

HYDRO-DISSECTION VERSUS CONVENTIONAL SCALPEL DISSECTION OF THE PALMAR HAND IN CADAVERS: A RUBRIC-BASED COMPARISON OF STRUCTURAL INTEGRITY

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ABSTRACT

Background: The palmar hand contains the palmar aponeurosis, palmar vascular arches, digital neurovascular bundles, flexor tendons and joint capsules within a compact anatomical space. Their successful delineation depends on the dissection technique and the maintenance of tissue integrity during preparation. A rubric is a structured scoring tool that lists predefined criteria, each with clear performance levels, so that a dissection can be assessed against the same standard every time. The author used it to reduce subjective judgement and to give a consistent, reproducible measure of how accurately and clearly structures of the palmar hand were identified with each technique

Objective: To compare conventional scalpel dissection with hydro-dissection (HDM) of the palmar hand using a customised anatomical dissection rubric to assess structural integrity.

Methods: Thirty-five students each completed one palmar dissection: 17 using conventional scalpel dissection and 18 using HDM. Six anatomical regions—epidermal reflection, palmar aponeurosis, neurovascular structures, vascular arch, musculoskeletal structures and joint capsule—were scored from 1 to 5, producing a total structural integrity score ranging from 6 to 30. Dissection time, desiccation incidents, critical errors and student perception scores were also recorded. Groups were compared using the Mann–Whitney U test, with bootstrap 95% confidence intervals and Holm adjustment for multiple comparisons within the specified outcome families.

Results: The total structural integrity score was higher in the HDM group than in the conventional scalpel group (24.61 ± 1.42 versus 19.35 ± 1.58 ; mean difference 5.26, 95% CI 4.30–6.23; $p < 0.001$). Five of the six anatomical regions favoured HDM. The largest differences were observed in the vascular arch, joint capsule and musculoskeletal regions. No significant difference was observed for the palmar aponeurosis (difference -0.17 , 95% CI -0.64 to 0.34). HDM was associated with fewer desiccation incidents and critical errors and higher student perception scores. However, the mean dissection time was 67.8 minutes longer with HDM (95% CI 62.0–73.4).

Conclusion: In this sample, hydro-dissection was associated with higher structural integrity scores, fewer recorded desiccation incidents and critical errors, and more favourable student perceptions than conventional scalpel dissection. These outcomes were accompanied by substantially longer dissection times. The findings are preliminary and require confirmation through larger studies with blinded, multi-rater assessment.

KEYWORDS: Hydro-dissection; hydropreservation; cadaveric dissection; palmar hand; anatomical education; structural integrity; dissection rubric.

1. INTRODUCTION

The palmar surface of the hand is one of the most demanding regions of the upper limb to dissect. Beneath its relatively thin and tightly bound skin lie the palmar aponeurosis, superficial and deep palmar arches, common and proper digital nerves and vessels, long flexor tendons and their sheaths, intrinsic muscles, and the capsules of the metacarpophalangeal and interphalangeal joints. The palmar fascia has received particular attention because of its anatomical complexity and clinical relevance to Dupuytren's disease (Holland and McGrouther, 1997; Rayan, 1999). Many of these structures are small, closely related and positioned within tissue planes that can be disrupted during conventional dissection.

Conventional dissection presents two major challenges in this region. The first is mechanical injury. A scalpel separates tissues by cutting, and an unintended movement can damage a digital nerve, disrupt a small vessel or compromise the continuity of the palmar vascular arch. Although blunt dissection is commonly used when approaching delicate structures, the rigid back or spine of a scalpel blade can also exert concentrated pressure during scraping. This may cause tissue crushing, tearing or the creation of artificial tissue planes that obscure natural anatomical boundaries. These challenges are particularly relevant to students who are developing the fine motor control required for precise cadaveric dissection.

The second challenge relates to the condition of the specimen during prolonged laboratory work. Exposure to the open laboratory environment can result in progressive desiccation. As tissues lose moisture, they may become less pliable, and differences in colour, texture and consistency between adjacent structures may become less apparent. This can make the identification and preservation of fine nerves, vessels, fascial planes and tendon structures more difficult. Appropriate specimen preservation is therefore an important consideration in anatomical education (Brenner, 2014).

