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The diagnostic value of frozen sections in intraoperative pathology.

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Introduction

Frozen section analysis is a critical tool in intraoperative pathology, enabling rapid histological evaluation during surgical procedures. This technique involves freezing tissue samples, slicing them thinly, staining them, and examining them under a microscope, typically within 20–30 minutes. Its diagnostic value lies in its ability to provide real-time information to surgeons, guiding immediate clinical decisions. Frozen sections are widely used in oncologic surgeries, transplant procedures, and other complex interventions to assess tumor margins, identify metastases, confirm tissue identity, and diagnose unexpected findings. [1].

One of the primary applications of frozen sections is in determining surgical margins in cancer surgeries. For instance, in breast-conserving surgery or prostatectomies, frozen sections help assess whether tumor cells extend to the resection margins. A study by Tsuboi et al. (2016) reported that frozen section analysis in breast cancer surgery achieved a sensitivity of 83% and specificity of 97% for detecting positive margins, allowing surgeons to perform additional resections during the same procedure, thus reducing the need for reoperation. Similarly, in head and neck cancers, frozen sections ensure complete tumor excision while preserving critical structures, improving both oncologic and functional outcomes [2].

Frozen sections also play a vital role in identifying metastatic disease intraoperatively. In procedures like sentinel lymph node biopsies for breast cancer or melanoma, pathologists use frozen sections to detect metastases, influencing decisions about lymphadenectomy. The accuracy of frozen sections in this context is high, with studies reporting concordance rates of 90–95% with permanent paraffin sections. However, limitations such as sampling errors or freezing artifacts can lead to false negatives, particularly in micrometastases, necessitating correlation with final histopathology. [3]

Beyond oncology, frozen sections are invaluable in transplant surgeries. In liver or kidney transplantation, they help evaluate donor organ suitability by assessing steatosis, fibrosis, or inflammation. For example, rapid assessment of liver grafts can identify severe steatosis, prompting surgeons to reconsider organ use. Frozen sections also aid in diagnosing unexpected intraoperative findings, such as distinguishing between benign and
malignant lesions in exploratory surgeries, ensuring appropriate surgical management [4].

Despite its advantages, frozen section analysis has limitations. The rapid freezing process can distort tissue morphology, potentially affecting diagnostic accuracy. Certain tissues, like fatty or necrotic samples, are challenging to section and interpret. Additionally, the technique relies heavily on the pathologist's expertise and the quality of communication with the surgical team. False positives or negatives, though rare (approximately 2–5% in most studies), can impact surgical

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decisions, highlighting the need for experienced pathologists and standardized protocols. [5].

Conclusion

The diagnostic value of frozen sections is enhanced by technological advancements, such as intraoperative molecular diagnostics and improved staining techniques, which increase accuracy and speed. However, challenges like resource availability in smaller centers and the time-sensitive nature of intraoperative consultation persist. In conclusion, frozen section analysis remains an indispensable tool in intraoperative pathology, offering high diagnostic accuracy and guiding critical surgical decisions. Its integration with emerging technologies promises to further refine its utility, ensuring optimal patient outcomes in complex surgical scenarios.

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