

Bridging Oral Histology and Maxillofacial Surgery: Dental Students' Perspectives on Clinical Relevance and Educational Integration

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Abstract

Oral Histology and Embryology provide basic knowledge about the structure and development of oral and craniofacial tissues. This knowledge is important for understanding many clinical conditions. However, because oral histology is usually taught during the early years of dental education, students may find it difficult to relate what they learned to later clinical subjects such as Oral and Maxillofacial Surgery (OMFS). This study aimed to evaluate dental students' perceptions of the clinical relevance of Oral Histology and Embryology to OMFS and to examine whether these perceptions differed across academic stages. An analytical cross-sectional questionnaire-based study was conducted among 221 undergraduate dental students from the second to fifth academic years at the College of Dentistry, Al-Ahl Al-Bayt University, Iraq. The questionnaire included 14 statements rated on a five-point Likert scale and covered three main areas: histopathological diagnostic integration; clinical, surgical, and developmental applications; and educational integration and curriculum development. Questionnaire reliability was assessed using Cronbach's alpha. Data were summarized using frequencies and percentages. Differences between academic stages were analyzed using the Kruskal-Wallis test, followed by Dunn's post-hoc test with Holm adjustment when required. Statistical significance was set at $p < 0.05$. The questionnaire showed acceptable internal consistency (Cronbach's $\alpha = 0.755$). In general, students had positive perceptions of the clinical relevance of Oral Histology and Embryology, although some differences were found between academic stages. Significant differences were observed for cellular differentiation and the diagnosis of cysts and tumors ($H = 13.700, p = 0.008$), keratinization and premalignant lesions ($H = 17.499, p = 0.004$), bone remodeling and resorption ($H = 23.876, p < 0.001$), craniofacial embryology ($H = 12.328, p = 0.015$), and salivary gland histology ($H = 11.818, p = 0.019$). Students also differed significantly in their views regarding the use of clinical case-based learning in Oral Histology teaching ($H = 15.056, p = 0.005$). No significant differences were found for several other clinical and educational applications. Dental students generally recognized the importance of Oral Histology and Embryology in OMFS education. However, not all subjects or academic levels shared the same perception of the connection between histological knowledge and its clinical application. Students may be better able to connect basic science knowledge to surgical practice if Oral Histology and OMFS are more closely integrated, especially through clinical cases and reinforcement of pertinent histological concepts during the clinical years. To determine whether this strategy enhances clinical performance and knowledge retention, more research is required.

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Introduction

The biological basis for clinical dentistry knowledge and decision-making is provided by basic sciences. Although anatomy, physiology, biochemistry, and histology are often taught in the early stages of dental education, their significance extends beyond the preclinical phase. A thorough understanding of normal tissue structure and function is necessary to interpret disease processes and comprehend the biological foundations of diagnosis and treatment. However, students may find these subjects less relevant when basic science instruction is separated from later clinical training, particularly if the clinical application of the knowledge is not made clear [1-3].

Oral Histology and Embryology occupies a particular position within the dental curriculum because it provides students with knowledge of the microscopic organization, development, and biological behavior of oral and craniofacial tissues. Concepts related to oral mucosa, bone, periodontal tissues, salivary glands, tooth development, and craniofacial embryology have direct relevance to several areas of clinical dentistry. Earlier educational approaches have therefore attempted to integrate oral histology with clinical observations, radiographic findings, and patient-related examples rather than teaching microscopic structure as an isolated body of knowledge. Such integration has been proposed as a means of helping students recognize the clinical significance of oral tissues while they are learning their normal structure and development [4,5].

The relationship between foundational knowledge and clinical practice is particularly relevant to Oral and Maxillofacial Surgery (OMFS). Surgical practice involves biological processes that students first encounter within basic and oral sciences, including bone remodeling and healing, epithelial and connective-tissue repair, developmental abnormalities of the craniofacial region, and the structural characteristics of oral and salivary tissues. Histological knowledge may therefore provide an important framework through which students interpret surgical pathology, understand wound healing and osseointegration, and relate tissue characteristics to clinical and surgical findings. However, knowing histological facts does not necessarily mean that students are able to retrieve and apply them when they encounter a clinical problem. The relationship between early basic-science learning and later clinical disciplines merits more investigation, as prior

research among Iraqi dental students revealed variations in the retention and clinical application of oral histology knowledge [6]. This issue is a component of a larger conversation about vertical integration in dental education. The goal of vertical integration is to link the knowledge learned in the early years of basic science to its later use in preclinical and clinical training. Although it is still difficult to achieve this connection consistently across a curriculum, evidence from dental education indicates that instructors and students generally value it [1,2,7]. Elangovan et al. (2016) [8] discovered that basic and clinical sciences were still commonly taught as distinct components in a survey of dental schools in the United States. Basic and clinical sciences were still frequently taught as separate components despite considerable interest in integrated curricula. More importantly, integration may influence how students use knowledge rather than simply how they perceive it. In oral radiology education, Baghdady et al. (2013) [9] demonstrated that students who learned relevant basic-science concepts integrated with clinical radiographic features achieved greater diagnostic accuracy than students who learned the same domains separately. These findings support the educational value of presenting foundational science within a meaningful clinical context.

Several approaches have been suggested to strengthen this connection, including case-based and problem-based learning, early exposure to clinical scenarios, reinforcement of basic-science concepts during clinical years, and collaboration between basic-science and clinical faculty [7,8]. Such strategies may be especially useful for Oral Histology and Embryology, where students are often required to recall microscopic and developmental concepts several years after the subject was initially taught. The time interval between the basic and clinical phases, examination-oriented learning, limited curricular coordination, and insufficient opportunities to revisit foundational concepts may all interfere with the student's ability to recognize the relevance of earlier learning in a surgical setting.

