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FROM MANUAL TRIMMING TO STANDARDIZED BLOCK PREPARATION: EVALUATION OF A NOVEL WAX-TRIMMING DEVICE IN HISTOPATHOLOGY

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ABSTRACT

Background: Preparation of high-quality paraffin sections depends on a well-formed block face before microtomy. Conventional manual trimming removes excess paraffin but is operator dependent and may produce uneven block margins, repeated trimming, prolonged handling and delay in routine laboratory workflow.

Objective: To design and evaluate an innovative manual wax trimmer for paraffin-embedded tissue blocks and compare its performance with conventional manual trimming.

Materials and methods: This prospective comparative experimental study included 60 formalin-fixed paraffin-embedded (FFPE) tissue blocks from large surgically resected specimens. Thirty blocks were trimmed by the conventional manual method and 30 by the innovative wax trimmer. Parameters assessed included trimming attempts, trimming time, uniformity of wax removal, block-face quality, ease of use, tissue loss, block damage, re-trimming requirement and microtomy suitability.

Results: The innovative trimmer reduced mean trimming time from 56.33 +/- 8.29 seconds to 37.33 +/- 7.04 seconds and completed trimming in a single attempt in all cases. Uniformity and block-face quality improved from fair in the manual group to good in the device group. Microtomy suitability was excellent in 29/30 (96.7%) blocks trimmed using the device, whereas all manually trimmed blocks were satisfactory. No tissue loss or block damage was observed.

Conclusion: The innovative wax trimmer is a simple, reproducible and user-friendly device that standardizes wax removal, reduces time and improves block preparation before microtomy.

KEYWORDS: paraffin block; wax trimming; microtomy; histotechnology; FFPE tissue; block-face preparation.

INTRODUCTION

Histopathology remains a cornerstone of diagnosis, prognosis and treatment planning. The FFPE tissue block is widely used because it provides structural support for thin sectioning, enables routine haematoxylin and eosin staining, permits ancillary tests and allows long-term archival storage. The diagnostic value of the slide, however, is determined not only by fixation and processing but also by the quality of the paraffin block presented to the microtome. A poorly prepared block face can produce incomplete tissue exposure, poor ribbon formation, tissue chatter, folds and repeated recuts.

Wax trimming is the preparatory step in which excess paraffin surrounding the tissue is removed to create a flat and controlled block face. In many laboratories this is still performed using a scalpel, blade or repeated facing on the microtome. Although routine, the procedure is technically important because excessive trimming may waste tissue whereas inadequate trimming leads to irregular sectioning. Manual trimming also depends on the operator's skill, confidence and fatigue level. In high-volume laboratories, small delays at this stage can accumulate and influence turnaround time.

The ideal trimming method should remove excess wax uniformly, expose the tissue gradually, minimize handling, protect the cassette and block, and generate a surface that is immediately suitable for microtomy. A manual, non-electric device capable of guiding the block at a fixed level may provide a practical alternative to freehand trimming. The present study therefore evaluated an innovative wax trimmer designed to standardize wax removal from paraffin-embedded tissue blocks and to compare its performance with conventional manual trimming.

Aim and objectives

The aim was to design, develop and evaluate an innovative wax trimmer for paraffin-embedded tissue blocks in histopathology laboratories. The specific objectives were to study the conventional method, identify its practical limitations, fabricate a stable manual trimming device, assess device performance in routine block preparation and compare both methods using objective and semi-quantitative parameters including trimming time, uniformity, block-face quality, ease of use and microtomy suitability.

REVIEW OF LITERATURE

Routine histotechnology depends on a sequence of pre-analytical and analytical steps: fixation, dehydration, clearing, wax infiltration, embedding, block trimming, microtomy, flotation, staining and microscopic examination. Standard histotechnology texts emphasize that each step must preserve tissue architecture while also creating adequate mechanical support for thin sectioning [1-3]. Paraffin wax remains the dominant embedding medium because it is inexpensive, compatible with routine stains and allows serial sections to be prepared from archived tissue blocks [1,2].

Paraffin embedding is effective only when the tissue is adequately fixed, dehydrated and cleared before wax infiltration. Incomplete dehydration or clearing can produce soft areas, crumbling and poor ribbon formation. Similarly, inappropriate cooling or excessive peripheral wax may alter block handling. Therefore, block trimming should be considered part of the continuum of tissue processing rather than a minor finishing step [3,4].