Hydro-dissection performed within a hydropreservation framework offers a potential alternative approach. Hydropreservation maintains the specimen in a water-rich environment during preparation and dissection, with the aim of maintaining tissue hydration and pliability. The hydrated environment may facilitate the separation of relatively loose connective tissues while limiting the progressive drying that occurs during open-air dissection. These features may assist the delineation of delicate anatomical structures and help preserve their spatial relationships.

A related principle is the use of controlled, non-cutting mechanical separation. Flexible brushes and similar instruments distribute contact across multiple filaments rather than concentrating force along a rigid metallic edge. When used gently on hydrated tissue, these filaments can adapt to surface contours and assist in clearing relatively loose connective tissue. Different degrees of flexibility and filament stiffness may be selected according to the tissue being exposed. Soft brushes may be suitable for superficial clearance, while finer or firmer tools may assist with more localized separation around deeper structures.

The distinction between rigid scraping and flexible filament-based separation is biomechanically relevant. A rigid edge applies force along a relatively narrow and unyielding surface, whereas flexible filaments can bend and adapt to the tissue encountered. This may provide a more controlled approach to removing superficial tissue around delicate neurovascular and musculoskeletal structures. However, the effectiveness of such approaches depends on the preparation method, the condition of the specimen, the instruments used and the technique of the operator.

A rubric is a structured assessment tool that sets out, in advance, what is to be judged and how well it has been done. It has three parts: the criteria (the features of performance being assessed), the performance levels (for example, poor, satisfactory, good, excellent), and a written descriptor for each level that says what that standard looks like in practice. Each level carries a score, so the descriptors turn a qualitative observation into a number. Rubrics are widely used in medical and surgical education to assess practical skills, and they are generally of two kinds. An analytic rubric scores each criterion separately and adds the scores. A holistic rubric gives one overall judgement. For anatomical dissection, an analytic rubric is more useful because it shows which aspect of the dissection was strong or weak, and not just whether the result was good overall.

In this study, the customised anatomic dissection rubric scores each palmar hand dissection on criteria such as how accurately a structure is identified, how clearly it is exposed, and how well neighbouring tissues are preserved. Each criterion has described performance levels, so the scorer judges the dissection against a written standard and not against personal impression. This matters because the comparison between brush dissection and blunt scalpel dissection rests on how well fine structures can be identified, which is otherwise a largely visual and subjective call. By scoring both techniques on the same criteria, the author could compare them on equal terms, make the assessment repeatable by other examiners, and report the outcome as measurable data rather than descriptive opinion.

Cadaveric dissection remains an important component of anatomical education (Ghosh, 2017). Nevertheless, comparisons between dissection approaches require structured assessment to distinguish observed anatomical preservation from subjective impressions of ease or usability. Instruments such as the Objective Structured Assessment of Technical Skill were developed to assess technical performance in clinical and operative settings (Martin et al., 1997). For anatomical dissection, a customised rubric can instead focus directly on the clarity, continuity and preservation of the structures being exposed.

The present study compared conventional scalpel dissection with hydro-dissection of the palmar hand using a customised anatomical dissection rubric. The primary outcome was the total structural integrity score. Secondary outcomes included dissection time, desiccation incidents, critical errors and student-reported perception. By examining both structural and practical outcomes, the study aimed to assess the potential educational utility of hydro-dissection while identifying its associated limitations.

2. MATERIALS AND METHODS

2.1 Study design and participants

This was a two-group comparative cadaveric study of palmar hand dissection. Thirty-five students each completed one palmar dissection. Seventeen students used the conventional scalpel technique, and eighteen used hydro-dissection (HDM). Each student contributed a single set of scores and was treated as the unit of analysis.

The procedures were conducted within an anatomy teaching environment, with the objective of exposing the relevant palmar structures while preserving their anatomical continuity and relationships.

2.2 Specimen preparation and hydropreservation principles

The preparation and dissection of cadaveric tissue can be affected by moisture loss, tissue stiffness and changes in the appearance of adjacent anatomical structures. Hydropreservation was therefore considered an important component of the hydro-dissection approach. Maintaining a water-rich working environment was intended to limit progressive desiccation and preserve tissue pliability during dissection.

The conceptual basis of hydropreservation is that hydrated tissues may be more amenable to controlled separation than tissues that have become dry and brittle. In combination with gentle mechanical clearance, this approach may facilitate the exposure of small neurovascular structures and deeper anatomical planes.

