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A multicentre study of the precision and accuracy of the TruSlice and TruSlice Digital histological dissection devices

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ABSTRACT

Background: Five key factors enabling a good surgical grossing technique include a flat uniformly perpendicular specimen cutting face, appropriate immobilisation of the tissue specimen during grossing, good visualisation of the cutting tissue face, sharp cutting knives and the grossing knife action. TruSlice and TruSlice Digital are new innovative tools based on a guillotine configuration. The TruSlice has plastic inserts whilst the TruSlice Digital has an electronic micrometre attached: both features enable these dissection factors to be controlled. The devices were assessed in five hospitals in the UK.

Material and Methods: A total of 267 fixed tissue samples from 23 tissue types were analysed, principally the breast (n = 32) skin (30), rectum (28), colon (27) and cervix (17). Precision and accuracy were evaluated by measuring the defined thickness, and the consistency of achieving the defined thickness of tissue samples taken respectively. Both parameters were expressed as a total percentage of compliance for the cohort of samples accessed.

Results: Overall, the mean (standard deviation) score for precision was 81 (11) % whilst the accuracy score was 82 (11) % (both $p < 0.05$, chi-squared test), although this varied with type of tissue. Accuracy and precision were strongly correlated ($r_p = 0.83$, $p < 0.001$).

Conclusion: The TruSlice Digital devices offer an assured precision and accuracy performance which is reproducible across an assortment of tissue types. The use of a micrometre to set tissue slice thickness is innovative and should comply with laboratory accreditation requirements, alleviating concerns of how to tackle issues such as the 'measurement of uncertainty' at the grossing bench.

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Introduction

Traditionally histological dissection has not always been seen as innovative in terms of applications of new devices to improve and enhance uniformity of process and procedures at the surgical grossing bench. [1] Histological dissection requirements across a wide spectrum of pathology providers are often quite diverse, encompassing mainstream as well as specialist dissection procedures. Similarly, conceptually developing any dissecting devices that will enable 100% precision and accuracy across the spectrum of human tissue samples is a complex task. When designing novel dissecting devices, the five key factors needed to ensure good surgical grossing technique are: flat uniformly perpendicular specimen cutting face, appropriate immobilisation of the tissue specimen during grossing, good visualisation of the cutting tissue face, sharp cutting knives and fit for purpose associated grossing equipment and finally the grossing knife action. Tissue processing devices currently available have satisfied some or all of these requirements in different ways.

The Xpress automated processor (Sakura Finetek, Torrance, USA) uses a grossing board with an indented well/slotted metal plate and a track to follow knife blade slicing. A development from this has been the introduction of a grossing board with numerous adjustable wells (the Accu-Edge) of differing depths in an attempt to improve on accuracy of tissue slicing thickness (Sakura Finetek, USA). More advanced equipment includes the ProCut device (Milestone, Sorisole, Italy), designed for dissecting whole tissue organs such as breast and prostate. A scaled down version of this is the CutMATE (Milestone) which relies on the use of innovative forceps with fork-like configurations with defined distances between the prongs of the forks (2, 3 and 4 mm). Following this, Milestone has developed their Biopsy Uniform Section

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device.[2] This apparatus focuses on factors such as tissue immobilisation, adequate tissue holding options and general visibility of tissue at the cutting edge.[3]

A further impetus to drive good accuracy and general good laboratory practice in the UK has been the introduction of UKAS ISO 15789 standards.[4] Similarly, there are increasing requirements in other international laboratory accreditation standards, which collectively suggest that there is a growing need to assure and enable precision and accuracy at the cut up bench within cellular pathology laboratories. Many of these accreditation bodies make clear statements regarding the measuring equipment used, promoting the development of improved devices.

In a previous publication, we have addressed shortcomings with existing histological dissection devices with the development of new dissecting devices TruSlice and TruSlice Digital.[5] Following these preliminary studies, which were performed in one centre on limited tissue types, we recognised the requirement to validate and test the original reported findings in a wider field setting to ensure that a broader spectrum of tissue types could be assessed in greater numbers. This we present in the current report.

Materials and methods

A multicentre study was established to determine the value of the TruSlice and TruSlice Digital devices across a full spectrum of histological tissue types. All five centres are large University Teaching Hospital cellular pathology laboratories dealing with a wide variety of tissue specimen types. The fifth is the largest dermatopathology laboratory within the UK, relevant because between 20–30% of most routine cellular pathology laboratory specimens are skin samples.