Microtomy requires a block that is flat, stable and properly oriented. When the block face is irregular, the microtome blade contacts wax and tissue unevenly. This can cause chatter, folds, compression, tearing and repeated recuts. Microtomy manuals also state that block orientation, wax hardness, blade angle and trimming quality are important determinants of the final tissue ribbon [12-15].

Although automated and semi-automated systems are available in larger laboratories, many diagnostic centres continue to use freehand trimming with blades or scalpel-like instruments. This method is inexpensive but operator dependent. The amount of wax removed, the pressure applied, the depth of trimming and the shape of the block face may vary between operators. A simple guide-based manual device is therefore relevant because it can retain the affordability of manual trimming while improving standardization.

MATERIALS AND METHODS

This prospective comparative experimental study was conducted in the Department of Pathology, Saveetha Medical College and Hospital, Chennai, after Institutional Review Board approval. The study period extended from January 2024 to May 2025. A total of 60 FFPE tissue blocks were evaluated. Thirty blocks were trimmed by the conventional manual method and 30 blocks were trimmed using the innovative wax trimmer.

Inclusion criteria were FFPE tissue blocks from large surgically resected specimens, blocks containing sufficient tissue for trimming and sectioning, blocks with visible excess paraffin requiring trimming before routine microtomy and blocks intended for routine histopathology processing. Damaged or cracked blocks and poorly embedded or improperly oriented blocks were excluded to avoid confounding due to pre-existing technical defects.

The observations recorded for each block included the number of trimming attempts, trimming time in seconds, uniformity of wax removal, block-face quality, ease of use, tissue loss, block damage, re-trimming requirement and microtomy suitability. Categorical variables were compared using Chi-square testing where appropriate, and continuous variables were summarized as mean with standard deviation. A p value less than 0.05 was considered statistically significant.

Study workflow and grading approach

For the conventional method, each block was handled manually and excess paraffin was removed by freehand trimming before microtomy. For the innovative device method, the block was placed over the base plate, aligned against the guide blocks, stabilized, trimmed in a controlled plane and then inspected. The trimmed blocks were subsequently assessed for tissue exposure and readiness for microtomy.

Uniformity of wax removal and block-face quality were graded as poor, fair, good or excellent based on the evenness of the surface and adequacy of wax removal around the tissue. Ease of use was recorded from the operator perspective, considering hand control, physical effort and repeat handling. Microtomy suitability was categorized as satisfactory, good or excellent according to the block face obtained after trimming and its expected performance during sectioning.

Trimming time was measured in seconds for each block from the start of trimming to the point when the block was considered ready for microtomy. Tissue loss was recorded if visible tissue was unintentionally removed during trimming. Block damage was recorded if the paraffin block or cassette showed cracks, fragmentation or distortion after trimming. These parameters were selected because they reflect routine laboratory outcomes that directly affect workload and sectioning quality.

Table 1. Study design, selection criteria and assessed parameters

Domain	Details	Relevance to study
Study setting	Department of Pathology, Saveetha Medical College and Hospital, Chennai	Represents routine diagnostic laboratory workflow
Study period	January 2024 to May 2025	Prospective evaluation of device performance
Sample size	60 FFPE blocks: 30 manual trimming and 30 innovative trimmer	Allows direct comparison between both methods
Inclusion	Large surgically resected FFPE blocks with sufficient tissue and visible excess wax	Ensures trimming was genuinely required before microtomy
Exclusion	Cracked, damaged, poorly embedded or improperly oriented blocks	Avoids bias from defective pre-analytical blocks

Parameters	Attempts, time, uniformity, block-face quality, ease of use, tissue loss, block damage, re-trimming and microtomy suitability	Covers efficiency, safety and sectioning suitability

Device design and working principle

The innovative wax trimmer was conceptualized as a simple, non-electric, manually operated bench-top device. It consists of a stable base plate, paired vertical supports, a horizontal trimming bar, guide blocks/stops, side rods and fasteners. The base plate provides stability, while guide blocks position the paraffin block in a fixed orientation. The horizontal trimming bar allows controlled removal of excess paraffin with consistent depth and direction.

Fabrication involved conventional machining operations such as material preparation, cutting, drilling, milling, turning, welding, assembly and finishing. The intention was to obtain a structurally stable and dimensionally accurate prototype suitable for repeated use in a histopathology laboratory. The workflow begins with placement of the block on the base plate, alignment against guide blocks, stabilization, adjustment of the trimming bar, controlled forward and backward passes, inspection of wax uniformity and transfer of the prepared block to the microtome.