Note: The specific preservation solution, specimen allocation, immersion duration, water temperature and fluid-circulation parameters should be reported according to the actual protocol used in the palmar-hand study. Details belonging exclusively to the separate dorsal-hand experiment have not been transferred into this manuscript.

2.3 Conventional scalpel dissection

The conventional group underwent palmar dissection using the scalpel-based approach employed in the study. Tissue layers were exposed and separated through conventional dissection techniques, with attention to the anatomical

relationships of the palmar aponeurosis, neurovascular structures, vascular arch, musculoskeletal structures and joint capsule.

Care was required to avoid inadvertent damage to small nerves and vessels and to preserve the continuity of the structures included in the assessment rubric.

2.4 Hydro-dissection procedure

Hydro-dissection was performed using the study's hydro-dissection method. The approach was based on controlled separation of tissue planes within a hydrated environment, with the objective of improving the delineation of anatomical structures while limiting unnecessary mechanical damage.

The broader methodological principle underlying this approach is the combination of hydropreservation with controlled, non-cutting tissue separation. Flexible brushes and suitable blunt instruments may be used for superficial tissue clearance and localized separation, according to the protocol implemented. Flexible filament-based instruments distribute contact across multiple points and may adapt to the contours of the tissue, whereas rigid instruments exert force over a comparatively narrow contact surface.

For the present study, the hydro-dissection procedure and its associated preservation conditions were evaluated as a combined method. Consequently, the observed outcomes cannot be attributed exclusively to the mechanical dissection technique independently of the preservation environment.

2.5 Anatomical assessment rubric

Structural integrity was assessed using a customised anatomical dissection rubric designed to evaluate the accuracy and clarity of anatomical identification. The rubric included six anatomical domains:

1. Epidermal reflection.
2. Palmar aponeurosis.
3. Neurovascular structures.
4. Vascular arch.
5. Musculoskeletal structures.
6. Joint capsule.

Each region was scored on a five-point scale, ranging from 1 (poor) to 5 (excellent). The total structural integrity score was calculated by summing the scores for the six regions, producing a possible range of 6–30.

The assessment focused on the extent to which each region could be exposed and identified while maintaining structural continuity and minimising damage. The rubric was intended to provide a structured measure of anatomical delineation rather than a general measure of technical skill.

2.6 Study outcomes

The primary outcome was the total structural integrity score.

The secondary outcomes were:

- Dissection time: total time recorded for completion of the dissection, in minutes.
- Desiccation incidents: recorded occurrences of tissue drying during the dissection process.
- Critical errors: recorded incidents involving accidental tissue damage or loss of important anatomical structures.
- Student perception score: a summed score reflecting student-reported perception of the dissection method.

The outcomes were selected to examine anatomical preservation alongside practical aspects of the dissection process.

2.7 Statistical analysis

Continuous and ordinal variables were summarised as mean $\pm$ standard deviation, with medians and interquartile ranges reported where appropriate. The primary comparison was the total structural integrity score between the two groups.

Because the regional scores were ordinal and the sample size was small, between-group comparisons used the two-sided Mann–Whitney U test (Mann and Whitney, 1947). Normality of the total score and dissection time was examined using the Shapiro–Wilk test (Shapiro and Wilk, 1965), and equality of variances was assessed using Levene's test. Welch's independent-samples t-test (Welch, 1947) was used as a sensitivity analysis for the total score and dissection time.

Mean differences were reported as HDM minus conventional scalpel, with 95% confidence intervals obtained using percentile bootstrap resampling with 10,000 resamples within each group (Efron, 1979). Standardised effect sizes were expressed as Hedges' g with approximate 95% confidence intervals (Hedges, 1981).

To limit the risk of false-positive findings, p -values were adjusted using Holm's method (Holm, 1979) within two outcome families: the six regional scores and the four secondary outcomes. The primary outcome was tested once without adjustment. Statistical significance was set at 0.05, using two-sided tests. No data were missing. Analyses were conducted in Python using NumPy and SciPy.

3. RESULTS

3.1 Participants and primary outcome

All 35 students contributed complete data: 17 in the conventional scalpel group and 18 in the HDM group.

