018 / Revised: 25 October 2018 / Accepted: 3 December 2018 / Published online: 7 January 2019

Over the past few decades, there has been a wealth of literature describing compartmental anatomy of the extremities, teaching that percutaneous biopsies for suspected malignant neoplasia must respect these boundaries and never cross from one compartment into a second [1–6]. This grew out of the concern for seeding the biopsy tract during tissue sampling, deducing that should seeding occur and lead to local recurrence, it would be confined to the original anatomical compartment or biopsy tract and thus more amenable to re-excision.

How did this all begin? In 1993, Davies et al. published a case report, "Recurrence of an osteosarcoma in a needle biopsy tract" [7]. Since then, there have been a total of 6 publications providing additional documentation on tract seeding; 2 single case reports [8, 9], 1 three-patient report [10], and 3 cohort studies [11–13]. One of these cohort studies [11] histologically evaluated biopsy tracts of 26 osteosarcomas and found "positive tumor infiltration" in 5 (19.2%). Of note, there was no tumor infiltration in any patient who had a good response to chemotherapy. Another [12] studied 35 patients with osteosarcoma, Ewing sarcoma, and chondrosarcoma, and found contamination along the tract in 4 (11.43%). The third [13] reviewed 180 biopsies of a variety of mesenchymal tumors and found tract contamination in 21 (12%).

There are several problems with these reports. First, the studies mix open and percutaneous biopsy. They do not report the biopsy systems used (for example, co-axial). One study considered necrotic cells following chemotherapy to represent seeding, but there was no recurrence [14].

Upon review of those publications promoting the compartmental theory and/or biopsy tract excision, 5 provide no references to seeding [1, 4, 5, 15, 16], 1 references an animal model using radioactive microspheres [3], and 3 reference the same two papers from 1993 and 1997, providing 4 documented cases in total [2, 6, 17].

Among all of these studies, there are two unifying concepts:

1. That open biopsies had a higher recurrence rate than percutaneous biopsies [2, 7, 12, 13, 16]
2. Regardless of whether the tract was excised or not, patients who receive neoadjuvant chemotherapy had a lower rate of recurrence [10–13]

Amidst the previous literature promoting the compartmental theory, there have also been several publications questioning its validity [18–22]. One study found no seeding in 10 patients with bone sarcoma when the tract was not resected [18]. Another found no local recurrences in 20 patients with high-grade sarcomas with no tract excision [19]. Another study of 363 mixed bone and soft-tissue lesions (188 malignant) had no seeding, despite ignoring compartmental boundaries in 13, and not excising the biopsy tract in any [20]. The biopsy trajectory was chosen to maximize patient comfort and provide the most direct route to the mass. Yet another review of 59 adults with soft-tissue sarcomas without tract excision found "… no increase in local recurrence rates… when resection of the core biopsy tract was not performed." The most recent study in 2017 compared 36 soft-tissue sarcomas with tract excised with 36 without, and found that tract excision is "likely to be of minor clinical importance in extremity soft-tissue sarcoma" [22].

Most oncology surgeons routinely excise the biopsy tract at the time of tumor excision. This is certainly true for open biopsies when the scar from the original procedure is evident. In the case of percutaneous biopsy, however, the entry site for the biopsy may not be apparent at the time of surgery, and the trajectory of the biopsy needle is unknown to the surgeon. Although the tumor itself is

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removed with wide "oncological" margins, extra subcutaneous fat and skin along the tract is not excised.

Although not scientifically documented, there is an overwhelming likelihood that the possibility of seeding is lower with coaxial systems than with multiple percutaneous needle passes, and most certainly less with coaxial systems than with open biopsy. Furthermore, neoadjuvant chemotherapy and radiation further reduce the possibility of tumor cells along the biopsy tract.

The classic articles by Mankin et al. on the hazards of biopsy of bone and soft-tissue tumors [23, 24] stress that sarcoma biopsies should be performed at the treating center rather than the referring center, because patient outcomes were superior. In the original 1982 report [23], 4% of the biopsies were needle. In the second 1996 report [24], this had increased to 14% needle biopsies. The authors did not look specifically at biopsy tract recurrence or compartmental anatomy in either report.

There are two clinically relevant issues:

1. Although it has been documented that seeding occurs, it is unusual. The incidence is clearly far lower than the literature reports of up to 19.2% [11–13]
2. Should seeding occur, it has never been documented that crossing anatomical compartments leads to less favorable long-term outcomes

The current status of this compartmental controversy was well summarized in a recent article by Berger-Richardson et al. [25]. "For patients with suspected sarcoma, the rationale for proper planning of the needle pathway into the tumor, and for routine excision of the needle biopsy tract should the diagnosis proved to be sarcoma, would appear sound based on intuition and oncologic principles, but not grounded in clinical evidence, other than a few published case reports."

It is clear that patients with bone and soft-tissue tumors need a biopsy for treatment planning. Percutaneous image-guided tissue sampling is known to be safer (especially with respect to seeding) and substantially less expensive that open biopsy. Advances such as co-axial biopsy systems and neoadjuvant chemotherapy seem to have significantly reduced the already uncommon incidence of tract seeding with percutaneous tissue sampling. That leaves us with the issue of the relevance of compartmental anatomy for biopsy planning. It seems that this has piggybacked to fame on the tail of tract seeding, with no reports or studies documenting that this is an issue.

The ideal means of settling this controversy would be a prospective multi-institutional study of image-guided percutaneous biopsies using a coaxial technique and chemotherapy where indicated. Subjects could be placed in groups where one compartment was crossed versus more than one, and randomized to whether the tracts were or were not resected at the time of surgery. A 2-year follow-up would make great strides in proving or disproving this debate. This could also address which tumor types are more prone to tract seeding. Unfortunately, the chance of such research coming to fruition is unlikely, as there are only a handful of oncology centers that would participate.

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