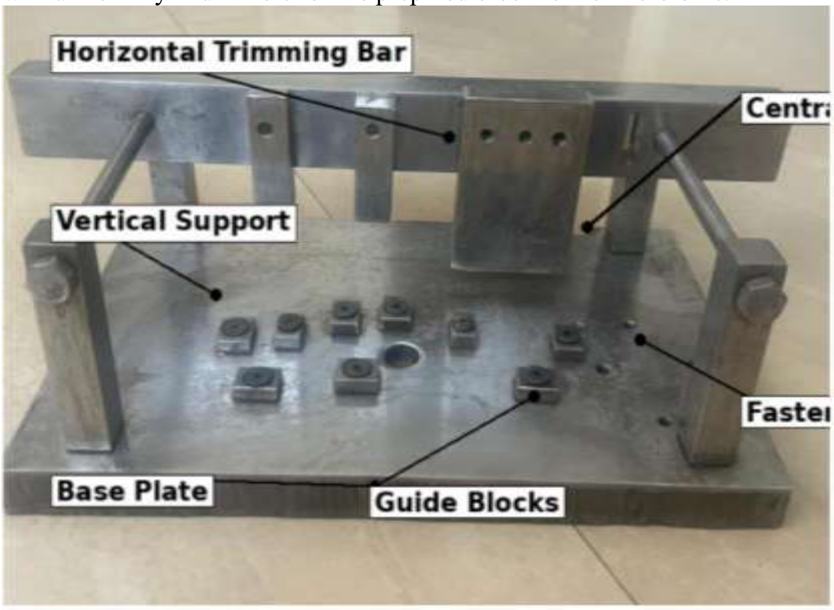


Figure 1. Innovative wax trimmer showing horizontal trimming bar, vertical supports, base plate and guide blocks.

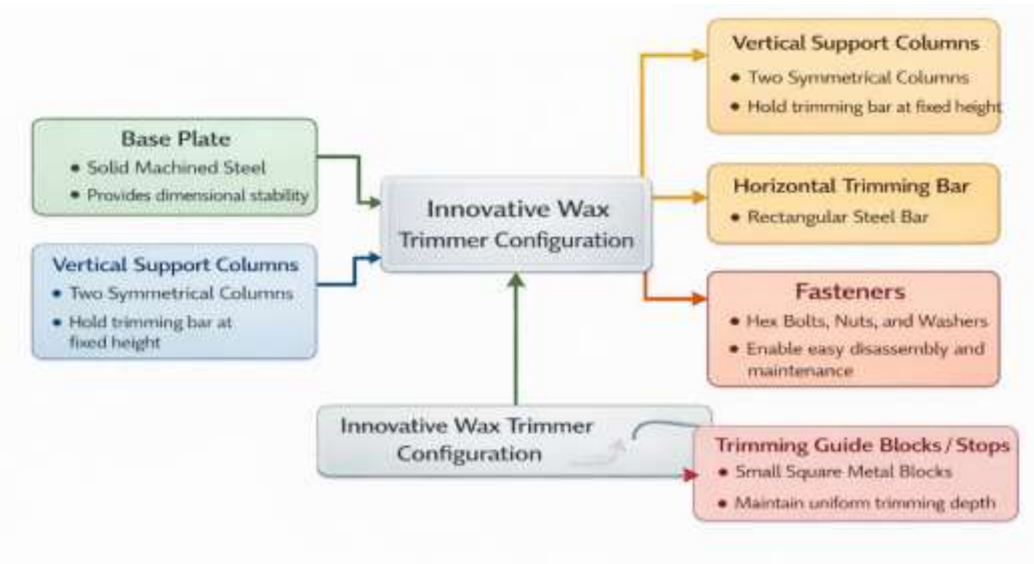


Figure 2. Configuration flow of the device components and their functional roles.

Operational considerations

The device was designed to address common problems encountered during freehand trimming. During manual trimming, the operator must control the block, blade direction, depth and angle simultaneously. Minor variation in any of these elements can produce an inclined or uneven block face. The guide blocks of the innovative trimmer reduce this variability by keeping the paraffin block in a defined position, while the horizontal bar provides a constant trimming plane.