The total structural integrity score was higher in the HDM group than in the conventional scalpel group (24.61 ± 1.42 versus 19.35 ± 1.58). The median score was 24.5 (IQR 24–25.75) for HDM and 19 (IQR 18–20) for conventional scalpel dissection. The mean difference was 5.26 points (95% CI 4.30–6.23; Mann–Whitney $p < 0.001$; Hedges' g 3.43, 95% CI 2.37–4.48).

Individual total scores ranged from 17 to 23 in the conventional scalpel group and from 22 to 27 in the HDM group. Thus, the distributions overlapped at the upper end of the scalpel group and the lower end of the HDM group.

Figure 1. Total structural integrity scores by dissection method. Each point represents one student; group means and their 95% bootstrap confidence intervals should be displayed.

3.2 Regional structural integrity scores

Five of the six anatomical regions had higher scores in the HDM group. The largest mean differences were observed in the vascular arch (1.33 points, 95% CI 0.88–1.78), joint capsule (1.29 points, 95% CI 0.90–1.69) and musculoskeletal structures (1.08 points, 95% CI 0.74–1.42). Epidermal reflection and neurovascular structures also favoured HDM, with differences of 0.83 and 0.89 points, respectively. All five differences remained significant after Holm adjustment. The palmar aponeurosis was the exception. The conventional scalpel group had a slightly higher mean score, but the difference was small and its confidence interval included zero (−0.17, 95% CI −0.64 to 0.34; adjusted $p = 0.53$).

Table 1. Primary and secondary outcomes by dissection method

Outcome	Conventional scalpel (n = 17)	HDM (n = 18)	Mean difference, HDM – scalpel (95% CI)	Hedges' g (95% CI)	p-value
Total structural integrity score (6–30)	19.35 ± 1.58	24.61 ± 1.42	5.26 (4.30 to 6.23)	3.43 (2.37 to 4.48)	<0.001
Dissection time (min)	111.6 ± 10.9	179.4 ± 6.7	67.8 (62.0 to 73.4)	7.38 (5.49 to 9.27)	<0.001
Desiccation incidents	3.41 ± 1.73	1.33 ± 0.49	−2.08 (−2.90 to −1.26)	−1.62 (−2.38 to −0.85)	<0.001
Critical errors	3.65 ± 1.69	1.44 ± 0.51	−2.20 (−3.02 to −1.44)	−1.74 (−2.53 to −0.96)	<0.001
Student perception score	14.12 ± 2.26	17.78 ± 1.06	3.66 (2.51 to 4.77)	2.05 (1.22 to 2.87)	<0.001