A total of 267 fixed tissue samples from 23 different types of tissue were analysed (Table 1). The precision and accuracy were evaluated by the consistency of achieving defined thickness of tissue samples taken and confirmed with a metric ruler. Thus, the translation of the number of cases showing compliance with the predefined thickness as a percentage for each tissue type was recorded as the precision reading. How consistently this thickness was achieved was recorded as a measurement of accuracy by performing 10 slices at the defined thickness and measuring how many of these complied with the defined thickness this was recorded as an accuracy reading. Both parameters were expressed as a total percentage of compliance for the total cohort of samples accessed.

The practitioners using the devices at all the five sites were trained to use both the TruSlice and TruSlice Digital (Figures (1)–(5)). The same devices were circulated from one institution to the other after each site had performed their assessments. These findings were recorded on a template log spreadsheet that also encompassed the user's individual comments regarding the ease of use and ergonomics of the two devices, which are mentioned in the discussion. Data were compared using the chi-squared test on Microsoft Excel, and t test and correlation on Minitab 17 (Coventry, UK).

Results

The precision and accuracy were evaluated by the consistency of achieving defined thickness of tissue samples taken (Table 1). Both parameters were expressed as a total percentage of the total cohort of samples accessed. Statistical analysis of all these data demonstrated that the mean score for precision was 81% ($p < 0.05$) with a standard deviation of 11% and the accuracy 82% ($p < 0.05$) with a standard deviation of 11%. Accuracy and precision were strongly correlated (Pearson correlation coefficient 0.83, $p < 0.001$). Across the spectrum of tissue types assessed at the test sites of skin, uterus, cervix and colon scored consistently high results for precision and accuracy with mean (standard deviation) scores of 96.2 (2.5)% and 92.0 (9.1)%, respectively. Variability in terms of precision and accuracy were seen with the softer, less dense tissue types; thus, ovary, gall bladder, lung and lymph node samples achieved scores of 68.0 (6.3)% for precision (*t* test $p = 0.004$ compared to skin/uterus/cervix and colon) and 68.7 (7.5)% for accuracy ($p = 0.011$ compared to skin/uterus/cervix and colon). Overall performance favoured the use of the TruSlice Digital device; however, for smaller samples, the TrueSlice device was found to be more beneficial and easier to use. The assessment of both devices suggest that the smaller device

Table 1. Summary of total number of tissue types evaluated with accuracy and reproducibility performance outcomes.

Tissue type	Number of specimens	Accuracy (%)	Reproducibility (%)	Tissue type	Number of specimens	Accuracy (%)	Reproducibility (%)
Skin	30	95	100	Spleen	2	85	75
Gall bladder	3	70	75	Liver	4	90	95
Lipoma	7	60	60	Decalcified bone	2	80	80
Uterus	25	100	80	Stomach	9	85	90
Kidney	13	80	90	Small bowel	2	70	75
Lung	5	60	60	Colon	27	95	90
Breast	32	70	75	Rectum	28	85	90
Cervix	17	95	98	Appendix	1	85	85
Salivary gland	6	85	90	Fallopian tube	8	90	90
Ovary	9	67	65	Local excisions	15	80	90
Lymph node	12	75	75	Sentinel lymph nodes	8	75	70
Prostate	2	85	85				

Figure 1. Showing the TruSlice device with the plastic colour coded inserts defining the tissue thickness for dissection.

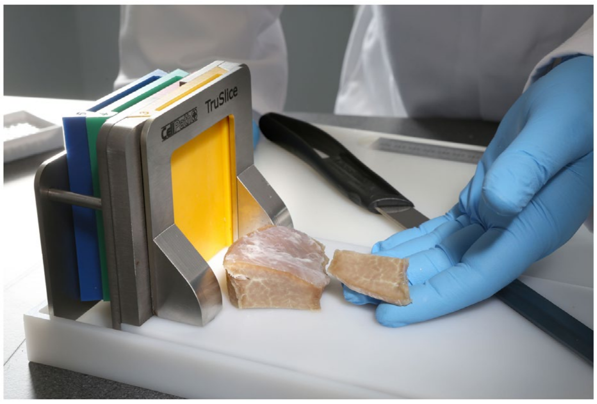

Figure 2. Showing the use of the TruSlice device sectioning tissue at a defined thickness with accuracy and precision.

Figure 3. Showing the solid steel configuration TruSlice Digital device exhibiting the attached metric scale and micrometre.