The base plate is important because paraffin blocks can slip during trimming when the bench surface is smooth or contaminated with wax fragments. A stable base reduces hand movement and allows the technician to apply controlled

pressure. The support columns and fasteners maintain the height of the trimming bar, while the bolted construction allows the device to be dismantled or adjusted for cleaning and maintenance.
From a laboratory safety perspective, reduction of uncontrolled hand movements is useful. Manual trimming with blades can cause cuts, especially when wax is hard or when blocks require repeated trimming. Although the present study focused on block quality and workflow parameters, the improved stability of the device may also contribute to safer handling. Future studies can specifically measure operator comfort and safety outcomes.

Table 2. Component specifications of the innovative wax trimmer

Component	Specification	Functional purpose
Overall size	38-45 cm x 22-28 cm x 18-24 cm	Compact bench-top footprint
Base plate	1.0-1.5 cm thick machined steel plate	Provides support and stability during trimming
Support columns	2.5-3 cm square metal sections	Maintains fixed height and alignment
Horizontal trimming bar	30-36 cm long rectangular steel bar	Controls depth and plane of wax removal
Side rods	1.2-1.8 cm diameter cylindrical rods	Maintains structural alignment
Guide blocks/stops	2-3 cm square blocks	Positions block and improves uniformity

Figure 3. Prototype used with paraffin blocks during functional assessment.

Prototype testing and laboratory integration
The prototype was assessed as a routine bench-side support tool rather than as a complex automated instrument. This approach is important because many histopathology laboratories require equipment that is durable, inexpensive and easy to clean. The use of a manually operated device avoids dependence on electricity and minimizes downtime caused by electronic failure. The metal framework provides weight and stability, while the small working area allows the device to be positioned close to the embedding station or microtome.
In routine workflow, the device can be used immediately after embedding and cooling of the paraffin block. Blocks with excessive peripheral wax can be aligned and trimmed before they are mounted on the microtome. This may reduce the amount of facing required on the microtome and decrease accumulation of paraffin debris around the blade holder. A cleaner block face also helps the operator judge whether the tissue has been adequately exposed.
The guide blocks are particularly useful because they create a reproducible starting position. During freehand trimming, the technician often makes multiple small cuts at different edges of the block. The device permits a more organized approach in which the block is stabilized and wax is removed in a controlled direction. This explains the single-attempt trimming observed in the device group.
The trimmer is not intended to replace the skill of the histotechnologist. Instead, it functions as an aid that reduces variability in a repetitive manual task. The best results are expected when the block is properly embedded, completely cooled and placed correctly against the guide blocks. If a block is poorly oriented or inadequately infiltrated, trimming alone cannot correct the primary defect, but the device can still reduce additional handling-related errors.
Cleaning and maintenance are also relevant for routine adoption. Paraffin fragments can be removed from the base plate after each session, and the bolted construction allows access to guide components if more thorough cleaning is required. Because the design is mechanical and open, routine inspection for wax accumulation, loosened fasteners or misalignment can be performed by laboratory personnel.

RESULTS
A total of 60 paraffin-embedded tissue blocks were assessed. The innovative wax trimmer showed consistent improvement in all practical parameters. All manually trimmed blocks required a second attempt, whereas all device-trimmed blocks were completed in a single attempt. This indicates better control during the trimming step and a reduction in unnecessary handling of paraffin blocks.