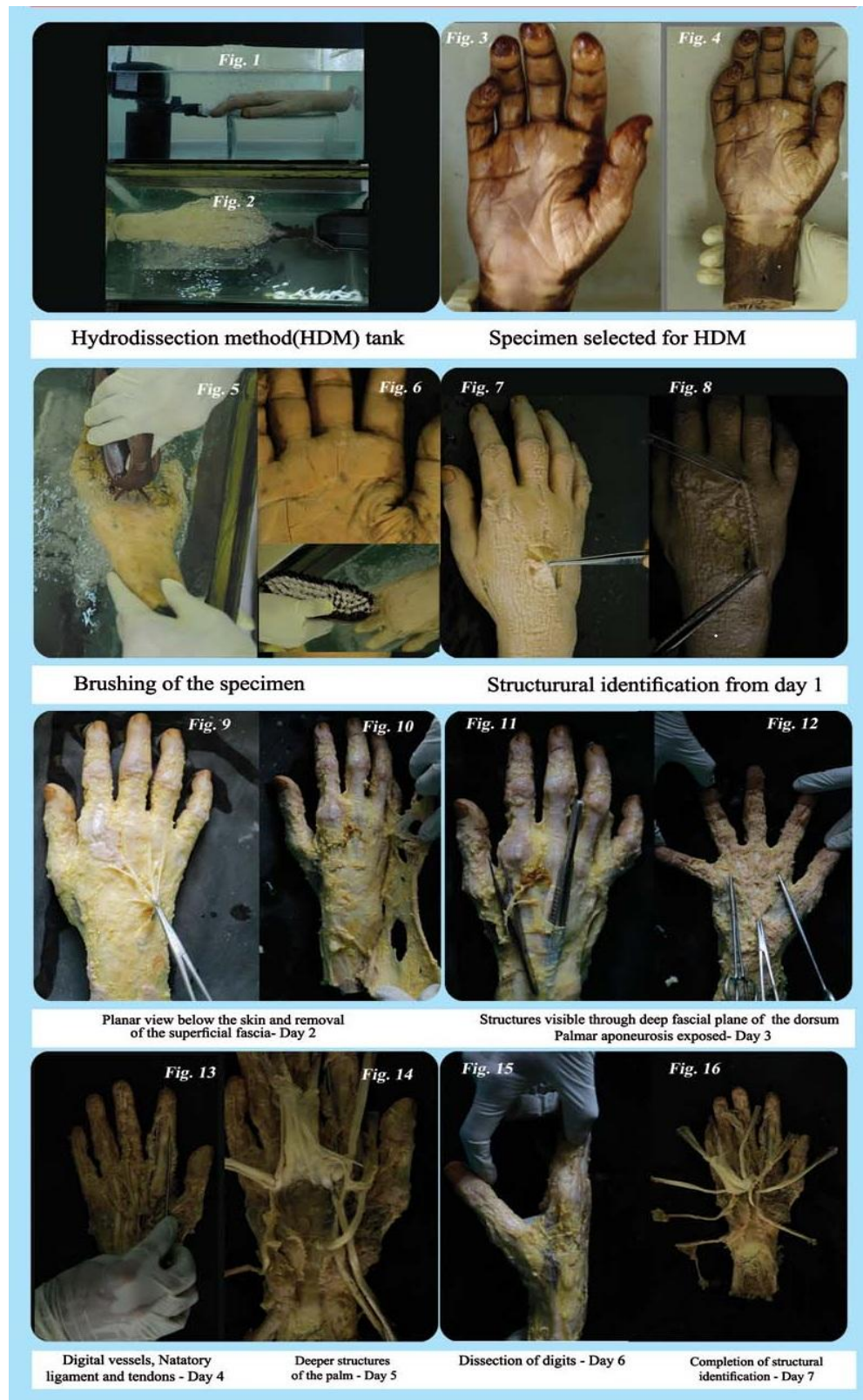
Values are mean ± SD. Confidence intervals are percentile bootstrap intervals. The primary outcome is unadjusted; the four secondary outcomes are Holm-adjusted within the secondary outcome family.

Table 2. Regional rubric scores by dissection method

Region (score 1–5)	Conventional scalpel (n = 17)	HDM (n = 18)	Mean difference, HDM – scalpel (95% CI)	Hedges' g (95% CI)	Holm-adjusted p-value
Epidermal reflection	3.00 ± 0.71	3.83 ± 0.38	0.83 (0.48 to 1.19)	1.44 (0.70 to 2.19)	0.0010
Palmar aponeurosis	4.06 ± 0.90	3.89 ± 0.58	−0.17 (−0.64 to 0.34)	−0.22 (−0.89 to 0.44)	0.53
Neurovascular structures	3.00 ± 0.71	3.89 ± 0.58	0.89 (0.48 to 1.29)	1.34 (0.61 to 2.08)	0.0015
Vascular arch	3.06 ± 0.66	4.39 ± 0.70	1.33 (0.88 to 1.78)	1.91 (1.11 to 2.72)	<0.001
Musculoskeletal structures	3.53 ± 0.51	4.61 ± 0.50	1.08 (0.74 to 1.42)	2.08 (1.25 to 2.91)	<0.001
Joint capsule	2.71 ± 0.59	4.00 ± 0.59	1.29 (0.90 to 1.69)	2.14 (1.30 to 2.98)	<0.001

Values are mean ± SD. Confidence intervals for the ordinal regional scores are approximate bootstrap intervals.

Figure 2. Regional rubric scores by dissection method. Panel A should display group means and 95% bootstrap confidence intervals for each region. Panel B should display between-group mean differences with 95% confidence intervals.



3.3 Secondary outcomes

The HDM group recorded fewer desiccation incidents than the conventional scalpel group (1.33 ± 0.49 versus 3.41 ± 1.73 ; mean difference -2.08 , 95% CI -2.90 to -1.26). Critical errors were also fewer in the HDM group (1.44 ± 0.51 versus 3.65 ± 1.69 ; mean difference -2.20 , 95% CI -3.02 to -1.44). Students using HDM reported higher perception scores (17.78 ± 1.06 versus 14.12 ± 2.26 ; mean difference 3.66 , 95% CI 2.51 – 4.77). Each of these differences remained significant after Holm adjustment (adjusted $p < 0.001$).

