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Capillary Versus Aspiration Biopsy: Effect of Needle Size and Length on the Cytopathological Specimen Quality

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Abstract

Purpose: To test the value of the nonaspiration, or capillary, biopsy technique by experimental comparison with the conventional fine-needle aspiration technique using various needle gauges and lengths.

Methods: On fresh hepatic and renal tissue from five autopsies, multiple biopsy specimens were taken with 20, 22, and 23-gauge Chiba needles of 5, 10, 15, and 20-cm length, using the aspiration technique and the capillary technique. The resultant specimens were graded on the basis of a grading scheme by a cytopathologist who was blinded to the biopsy technique.

Results: The capillary technique obtained less background blood or clot which could obscure diagnostic tissue, although not significantly different from the aspiration technique ($p = 0.2$). However, for the amount of cellular material obtained, retention of appropriate architecture, and mean score, the capillary technique performed statistically worse than aspiration biopsy ($p < 0.01$). In addition, with decreasing needle caliber (increasing needle gauge) and increasing length, the capillary biopsy was inferior to the aspiration biopsy.

Conclusion: The capillary biopsy technique is inferior to the aspiration technique according to our study. When the capillary technique is to be applied, preference should be given to larger caliber, shorter needles.

Key words: Biopsies, technology—Liver—Kidney

Over the past 20 years, ultrasound, computed tomography (CT), and fluoroscopically guided fine needle aspiration biopsies (FNAB) have become commonplace in most radiology practices. These biopsies are usually obtained by aspiration with suction applied through a hand-held syringe while a to-and-fro rotary biopsy action is performed. Before withdrawal, suction is released to prevent pulling the specimen back into the syringe. Recently, a capillary technique has been introduced as an alternative to the aspiration method. It does not use a syringe nor suction, rather it relies on the capillary suction inside the needle itself. Primarily employing small caliber 23- and 25-gauge needles ranging from 1.5 to 3 inches in length, the capillary technique has been shown by several investigators to yield results equal to aspiration biopsy in nonblinded small series [1–7]. However, in other studies, the capillary method did not perform as well as the aspiration method when using the needles in the size and length commonly employed in imaging-guided biopsy [8]. It may be that the capillary method is only useful with shorter and smaller caliber biopsy needles. Therefore we compared the two techniques using all lengths and diameters of biopsy needles commonly employed to obtain cytologic specimens by imaging guidance.

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Materials and Methods

Tissue from five autopsies obtained no more than 4 hr after death was used. Biopsy specimens were taken from six different liver and renal sites per autopsy for each needle size/length with half using the aspiration and half the capillary technique. The needles and lengths used are listed in Table 1. For each aspiration and/or capillary biopsy, up to 10 2.0-cm passes were made until blood was obtained in the needle hub. All biopsies were done by the principal investigator, who had performed 4000 image-guided biopsies. Each specimen was smeared at the time of biopsy by a cytopathologist. Each aspirate yielded 2–4 slides which were identified by a randomly selected control number and placed into 95% ethyl alcohol. A separate recordkeeper completed a key identifying each autopsy number, site of biopsy, slice and number, biopsy technique, and device. This key was forwarded directly to the Biostatistics Section for data entry. Chiba needles with centimeter markings were utilized for all biopsies to ensure a biopsy depth of 2.0

Table 1. Chiba needles used

Gauge	Length (cm)	Excursion (cm)
20	5	2
20	10	2
20	15	2
20	20	2
22	5	2
22	10	2
22	15	2
22	20	2
23	5	2
23	10	2
23	15	2
23	20	2

cm. Careful attention was taken during the biopsy process to avoid repetitive biopsies into the same area of any organ.

The slides were stained with the Papanicolaou stain by an automated processor (Automated Slide Stainer, Sakura Finetek U.S.A., Inc., Torrance, CA, USA) and stored until the completion of the study. The numbers applied to the slide sets were randomized prior to their use, then reordered and mixed after all slides were stained. The order of the techniques used with each biopsy (aspiration vs capillary) was also varied.

All slides were forwarded at one time to a subspecialty-trained cytopathologist with extensive experience in the interpretation of such specimens. Evaluation was performed using a previously published grading scheme [1] (Fig. 1). This scheme assigns a minimum score of 0 to a maximum score of 2 for each of five criteria: background blood, amount of cellular material, degree of cellular degeneration, degree of cellular trauma, and retention of appropriate architecture. A higher score in each category indicates a better quality specimen. In the case of background blood, a higher score indicates little or no background blood that could obscure the diagnostic material. The written evaluations were forwarded directly to Biostatistics, where they were correlated to the key which identified the organ of origin, autopsy number, and biopsy needle.

