A Comprehensive Comparative Analysis of Tissue Sample Volumes and Quality Between Side Notch and Full Core Biopsy Devices

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Abstract

Biopsy techniques play a pivotal role in diagnosing and treating diseases. The significance of acquiring sufficient, high-quality tissue samples for accurate diagnosis and prognosis is irrefutable. This comprehensive study investigates the differences in tissue sample volumes procured from side notch biopsy devices and full core biopsy devices, specifically the BioPince Ultra™, quantifying these discrepancies. It also expounds on the implications of these findings in view of current and anticipated future diagnostic trends.

Introduction

Diagnostic accuracy is contingent upon the quality and quantity of tissue samples acquired during a biopsy. As technology and medicine evolve, a better understanding of disease processes, especially cancer, emphasizes the importance of acquiring larger and higher-quality samples. The current study quantifies the differences in sample volume and quality obtained from two commonly employed biopsy techniques: side notch biopsy and full core biopsy using devices such as the BioPince Ultra™. The objective is to guide clinicians in selecting the most suitable method based on their specific requirements.

Methods

The process of approximating specimen volumes involved a formula-based calculation that considered the needle gauge, length, and unique physical attributes of the devices. These formulas were confirmed in analysis of biopsy specimens obtained in a controlled lab setting utilizing bovine liver and kidney. For side notch devices, we factored in a 20% volume reduction, assuming potential tissue deformations such as crush artifacts and flattening, common occurrences during biopsies at the posterior portion of the specimen trough as demonstrated under microscopy specimen evaluation.

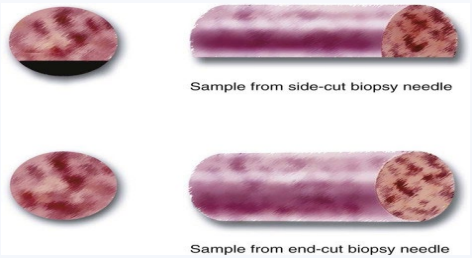

Fig. 1 Full Core vs. Side Notch

Results

Our calculations yielded volumes for each type of biopsy device as follows:

Full Core Biopsy Specimen Volumes:

Gauge (G)	Diameter (mm)	Radius (mm)	Length (mm)	Volume (mm^3)
16	1.29	0.645	13	$\pi * (0.645)^2 * 13 \approx 17.16$
16	1.29	0.645	23	$\pi * (0.645)^2 * 23 \approx 30.01$
16	1.29	0.645	33	$\pi * (0.645)^2 * 33 \approx 42.86$
18	1.02	0.51	13	$\pi * (0.51)^2 * 13 \approx 10.79$
18	1.02	0.51	23	$\pi * (0.51)^2 * 23 \approx 19.28$
18	1.02	0.51	33	$\pi * (0.51)^2 * 33 \approx 27.77$

Side-notch Biopsy Specimen Volumes After 20% Reduction:

Gauge (G)	Diameter (mm)	Radius (mm)	Length (mm)	Volume (mm^3)	Volume after 20% decrease (mm^3)
14	1.60	0.80	1	$\pi * (0.80)^2 * 1 \approx 2.01$	$2.01 * 0.8 \approx 1.61$
14	1.60	0.80	2	$\pi * (0.80)^2 * 2 \approx 4.02$	$4.02 * 0.8 \approx 3.22$
16	1.29	0.645	1	$\pi * (0.645)^2 * 1 \approx 1.31$	$1.31 * 0.8 \approx 1.05$
16	1.29	0.645	2	$\pi * (0.645)^2 * 2 \approx 2.62$	$2.62 * 0.8 \approx 2.10$
18	1.02	0.51	1	$\pi * (0.51)^2 * 1 \approx 0.82$	$0.82 * 0.8 \approx 0.66$
18	1.02	0.51	2	$\pi * (0.51)^2 * 2 \approx 1.64$	$1.64 * 0.8 \approx 1.31$

Gauge (G)	Diameter (mm)	Radius (mm)	Length (mm)	Volume (mm^3)	Volume after 20% decrease (mm^3)
20	0.91	0.455	1	$\pi * (0.455)^2 * 1 \approx 0.65$	$0.65 * 0.8 \approx 0.52$
20	0.91	0.455	2	$\pi * (0.455)^2 * 2 \approx 1.31$	$1.31 * 0.8 \approx 1.05$

Discussion

With the advent of molecular diagnostics and the increasing focus on personalized medicine, the role of biopsy has evolved far beyond simple histological diagnosis. Today, tissue samples obtained from biopsies are often used for comprehensive molecular and genetic analyses, which play a crucial role in diagnostic, prognostic, and therapeutic decision-making. One such advanced technique is next-generation sequencing (NGS). NGS is a high-throughput methodology that enables the sequencing of large portions of the genome in a single run, providing detailed insights into the genetic alterations in cancer cells. NGS has been successfully applied in identifying actionable mutations, detecting minimal residual disease, predicting prognosis, and .monitoring disease progression in various types of cancers (Mosele et al., 2020). However, NGS requires an ample amount of high-quality DNA, which is directly. However, NGS requires an ample amount of high-quality DNA, which is directly dependent on the volume and quality of the tissue sample obtained. Larger samples, such as those obtained from full core biopsy devices, are more likely to meet this requirement. Proteomics, the large-scale study of proteins, has also emerged as a powerful tool in cancer research. Proteomic profiling can provide insights into the functional dynamics of cancer cells and their microenvironment, facilitating the identification of novel biomarkers and therapeutic targets (Zhang et al., 2014). Like NGS, proteomic analyses require larger tissue samples to ensure a comprehensive protein extraction and identification. Furthermore, techniques like gene expression profiling and whole-exome sequencing have revolutionized our understanding of tumor biology. These techniques provide information about the expression level of genes and identify all the changes in the coding regions of the genome, respectively. This information can be leveraged to classify patients into different risk groups, predict response to treatment, and identify potential targets for therapy. Yet again, the successful application of these techniques is contingent on the availability of sufficient, high-quality tissue samples. Apart from these, there are several other high-throughput techniques, such as metabolomics, transcriptomics, epigenetic analysis, and single-cell sequencing, which have opened up new avenues in cancer research and treatment. These techniques require larger and higher-quality biopsy samples for accurate and meaningful interpretation of results. In light of the above, larger tissue samples, as obtained from full core biopsy devices like the BioPince Ultra™, hold significant potential in maximizing the benefits of these advanced molecular techniques. As personalized medicine continues to gain prominence, larger, high-quality biopsy samples will increasingly be needed to facilitate individualized diagnostic and therapeutic strategies.

References

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