Dissection time was longer in the HDM group. The mean time was 179.4 ± 6.7 minutes for HDM and 111.6 ± 10.9 minutes for conventional scalpel dissection, giving a mean difference of 67.8 minutes (95% CI 62.0–73.4; adjusted $p < 0.001$). The longest conventional scalpel dissection took 131 minutes, while the shortest HDM dissection took 165 minutes. Variance in dissection time differed between groups (Levene's $p = 0.012$), supporting the use of Welch's test as a sensitivity analysis alongside the Mann–Whitney U test.

Figure 3. Secondary outcomes by dissection method. Group means and 95% bootstrap confidence intervals should be displayed, with the mean difference and corresponding confidence interval shown alongside each outcome.

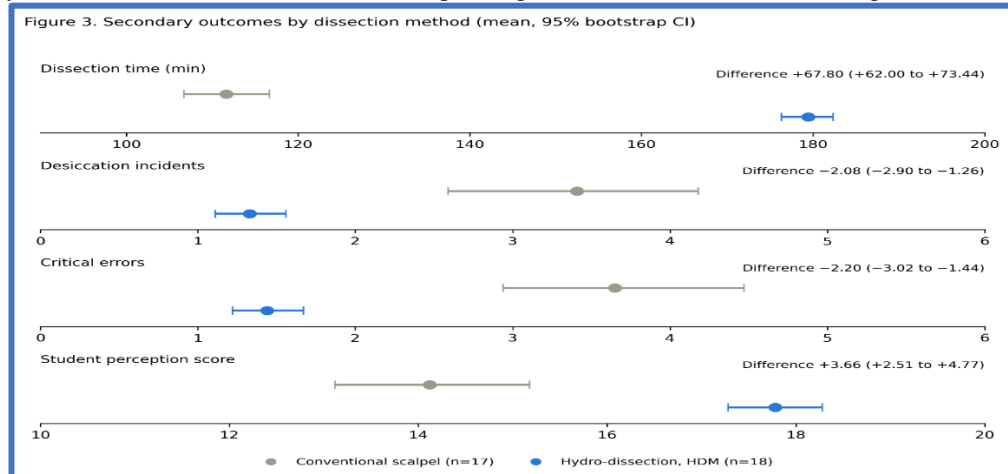
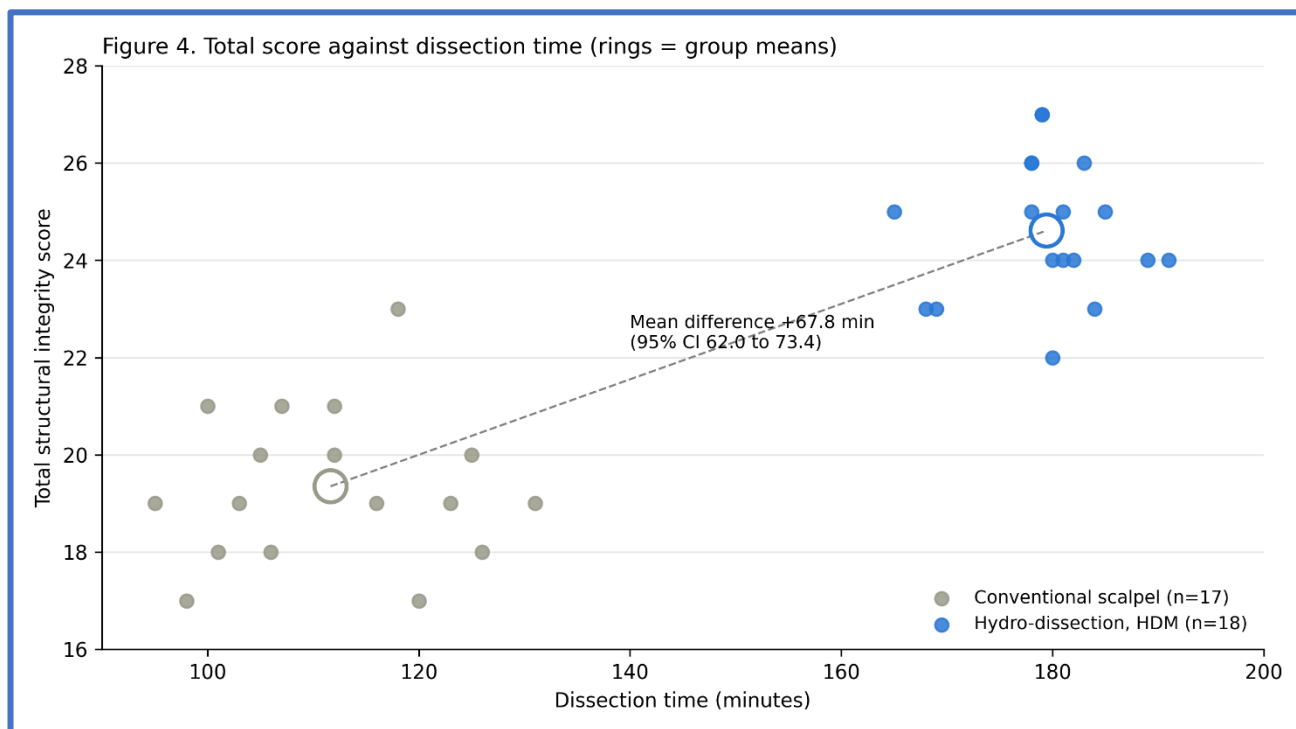


