Section: Pathology

Original Research Article

PREVALENCE AND IMPACT OF PROCEDURAL ARTIFACTS ON HISTOPATHOLOGICAL DIAGNOSIS IN A TERTIARY CARE CENTER

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ABSTRACT

Background: Histopathological examination is crucial for definitive diagnosis, but artifacts—artificial structures or tissue alterations—can lead to misinterpretations and diagnostic pitfalls. These artifacts can arise at multiple stages, including pre-fixation (e.g., surgical handling, injection, crush, fulguration), fixation, tissue processing, sectioning, and staining. Recognizing and mitigating these artifacts is a significant challenge in pathology laboratories. **Aim:** This study aims to prospectively identify the prevalence and types of artifacts occurring throughout the histopathological process, evaluate their impact on diagnostic accuracy, and assess the effectiveness of targeted remedial measures.

Materials and Methods: A prospective observational study involving a consecutive series of tissue biopsies received at the histopathology department over a defined period. Each specimen will be tracked through all stages from grossing to final slide preparation. Artifacts will be systematically documented and classified. A blinded review by experienced pathologists will assess diagnostic impact. Remedial interventions will be implemented and their effect on artifact reduction monitored.

Expected Results: We expect to identify the most prevalent types of artifacts, correlate them with specific procedural steps, and quantify their diagnostic significance. Furthermore, the study aims to demonstrate that targeted interventions can significantly reduce artifact occurrence, thereby improving diagnostic accuracy and patient care.

Conclusion: Understanding the etiology and impact of artifacts is crucial for maintaining diagnostic quality. This study will provide actionable insights for quality improvement in histopathology laboratories.

Keywords: Artifacts, Histopathology, Biopsy.

INTRODUCTION

Importance of Histopathology: Histopathology remains the gold standard for diagnosing various lesions and diseases. Accurate diagnosis depends on well-prepared microscopic sections that truly represent the tissue's cellular components.

Definition of Artifacts: An "artifact" is an artificial structure or tissue alteration on a prepared microscopic slide resulting from extraneous factors, not normally present in living tissue. They are introduced by standard procedures of fixation, processing, and staining.[1,4]

Consequences of Artifacts: The presence of artifacts can lead to misinterpretations, diagnostic dilemmas, and potentially incorrect or inconclusive interpretations, increasing patient morbidity. Some artifacts are easily distinguishable, while others are difficult to differentiate from actual tissue components, compromising accurate diagnosis. In severe cases, artifacts can render a specimen

suboptimal or even useless for diagnostic purposes.[2]

Causes of Artifacts: Artifacts can occur before fixation (e.g., injection, forceps/crush, fulguration, contamination by foreign materials like sutures or hair, cellulose contamination), during fixation (e.g., inadequate fixation, improper fixation medium, delayed fixation, drying), during tissue processing (e.g., improper dehydration, clearing, infiltration), during microtomy/sectioning (e.g., folding, chatter, knife lines, holes), and during staining/mounting (e.g., uneven staining, precipitate, air bubbles, excess mountant).[3]

Knowledge Gap/Rationale for the Study: While many review articles discuss artifacts and their remedies, there is a continuous need for prospective studies that systematically assess their prevalence, correlate them with specific procedural errors within a contemporary laboratory setting, and evaluate the effectiveness of real-time interventions.

Study Objectives:

- To prospectively identify and classify the types and prevalence of artifacts in routine histopathological specimens.
- To correlate specific artifacts with the procedural stages (pre-fixation, fixation, processing, sectioning, staining) where they originate.
- To assess the diagnostic impact of common artifacts as perceived by reporting pathologists.
- To implement and evaluate the efficacy of targeted remedial measures in reducing artifact occurrence and improving slide quality.