Statistical analyses comparing the two biopsy methods for the differing needle calibers and lengths was conducted for both the liver and kidney separately, as well as for the combined data. Evaluation of the results for each of the grading criteria, in addition to the overall performance score, was also performed. Analyses of capillary technique to aspiration technique, needle size and length differences, and their interactions were performed with ordinal logistic regression models which included effects related to the autopsy. Subgroup analyses of differences between the two techniques were also performed with these ordinal logistic regression models. The p values were adjusted using the Bonferroni procedure to account for multiple comparisons.

Results

There is marked uniformity in the results of the aspiration biopsies, both by individual criteria and the overall mean score (Table 2). In other words, there is little variation in the mean aspiration scores for each of the criteria between needles of different gauges and lengths. In contrast, there is considerable variability in these results for the capillary technique, with decreasing scores for the amount of recovered cellular material, retention of appropriate architecture, and mean combined score for both organs, with increasing needle gauge and length ($p < 0.01$). However, for the amount of background blood or clot, the degree of cellular degeneration, and the degree of cellular trauma, the capillary and aspiration techniques provided identical results regardless of needle

Table 2. Mean scores according to grading system [1]

	Overall		Needle size						Needle length							
	Asp	Cap	20		22		23		5 cm		10 cm		15 cm		20 cm	
			Asp	Cap	Asp	Cap	Asp	Cap	Asp	Cap	Asp	Cap	Asp	Cap	Asp	Cap
n	237	238	79	80	78	80	80	60	60	60	58	60	60	58	59	60
Background blood or clot	1.57 (0.65)	1.71 (0.49)	1.68 (0.59)	1.71 (0.49)	1.55 (0.66)	1.68 (0.50)	1.50 (0.69)	1.72 (0.48)	1.53 (0.68)	1.75 (0.44)	1.55 (0.68)	1.80 (0.40)	1.58 (0.65)	1.61 (0.58)	1.63 (0.61)	1.64 (0.52)
Amount of cellular material	1.81[b] (0.42)	0.99[b] (0.73)	1.78 (0.47)	1.31 (0.67)	1.82[b] (0.39)	0.87[b] (0.76)	1.84[b] (0.40)	0.79[b] (0.65)	1.70 (0.50)	1.12 (0.69)	1.78[a] (0.50)	1.02[a] (0.75)	1.88[b] (0.32)	0.76[b] (0.66)	1.90[b] (0.30)	1.07[b] (0.78)
Degree of cellular degeneration	1.80 (0.40)	1.73 (0.44)	1.75 (0.43)	1.70 (0.46)	1.82 (0.39)	1.72 (0.45)	1.84 (0.37)	1.78 (0.42)	1.82 (0.39)	1.76 (0.43)	1.86 (0.35)	1.71 (0.46)	1.80 (0.40)	1.73 (0.45)	1.75 (0.44)	1.74 (0.45)
Degree of cellular trauma	1.89[b] (0.32)	1.7[b] (0.43)	1.88 (0.34)	1.78 (0.42)	1.87 (0.34)	1.70 (0.46)	1.91 (0.28)	1.78 (0.42)	1.95[a] (0.22)	1.76[a] (0.43)	1.86 (0.35)	1.75 (0.44)	1.87 (0.34)	1.70 (0.46)	1.86 (0.35)	1.81 (0.39)
Retention of appropriate architecture	1.82[b] (0.48)	0.78[b] (0.85)	1.81 (0.46)	1.08 (0.81)	1.81[b] (0.49)	0.71[b] (0.82)	1.84[b] (0.49)	0.54[b] (0.83)	1.72 (0.56)	1.02 (0.85)	1.75[b] (0.61)	0.69[b] (0.85)	1.90[b] (0.35)	0.60[b] (0.75)	1.90[b] (0.30)	0.78[b] (0.88)
Total score	8.84[b] (1.42)	6.12[b] (2.97)	8.71 (1.80)	7.04 (2.66)	8.87 (1.19)	5.49 (3.19)	8.93 (1.18)	5.83 (2.85)	8.72 (1.34)	6.97 (2.46)	8.55 (2.04)	6.08 (3.00)	9.03 (1.07)	5.05 (3.17)	9.03 (0.95)	6.35 (2.96)

Asp = aspiration; Cap = capillary; n = number; () = standard deviation

[a] Statistically significant difference between aspiration and capillary biopsy ($p < .05$)

[b] Statistically significant difference between aspiration and capillary biopsy ($p < .01$)

CYTOPATHOLOGICAL EVALUATION

Specimen # _____
Slides: _____
ORGAN BIOPSIED: _____

SPECIMEN GRADING[1]