Figure 4. Total structural integrity score plotted against dissection time for each student, with group means indicated.



4. DISCUSSION

In this comparative series, hydro-dissection of the palmar hand was associated with higher structural integrity scores than conventional scalpel dissection, with a mean difference of 5.26 points on a 30-point scale. The direction of the difference favoured HDM in five of the six anatomical regions. The same general pattern was observed in the secondary outcomes: fewer desiccation incidents, fewer critical errors and more favourable student perception scores. These findings suggest that the combined hydro-dissection and hydropreservation approach may facilitate the delineation of selected palmar structures, although the longer dissection time represents an important practical consideration.

4.1 Structural integrity and anatomical delineation

The regional findings indicate that the observed differences were not uniform across all anatomical domains. The largest differences were seen in the vascular arch, joint capsule and musculoskeletal regions. These domains include structures whose boundaries and relationships may be difficult to expose without disturbing adjacent tissues. The findings are consistent with the possibility that maintaining tissue hydration and using controlled tissue separation may help preserve the continuity of selected structures during dissection.

The palmar aponeurosis showed no significant difference between the groups. The conventional scalpel group had a slightly higher mean score in this region. One possible explanation is that the relatively dense and well-defined aponeurosis can be exposed effectively by conventional techniques. A ceiling effect may also have contributed, but this interpretation was not directly tested and should be considered cautiously.

The results therefore suggest that the potential utility of HDM may vary according to the anatomical characteristics of the region being exposed. A method that facilitates the separation of delicate or closely related structures may not necessarily provide the same advantage for a dense and relatively distinct fascial structure.

4.2 Hydropreservation and tissue condition

The lower number of desiccation incidents in the HDM group is consistent with the use of a hydrated working environment. Progressive drying during open-air dissection can alter tissue compliance and reduce the visual contrast between adjacent structures. Hydropreservation is intended to minimise these changes and maintain the tissue in a condition that facilitates anatomical identification.

However, the lower desiccation count should not be interpreted as an independent effect of the mechanical dissection technique. Because the method and preservation environment were not evaluated separately, their individual contributions cannot be distinguished. Some of the observed differences in structural integrity may likewise reflect the combined influence of hydration and the dissection procedure.

This distinction is important when interpreting the study. The results describe the performance of the combined approach as implemented, rather than proving that hydro-dissection alone accounts for all observed differences.

4.3 Mechanical principles of tissue separation

Conventional scalpel dissection provides direct and precise cutting but requires control of the direction and depth of each movement. When a small structure lies close to the tissue being removed, unintended contact can result in damage or loss of anatomical continuity. Blunt dissection reduces reliance on a cutting edge in some circumstances, but rigid instruments may still exert concentrated mechanical force.

Flexible filament-based tools offer a different mode of tissue interaction. Their multiple contact points can adapt to surface contours and may assist in clearing relatively loose connective tissue through repeated, controlled movements. This

provides a plausible mechanical basis for exploring flexible brushes in anatomical preparation, particularly when combined with hydropreservation.