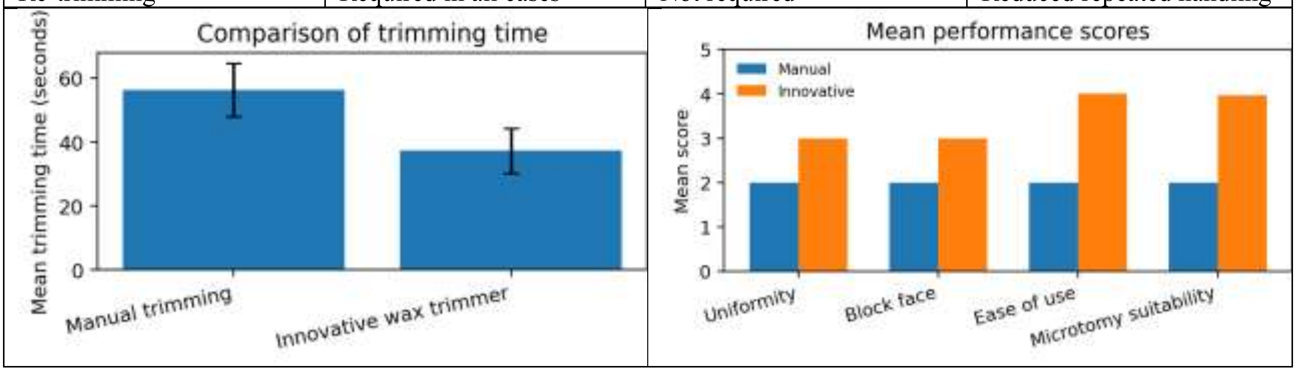
Uniformity of wax removal and block-face quality were fair in the manual group and good in the innovative trimmer group. Ease of use also improved: manual trimming was rated as difficult, while use of the device was rated as easy in all cases. No tissue loss or block damage was recorded in either group, showing that the improved performance of the device did not occur at the expense of tissue integrity.
The mean trimming time decreased from 56.33 +/- 8.29 seconds with conventional manual trimming to 37.33 +/- 7.04 seconds with the innovative wax trimmer. This saving of approximately 19 seconds per block is important in high-volume laboratories, where repeated small reductions in time can improve total daily workflow. Re-trimming was completely eliminated in the innovative trimmer group.

Table 3. Microtomy suitability after trimming

Microtomy suitability	Manual trimming n (%)	Innovative wax trimmer n (%)	Total
Satisfactory	30 (100.0)	0 (0.0)	30
Good	0 (0.0)	1 (3.3)	1
Excellent	0 (0.0)	29 (96.7)	29
Total	30 (100.0)	30 (100.0)	60

Table 4. Overall comparative analysis of trimming parameters

Parameter	Manual trimming	Innovative trimmer	Interpretation
Trimming time	56.33 +/- 8.29 sec	37.33 +/- 7.04 sec	Faster by about 19 seconds/block
Uniformity score	2.00	3.00	Improved uniform wax removal
Block-face score	2.00	3.00	Smoother and more even block face
Ease-of-use score	2.00	4.00	Less operator dependent
Microtomy suitability score	2.00	3.97 +/- 0.18	Marked improvement for sectioning
Re-trimming	Required in all cases	Not required	Reduced repeated handling



Figures 4 and 5. Graphical comparison of trimming time and mean performance scores.

Interpretation of numerical findings
The categorical results showed a clear separation between both techniques. In the manual group, all 30 cases were graded satisfactory for microtomy suitability. In the innovative trimmer group, none were merely satisfactory; one case was good and 29 were excellent. This distribution indicates that the device improved the functional readiness of the block for microtomy rather than producing only a small marginal benefit.
The group statistics also showed improvement in all mean scores. Uniformity improved from 2.00 to 3.00, block-face quality from 2.00 to 3.00, ease of use from 2.00 to 4.00 and microtomy suitability from 2.00 to 3.97. These values support the practical observation that the trimming plane was more consistent with the device. The device did not merely shorten time; it improved the quality of the prepared block face.
The absence of tissue loss and block damage in both groups is important. It shows that manual trimming can be safe when performed carefully, but the innovative trimmer adds standardization and efficiency without introducing a new risk. In routine histopathology, any device used near tissue must protect diagnostic material. This was achieved in the present evaluation.

DISCUSSION
The present study demonstrates that a simple manual device can improve an important but often overlooked pre-microtomy step. Conventional manual trimming is familiar and inexpensive, but the free-hand nature of the technique makes it vulnerable to inconsistency. In this study, the manual method required repeat attempts in all cases, while the innovative wax trimmer achieved single-attempt trimming in all blocks. This difference reflects the effect of mechanical guidance on trimming depth and plane.