Criterion	Quantitative Description	Point Score	
A. Background blood or clot	Large amount; great compromise to diagnosis	0	
	Moderate amount; diagnosis possible	1	____
	Minimal; diagnosis easy; specimen of "textbook" quality	2	
B. Amount of cellular material	Minimal to absent; diagnosis not possible	0	
	Sufficient for cytodiagnosis	1	____
	Abundant; diagnosis simple	2	
C. Degree of cellular degeneration	Marked; diagnosis impossible	0	
	Moderate; diagnosis possible	1	____
	Minimal; good preservation; diagnosis easy	2	
D. Degree of cellular trauma	Marked; diagnosis not possible	0	
	Moderate; diagnosis possible	1	____
	Minimal; diagnosis obvious	2	
E. Retention of appropriate architecture	Minimal to absent; nondiagnostic	0	
	Moderate; some preservation of, e.g., follicles, papillae, acini, flat sheets, syncytia or single cell patterns	1	____
	Excellent architectural display closely reflecting histology; diagnosis obvious	2	
		TOTAL SCORE:	____

Fig. 1. The cytopathological grading form.

size and length for both the combined data and individual results of the liver and kidney.

With equivalent needle sizes and lengths, there are significant differences between the capillary and the aspiration technique ($p < 0.05$ or $p < 0.01$) for three of the five grading criteria (amount of cellular material obtained, degree of cellular trauma, and retention of appropriate architecture) as well as for the overall mean score (Table 2). For the other two criteria plus the overall score, there is an obvious advantage to the aspiration technique. These differences are most apparent in the amount of cellular material obtained and retention of the appropriate architecture, both of which show a regressive trend for the capillary technique with increasing needle gauge and length in contrast to the aspiration technique which performed uniformly well across all needle sizes and lengths.

Discussion

The rapid rise over the past 2 decades of radiographically guided FNAB for tumor diagnosis has paralleled the dynamic development of ultrasound, CT, and new biopsy techniques. Small diameter, ''skinny'' needles are most often employed, with the specimen smeared on glass slides, fixed, and stained for cytopathologic analysis.

Many investigators, or indeed practicing physicians, have discovered a wide diversity of results with the FNAB [8–11]. There is operator variation in biopsy depth, number of biopsies per site, number of strokes for each biopsy, needle selection (both size and type), and the amount of applied suction. These differences among physicians partly account for the wide range of accuracy found with the FNAB. In the breast, for instance, the reported accuracy of FNAB ranges from 50% to greater than 95% [9].

Several recent reports [1–7] have extolled the quality of specimens obtained with no suction at all. Called cytopuncture [4], fine-needle sampling without aspiration [3], nonaspiration fine-needle cytology [2], and fine-needle capillary [1], this technique relies on the capillary suction within a small needle to obtain a spec-

imen. These authors [1–7] have found that although aspiration increases specimen weight, suction can damage cells and cause excess blood contamination of the specimen. The fine-needle capillary biopsy (FNCB) is also easier to learn and perform than the conventional aspiration biopsy.

Most of the reported studies of the FNCB, however, have used short 1.5–3.0'', 23–25 gauge needles for the biopsy of palpable lesions such as in the breast, thyroid, salivary gland, lymph nodes, and periorbital tumors [1, 3–7]. In addition, only the study by Mair et al. [1] used an objective grading scheme for specimen evaluation. However, for the larger-sized and longer needles generally employed in radiology, Krebs et al. [12] found a greater true-positive biopsy in the pancreas with aspiration vs the capillary technique.

Imaging-directed fine-needle biopsy of primary and secondary tumor foci has become a mainstay in oncologic diagnosis and staging. However, fine-needle aspiration biopsy is a complex procedure requiring extensive training and experience to perform well. One critical advantage of the capillary technique is that it is simple to learn and easy to perform with a much higher level of consistency than is possible with the fine-needle aspiration biopsy. However, because a well-designed blinded study using established predetermined grading criteria has not been previously performed with needles commonly used in radiology for percutaneous biopsy (20–23 gauge, 5–20 cm length), questions remain concerning the capillary technique as a viable alternative to aspiration for radiographically guided biopsies.

The results of this study show that the capillary technique tends to obtain less background blood or clot which could obscure diagnostic tissue. Our study, however, was performed using nonperfused organs outside the body, and this difference (mean capillary 1.71, aspiration 1.57) was not statistically significant. For the amount of cellular material obtained and retention of appropriate architecture, the capillary technique performed increasingly worse than aspiration with increasing needle gauge and length.

In conclusion, the capillary technique obtains fine-needle specimens for cytopathologic analysis which are contaminated with less blood and background clot than those from aspiration biopsies. However, the capillary biopsy technique performs statistically worse than the aspiration technique for three of the grading criteria and with the overall performance score in both the liver and kidney, and with the combined data. When the capillary technique is to be performed, preference should be given to larger caliber, shorter needles.

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