Nevertheless, the present palmar-hand study did not independently compare different brush materials, filament stiffnesses or instrument geometries. Nor did it isolate the mechanical effect of brushing from the effect of hydration. The proposed mechanism should therefore be treated as a rationale for further investigation rather than a mechanism established by the current data.

4.4 Dissection time and practical feasibility

The principal practical trade-off was the longer dissection time associated with HDM. The mean difference was 67.8 minutes, and the observed times did not overlap between the two groups. This is relevant for anatomy programmes operating within fixed laboratory schedules or with limited access to cadaveric facilities.

The present dataset does not establish where the additional time was spent. It may be useful in future studies to record preparation time, active dissection time, instrument handling and the time required to identify individual anatomical regions separately. Such measurements could help determine whether the additional time reflects the technique itself, the learning curve associated with an unfamiliar method, or additional procedural steps.

Further work should also examine whether the time requirement changes with repeated practice. Until such evidence is available, the observed time difference should be considered an important part of the overall assessment of HDM.

4.5 Student perception and educational relevance

Students using HDM reported higher perception scores than those using conventional scalpel dissection. This suggests that the method was viewed more favourably by the participating students. However, students could not be blinded to the technique they used, and their responses may reflect both their direct experience and their expectations about the method. The perception score was recorded as a single summed value and cannot be separated into individual components in the available dataset. It should therefore be interpreted as a measure of overall reported perception rather than a specific measure of safety, ease of use or educational effectiveness.

The findings nevertheless provide a basis for investigating whether alternative tissue-separation methods can support anatomical learning. Future research could combine structured anatomical scoring with independently assessed learner performance, inter-rater agreement and measures of anatomical knowledge retention.

5. LIMITATIONS

Several limitations should be considered when interpreting these findings.

First, the sample was small, with 17 students in the conventional scalpel group and 18 in the HDM group. Each student contributed one dissection, so individual ability and method-related effects cannot be fully separated.

Second, the customised rubric has not been externally validated. Although it was designed to assess the clarity and preservation of anatomical structures, its reliability and validity require further evaluation. The regional scores are ordinal and have a limited range, so confidence intervals for their means should be interpreted as approximate.

Third, assessor blinding and inter-rater agreement were not assessed in the available dataset. Both should be incorporated into future studies to establish whether the rubric can be applied consistently by independent assessors.

Fourth, the student perception score was recorded as a single summed value and could not be analysed at the individual-item level. This limits the conclusions that can be drawn about specific aspects of usability or educational experience.

Finally, the dissection method and preservation environment were not evaluated independently. The observed differences therefore represent the combined effect of the method and the conditions under which it was performed. The findings cannot establish the independent contribution of hydropreservation, mechanical tissue separation or other procedural factors.

6. Implications and Further Research

The findings support further evaluation of hydro-dissection through larger comparative studies. Future investigations should use matched specimens where feasible, standardised protocols and blinded assessment. At least two independent assessors should score each dissection so that inter-rater agreement can be reported.

The assessment rubric should also undergo formal evaluation for content validity, reliability and reproducibility. More detailed recording of procedural steps would help distinguish setup time from active dissection time and identify the stages responsible for the additional time requirement.

Further studies could investigate whether the observed differences are maintained across different anatomical regions, specimen conditions and levels of student experience. Separating the effects of hydropreservation from those of the dissection technique would also clarify the contribution of each component.

If structural preservation is to support anatomical atlas development, subsequent work should assess whether the exposed structures retain sufficient anatomical continuity and spatial relationships for consistent photography, digital documentation and three-dimensional reconstruction. Such applications remain potential future directions and were not directly evaluated in the present study.

7. CONCLUSION

Hydro-dissection of the palmar hand was associated with higher rubric-based structural integrity scores, fewer recorded desiccation incidents and critical errors, and more favourable student perception scores than conventional scalpel dissection. The observed differences were concentrated in five anatomical domains, while the palmar aponeurosis showed no significant difference between methods.

These findings suggest that the combined hydro-dissection and hydropreservation approach may have educational value for exposing selected palmar structures. However, it required substantially more time, and the study design could not

separate the effects of the dissection technique from those of the preservation environment. The results should therefore be interpreted as preliminary and confirmed through larger studies using blinded, multi-rater assessment and standardised protocols.

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