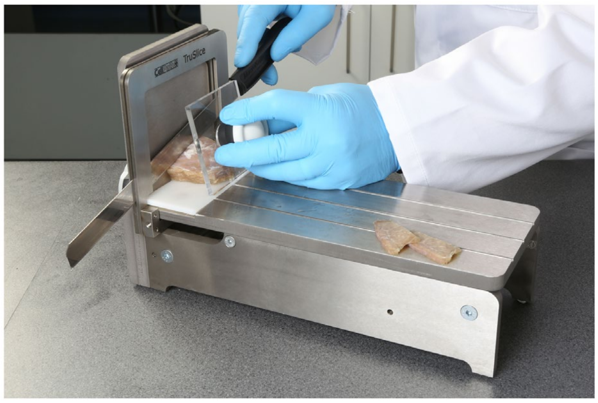

Figure 4. Showing sectioning of the tissue with good visibility and immobilisation.

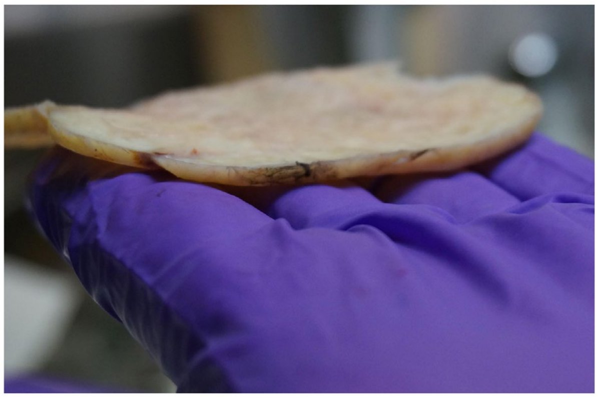

Figure 5. Slice of a large lipoma dissected on the TruSlice Digital device, exhibiting uniformity of tissue thickness across the entire cross section of the tissue slice.

(TruSlice) was more user-friendly, with one centre out of the five suggesting that it was less complicated than the larger TruSlice Digital device.

In terms of evaluation of assessors comments, a number of factors were identified. Overall the design of the TrueSlice Digital device was thought to be compact, yet heavy. The combination of macro-knife aligner and adjustable plate seemed safer than "free hand". Both devices were thought to be useful in producing thin, consistent slices of tissue particularly for larger Supa Mega Mother Ship cassettes. The use of a slicing action was favoured over a sawing action particularly with larger tissue samples. The sawing action with larger blades could produce flexing of the blade and this impacted precision and accuracy of the results achieved. The devices were both found easy to use, with improvements noted over manual procedures with some benefits in terms of speed of procedures compared to manual methods. Similarly, it was reported that good sections from a relatively fresh tissue could be achieved consistently. Certain tissue types notably the lung and bloody samples including lymphoid, and soft tissues were found to produce more variability as a result of the 'spongy' nature of the tissue when slicing. The tissue holding devices were reported to be adequate by the majority although some reported that improvements in these to secure tissue prior to sectioning would benefit the overall design. Some reported very positive indicators regarding 'ease of use', while others felt the devices were time-consuming to clean. This could be an issue when cleaning between differing tissue samples. One site reported on the TruSlice Digital model that there was movement in back plate during slicing depending on pressure applied. When dealing with friable and fatty tissue occasional dragging of tissue through the knife guard was observed which required cleaning in order to avoid tissue carry over. This was not a consistent finding and was not a consideration for the majority of tissue types assessed.

The devices were both felt to be of value by all five centres (100%), and depending on the tissue types, both provided value and benefits to histological dissection procedures. With some tissue types notably skin, uterus, cervix, kidney, salivary gland, liver, stomach, colon, rectum and fallopian tube scored between 80–100% for precision and accuracy. Tissues with the lowest accuracy and precision include those of the breast, gall bladder, small bowel, ovary, lipoma and lung (60–75%).

Discussion

Our multicentre UK study supports the notion that the TruSlice and TruSlice Digital devices represent an advance in histological techniques. The TruSlice devices offer an assured precision and accuracy of performance which is reproducible across an assortment of tissue types.