MATERIALS AND METHODS

- **Study Design:** This will be a single-center, prospective observational study conducted over a 12-month period.
- **Study Setting:** Department of Histopathology, [Name of Tertiary Care Hospital], [City, Country].
- **Study Population:** All consecutive surgical biopsies and resection specimens received in the histopathology laboratory during the study period.
- **Exclusion Criteria:** Cytology specimens, frozen sections, and specimens received from external laboratories for review.
- **Data Collection Protocol:**
  - **Specimen Tracking:** Each specimen will be assigned a unique identifier and tracked through all stages:
    - **Grossing/Pre-fixation:** Documentation of any observed pre-fixation artifacts (e.g., crush marks, cautery effects, foreign bodies) upon receipt or during gross examination. This will involve collaboration with surgeons and collection personnel to identify potential pre-analytical issues.
    - **Fixation:** Recording fixation time, fixative type (e.g., 10% neutral buffered formalin), and volume-to-tissue ratio.
    - **Tissue Processing:** Monitoring steps like dehydration (e.g., graduated isopropyl alcohol), clearing (e.g., xylene), and paraffin infiltration. Any deviations or issues during automated or manual processing will be noted.
    - **Embedding:** Documentation of orientation issues or air bubbles during embedding.
    - **Microtomy/Sectioning:** Direct observation and recording of sectioning artifacts (e.g., folds, tears, knife lines, compression, chatter, holes, skipped sections, thick/thin sections) by the histotechnologists. An experimental study by Mane et al. correlated sectioning artifacts to errors like immersion in spirit/saline for prolonged times or improper dehydration.
    - **Staining:** Assessment of staining quality immediately after H&E staining, noting issues like uneven staining, excessive basophilia (e.g., due to high pH formalin or prolonged saline immersion), or stain precipitates.
    - **Mounting:** Checking for air bubbles or excess mountant.
  - **Artifact Assessment:**
    - A standardized checklist based on common artifacts (e.g., injection, crush, folding, knife marks, foreign bodies, uneven staining, air bubbles) derived from the reviewed literature will be used.
    - For each artifact identified, the suspected procedural stage and specific cause will be recorded.
  - **Diagnostic Impact Assessment:**
    - Slides will be reviewed by two independent, experienced histopathologists blinded to the artifact documentation.
    - Pathologists will rate the diagnostic impact of any observed artifacts on a scale (e.g., 0 = no impact, 1 = minor difficulty, 2 = moderate difficulty requiring careful interpretation, 3 = significant difficulty compromising diagnosis, 4 = undiagnosable).
    - Any cases with a rating of 2 or higher will be further discussed to reach a consensus on the specific diagnostic challenge posed by the artifact.
- **Interventional Phase (if applicable, depending on study design evolution):** Based on the initial phase's findings regarding prevalent artifacts, targeted interventions (e.g., retraining of staff, recalibration of equipment, adjustment of reagent concentrations, strict adherence to protocols for gentle tissue handling and timely fixation) will be implemented. The subsequent artifact rates will be monitored to assess intervention effectiveness.[5]
- **Ethical Considerations:** The study will obtain approval from the Institutional Ethics

Committee. Patient confidentiality will be maintained by using anonymized data. As no direct patient intervention is involved, informed consent may be waived for retrospective data collection/prospective observation, but local guidelines will be followed.

- **Data Analysis**

- Descriptive statistics (frequencies, percentages) will be used to report the prevalence of different artifact types.
- Inferential statistics (e.g., chi-square tests, t-tests) will be used to determine associations between artifact types and their procedural origins, and to compare artifact rates before and after interventions.
- Correlation analysis will be performed between artifact severity and diagnostic impact scores.
- All statistical analyses will be performed using appropriate software (e.g., SPSS, R).

RESULTS AND DISCUSSION

- This section would detail the anticipated findings based on common artifacts. For example:

- Pre-fixation artifacts like crush artifacts and electrocautery-induced changes are expected to be prevalent, impacting cellular morphology and nuclear details. Remedies include using atraumatic forceps and avoiding electrocautery for biopsy.
- Fixation artifacts, particularly those due to delayed or improper fixation, may lead to autolysis and poor cellular preservation. Proper fixation is a basic requirement for diagnosis.
- Tissue processing artifacts, such as those related to dehydration and clearing, could result in brittle tissues or altered staining characteristics. An experimental study showed that improper dehydration (e.g., using 100% IPA without graduation) or prolonged xylene clearing can lead to loss of connective tissue architecture or poorly distinct epithelial cell boundaries.
- Sectioning artifacts like folding are reported to be highly prevalent, causing misinterpretation.
- The study would discuss how understanding these patterns helps differentiate true pathological changes from processing errors.
- The discussion would highlight the importance of continuous quality assurance programs in histopathology laboratories to minimize artifact occurrence.

CONCLUSION

The findings of this prospective study would reinforce the critical role of meticulous technique at every stage of histopathological preparation in ensuring diagnostic accuracy. By identifying the root causes of artifacts and implementing targeted remedies, laboratories can significantly improve the quality of microscopic sections, ultimately benefiting patient diagnosis and care.

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