The improvement in uniformity and block-face quality is relevant because microtomy depends on a stable, regular surface. When wax is removed unevenly, the block may require additional facing on the microtome, which can waste time and may risk loss of small or superficial tissue. A smoother block face also supports better ribbon formation and may reduce artefacts such as chatter, folds and fragmented sections. Therefore, even though trimming is a preparatory step, its influence extends to final slide quality.
The reduction in trimming time is another practical advantage. A mean saving of approximately 19 seconds per block may appear modest in isolation, but it becomes meaningful when multiplied across daily histopathology workload. In high-volume laboratories, cumulative time savings can help technicians complete embedding-to-microtomy transitions more efficiently. The elimination of re-trimming also reduces repetitive hand movements and unnecessary manipulation of blocks.
Ease of use improved substantially with the device. Manual trimming requires confidence, experience and careful control of blade angle. In contrast, the guide blocks and horizontal trimming bar create a standardized path for wax removal. This may be useful for training junior technicians and for maintaining uniform output between operators. Importantly, no tissue loss or block damage occurred, suggesting that the device improved process control without compromising safety of tissue material.
The findings should be interpreted with certain limitations. The sample size was limited to 60 blocks and the study was performed in a single centre. The study focused on large surgically resected specimens with excess paraffin, and results may differ for very small biopsies, fragile tissues or blocks with unusual orientation. Further evaluation with larger sample sizes, different tissue categories, multiple operators and inter-observer scoring would strengthen validation. Cost analysis, durability testing, cleaning assessment and comparison with automated trimmers may also be useful in future studies.

Practical implications

The proposed device is especially relevant for laboratories where trimming is performed manually and where automated trimming systems are not routinely available. It is non-electric, simple to operate and can be placed near the embedding or microtomy area. The design also allows the technician to use familiar hand movements while benefiting from a stable guide and fixed trimming plane.
From a training perspective, the trimmer can reduce dependence on individual operator skill. Junior technicians may require time to develop freehand trimming confidence, while experienced technicians may still produce variable results when workload is heavy. A guide-based device can make the endpoint of trimming more reproducible and may reduce the number of recuts requested because of poor block-face preparation.
From a workflow perspective, a reduction of 19 seconds per block becomes meaningful when multiplied across dozens or hundreds of blocks processed per day. Time saved during trimming can be redirected to embedding, microtomy, staining preparation or quality checks. The cumulative benefit is likely to be higher in centres with high surgical pathology volume or limited technical staff.

Comparison with existing trimming practice

Freehand trimming remains common because it needs no special equipment and can be performed rapidly by an experienced technician. However, its apparent simplicity masks significant variation. A block may be over-trimmed at one edge and insufficiently trimmed at another. The technician may then need to remount the block, adjust the angle or perform additional facing on the microtome. These corrections are usually not recorded in routine practice, but they consume time and increase handling.
Automated systems can reduce operator effort, but they are expensive, require power supply and may not be practical for every laboratory. The innovative wax trimmer evaluated in this study occupies an intermediate position. It is manually operated and therefore affordable and easy to maintain, but it introduces a mechanical guide that standardizes the trimming plane. This balance may be useful for teaching institutions and mid-volume diagnostic laboratories.
The device may also improve communication between embedding and microtomy areas. When blocks are trimmed in a uniform way, the microtomy technician receives a predictable block face and can proceed with sectioning with fewer adjustments. This may reduce the subjective variation that occurs when each operator prepares blocks according to individual habit.

Diagnostic relevance of improved block-face preparation

The final microscopic interpretation depends on obtaining representative, artefact-free sections. Technical artefacts introduced during processing or sectioning can obscure epithelial details, margins, stromal reaction, inflammatory patterns or tumour architecture. In small or diagnostically critical tissues, unnecessary loss of tissue during repeated facing may reduce the available material for deeper sections, special stains or immunohistochemistry.
Better trimming does not replace proper fixation, processing or embedding, but it helps preserve the benefit of those earlier steps. A well-infiltrated and correctly oriented block still requires a suitable surface before thin sections can be cut. By improving the uniformity of wax removal, the device supports the transition from block preparation to microtomy and may indirectly reduce recuts and sectioning artefacts.
In the present study, the excellent microtomy suitability observed in 96.7% of the device-trimmed blocks suggests that the trimmer created a block face closer to the ideal sectioning plane. This finding is consistent with the observed improvements in uniformity, block-face quality and ease of use. The absence of tissue loss further supports the device as a conservative method for preparing blocks before microtomy.

Limitations and future scope

This study provides preliminary evidence but has limitations. It was conducted at a single centre with a sample size of 60 blocks. The blocks were selected from large surgically resected specimens with visible excess paraffin, and the results may not directly apply to tiny biopsies, fragile curettage material or extremely hard tissue blocks. The scoring system was practical and laboratory oriented, but further studies can include blinded assessment and inter-observer reproducibility. Future work may evaluate the device across different tissue types, wax formulations, cassette systems and operators with varying experience. Durability testing, cleaning protocols, safety assessment, cost-benefit analysis and comparison with commercially available automated trimmers can further define the role of this device in routine laboratory practice.