The last few decades have seen very little true attempts to innovate in the area of grossing equipment. The techniques employed have not changed significantly over a relatively long period of time. The focus has traditionally often been on developing ever more sophisticated equipment to assist the processes and procedures that follow histological dissection, rather than focusing on histological dissection procedures themselves. Thus, we have seen great strides in innovation made in the areas of tissue processing, microtomy, staining and molecular-based assessments. There are two reasons why this is the case. The first relates to the difficulty in developing equipment or devices that can accommodate all the various parameters required and which can achieve precision and accuracy of histological dissection on a complete spectrum of tissue types. The second relates to a shift of focus away from traditional tissue preparation methods to the development of new and emerging technologies such as immunohistochemistry, *in situ* hybridisation and an ever growing array of molecular genetic-based techniques. This is in contrast to how our understanding of the importance of fixation and processing of tissues has enabled us to define parameters of best practice in these early histological procedural steps. It is perhaps only now that we are beginning to develop a growing interest in how best we can dissect tissues optimally and consistently to improve overall tissue preparation prior to cellular demonstration techniques.

In addition, there is little evidence for how important quantification and validation of histological dissection is within the scientific literature or indeed how to define the significant variables. Most of the focus has been on microdissection methods relating to the removal of tissue from stained slides or directly from tissue blocks, rather than the initial dissection procedure.[6,7]

We report in this current study a five-site assessment of two dissection devices that have shown good evidence of precision and accuracy across a wide variety of tissue types. Ideally, in order to be completely satisfied the results would reflect 100% for precision and accuracy. But how realistic is this objectively when we consider the variability of tissue types that we currently dissect? Familiarity in the use of new equipment always leads to improvement in performance and the results we report here are very likely to improve with more usage by the practitioners. Evidence for this can be seen when we compare sites who achieved 100% scores for precision and accuracy in specific tissue types with those who reported figures of 50–80% with the same tissue types.

We are now also in the era of new laboratory accreditation standards as set by UKAS. Most laboratories are now working towards ISO 15189 standards for laboratory practice.[4] These standards would seem to imply that all tissue samples would need to be handled practically in the same way. Therefore, adopting dissection procedures based on the use of manual techniques in combination with histological devices is perhaps not ideal practice. In contrast to this, there is now a growing emphasis on the 'measurement of uncertainty' of any numerical or quantifiable parameters that need to be recorded during histological dissection and how these are calibrated and validated for use. It would seem that histological dissection devices that are able to comply with UKAS validation of 'measurement of uncertainty' requirements would be a popular development. These current devices do have the capacity for validation under these standards.

Without doubt there is a need to focus assurance of precision and accuracy at cut up. It is inevitable that minor measurement errors during cut up will take place regularly when employing totally manual methods. The culmination of these errors will therefore have an impact on the adequacy of processing and all the subsequent steps of histological investigation that follow. The issue of adequacy of histological dissection is also not just an evaluation of defined measurements but also efficiency of grossing technique. Histological devices that can assist in controlling the five key dissection parameters and achieve consistency will reduce issues of uneven grossing and angulated tissue preparations (Figure 6). This in turn will improve subsequent processing and embedding procedures.

There are certain areas of histological dissection which we know are critical and require accuracy. Most

Figure 6. Sections of manually dissected tissue through a keloid, demonstrating the lack of perpendicular sectioning which produces an irregular cut surface and different tissue thickness for embedding. This can produce poor uneven epidermal section quality.

notably avoiding tangential cutting in instances of assessing Breslow thickness for tumour cell invasion in malignant melanoma, where perpendicular slicing is extremely important.[8] Similarly, when slicing horizontally small scalp biopsies for the assessment of alopecia, the margin of error for achieving perpendicular sectioning at the isthmus just below the dermal / epidermal junction is often crucial for diagnostic purposes.[9–11] The use of a micrometre (TruSlice Digital) to set tissue slice thickness is beneficial in many ways since the use of a micrometre on this device also reminds us of how we have traditionally defined measurement and accuracy for the microtomy for histological sectioning of paraffin blocks using microtomes. Finally, there remains the requirement to test and try the most promising devices currently available, simply in order to determine which of these provides the best overall options for routine histological dissection. This area of investigation will continue to be a focus of development.

This work represents an advance in biomedical science because it is an innovative approach to addressing the issues associated with achieving precision and accuracy in the procedures of histological dissection techniques.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Summary table

What is known about this subject:
- Histological dissection is a highly skilled procedure which requires accuracy and precision in practice.
- Histological dissection forms the foundation of all of subsequent tissue based science investigations.
- Innovation and design in equipment used in these procedures is limited.

What this paper adds:
- An investigation into defining the key parameters of good histological dissection practice.
- The accuracy and precision of the TruSlice devices are closely linked with a very good correlation coefficient of 0.83.
- The TruSlice Digital devices offer an assured precision and accuracy performance which is reproducible across an assortment of tissue types.

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