CONCLUSION

The innovative wax trimmer is an effective and user-friendly manual device for preparing paraffin-embedded tissue blocks before microtomy. Compared with conventional manual trimming, it reduced trimming time, eliminated re-trimming, improved uniformity of wax removal, produced better block-face quality and enhanced microtomy suitability. The device has the potential to standardize wax trimming and improve routine histopathology workflow, particularly in laboratories handling large numbers of paraffin blocks.

REFERENCES

1. Suvarna SK, Layton C, Bancroft JD. Bancroft's theory and practice of histological techniques. 8th ed. Elsevier; 2019.
2. Carson FL, Cappellano CH. Histotechnology: a self-instructional text. 4th ed. American Society for Clinical Pathology Press; 2015.
3. Kiernan JA. Histological and histochemical methods: theory and practice. 5th ed. Scion Publishing; 2015.
4. Slaoui M, Fiette L. Histopathology procedures: from tissue sampling to histopathological evaluation. Methods Mol Biol. 2011;691:69-82.
5. Fox CH, Johnson FB, Whiting J, Roller PP. Formaldehyde fixation. J Histochem Cytochem. 1985;33(8):845-853.
6. Zhang P, Lehmann BD, Shyr Y, Guo Y. The utilization of formalin-fixed paraffin-embedded specimens in high-throughput genomic studies. Int J Genomics. 2017;2017:1926304.
7. von Ahlfen S, Missel A, Bendrat K, Schlumpberger M. Determinants of RNA quality from formalin-fixed paraffin-embedded samples. PLoS One. 2007;2(12):e1261.
8. Masuda N, Ohnishi T, Kawamoto S, Monden M, Okubo K. Analysis of chemical modification of RNA from formalin-fixed samples and optimization of molecular biology applications. Nucleic Acids Res. 1999;27(22):4436-4443.
9. Ramos-Vara JA. Technical aspects of immunohistochemistry. Vet Pathol. 2005;42(4):405-426.
10. Shi SR, Liu C, Taylor CR. Standardization of immunohistochemistry for formalin-fixed paraffin-embedded tissue sections. Biotech Histochem. 2007;82(2):69-78.
11. Titford M. Progress in the development of microscopical techniques for diagnostic pathology. J Histotechnol. 2009;32(1):9-19.
12. Prophet EB, Mills B, Arrington JB, Sobin LH. Laboratory methods in histotechnology. Washington: Armed Forces Institute of Pathology; 1992.
13. Sy J, Ang LC. Microtomy: cutting paraffin-embedded sections. In: Histopathology Methods. Springer; 2018. p. 45-62.
14. Leica Biosystems. Microtomy and sectioning manual. Leica Microsystems; 2018.
15. Sakura Finetek. Tissue-Tek AutoSection system technical manual. Sakura Finetek; 2020.
16. Buesa RJ. Histology without xylene. Ann Diagn Pathol. 2009;13(4):246-256.
17. Dapson RW. Glyoxal fixation: how it works and why it only occasionally needs antigen retrieval. Biotech Histochem. 2007;82(3):161-166.
18. Rolls G. Microtomy and paraffin section preparation. Leica Biosystems Knowledge Pathway; 2018.
19. Bancroft JD, Gamble M. Theory and practice of histological techniques. 7th ed. Churchill Livingstone; 2013.
20. Cook HC. Origins of tinctorial methods in histology. J Clin Pathol. 1997;50(9):716-720.
21. Renshaw AA, Gould EW. Measuring errors in surgical pathology. Arch Pathol Lab Med. 2007;131(12):1817-1819.
22. Dapson RW. Macromolecular changes caused by formalin fixation and antigen retrieval. Biotech Histochem. 2007;82(3):133-140.
23. Musumeci G. Past, present and future: overview on histology and histopathology. J Histol Histopathol. 2014;1:5.
24. Sompuram SR, Vani K, Messana E, Bogen SA. A molecular mechanism of formalin fixation and antigen retrieval. Am J Clin Pathol. 2004;121(2):190-199.
25. Rolls G. Fixation and fixatives: roles and effects. Leica Biosystems Knowledge Pathway; 2019.
26. Dey P. Basic and advanced laboratory techniques in histopathology and cytology. Singapore: Springer; 2018.