Despite the increasing emphasis on integration in dental education, the specific relationship between Oral Histology and Embryology and undergraduate OMFS education has received limited focused investigation. Existing studies have largely examined integration of basic and clinical sciences at the curriculum level or across several dental disciplines rather than

exploring how students perceive and apply individual oral histological concepts within surgical education. Understanding this relationship from the students' perspective may help identify which concepts are perceived as clinically meaningful, where difficulties in knowledge transfer occur, and which educational strategies may strengthen the link between preclinical learning and surgical practice.

Therefore, the present study aimed to evaluate dental students' perceptions of the clinical relevance of Oral Histology and Embryology to Oral and Maxillofacial Surgery education. It also sought to assess students' perceived ability to connect selected histological and developmental concepts with surgical applications, identify barriers to basic-clinical integration, and explore their views regarding educational approaches that may improve this integration. In addition, differences according to academic stage, academic performance, and type of academic institution were considered to provide a broader understanding of how students perceive the transition of oral histology knowledge from the classroom to the clinical surgical setting.

Material and Methods

The College of Dentistry at Ahl Al-Bayt University in Iraq carried out an analytical cross-sectional questionnaire-based study. The study sought to determine how dental students perceived the degree of curricular integration between oral and maxillofacial surgery (OMFS) and the clinical relevance of oral histology and embryology. To ascertain whether undergraduate dental students' perceptions changed as they advanced academically, the study focused on students at various stages of dental education.

Undergraduate dental students enrolled in the second, third, fourth, and fifth academic years at Al-Ahl Al-Bayt University's College of Dentistry made up the study population. Students from different academic stages were included to allow comparison of perceptions between preclinical and clinical levels of dental education. Students were also asked to provide information regarding their academic stage and previous academic performance in Oral Histology and Embryology.

Data were collected using a structured, self-administered electronic questionnaire designed to assess students' perceptions of the relationship between Oral Histology and Embryology

and its clinical application in Oral and Maxillofacial Surgery.

The questionnaire was anonymous and participation was voluntary. No personally identifying information was collected. The questionnaire required approximately 5–7 minutes to complete.

The questionnaire included demographic and academic information, 14 perception-based statements, and a section addressing perceived barriers to curricular integration.

For analysis, the 14 statements were classified into three categories:

Histopathological Diagnostic Integration. Three statements addressing cellular differentiation and diagnosis of cysts and tumors, correlation of histological findings with biopsy reports, and keratinization patterns in the assessment of premalignant lesions.

Clinical, Surgical and Developmental Applications. Seven statements addressing oral mucosal histology and wound healing, bone remodeling, craniofacial embryology, salivary gland histology, age-related histological changes, amelogenesis and dentinogenesis, and osseointegration.

Educational Integration and Curriculum Development. Four statements addressing theoretical memorization, integration between histology and surgery, clinical case-based learning, and joint educational activities between oral histologists and oral and maxillofacial surgeons.

Responses were recorded using a five-point Likert scale: Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree.

Higher scores represented stronger agreement with each statement. For descriptive analysis, responses were summarized using frequencies and percentages and Agree and Strongly Agree responses were combined as positive responses.

Students were also asked to identify perceived barriers to effective integration between Oral Histology and Oral and Maxillofacial Surgery. These included the time gap between the two subjects, emphasis on theoretical examination-oriented learning, lack of coordination between teaching staff, and excessive focus on surgical skills without sufficient reinforcement of their histological and biological basis. More than one response could be selected.

Google Forms was used to electronically distribute the questionnaire to qualified dental students. Participants were made aware of the study's objectives, the voluntary nature of participation, and the confidentiality of their answers prior to filling out the questionnaire. Completing the questionnaire and submitting it was regarded as consent to participate.

Cronbach's alpha was used to evaluate the questionnaire's internal consistency. Internal

consistency was deemed acceptable if the value was 0.70 or greater.

Jamovi statistical software was used to analyze the data. Frequencies and percentages were used to summarize questionnaire responses and categorical variables. Responses on a Likert scale were handled as ordinal data. Responses from different academic stages were compared using the Kruskal–Wallis H test. Statistical significance was defined as a p-value of less than 0.05. Dunn's post-hoc test was used to identify the precise academic-stage differences when a significant Kruskal–Wallis result was found. To account for multiple comparisons, the Holm adjustment was used.

Results

The study included 221 dental students in total. 220 participants had access to academic-stage data. Students in the fourth and fifth stages made up most of the study sample, making up roughly 61% of all participants. Third-stage students made up 22.2% of the sample, fourth-stage students made up 30.3%, fifth-stage students made up 30.8%, and second-stage students made up 16.3%. For 220 participants, academic performance information was available. Good (40.9%) was the most reported category of academic performance, followed by Fair (25%) and Very Good (23.2%).

Cronbach's alpha was used to evaluate the questionnaire's internal consistency. With a Cronbach's alpha coefficient of 0.755, the overall scale showed acceptable internal consistency, demonstrating the questionnaire's reliability for evaluating students' opinions about the integration of oral histology with clinical and surgical education.

Table 2. Scale reliability statistics.

Reliability Measure	Value
Cronbach's α	0.755

The questionnaire items were categorized into three conceptually related domains for descriptive analysis: Educational Integration and Curriculum Development, Clinical, Surgical, and Developmental Applications, and Histopathological Diagnostic Integration. A five-point Likert scale, ranging from strongly disagree to strongly agree, was used to record responses. Agree and Strongly Agree were regarded as positive responses for the purpose of interpreting the response patterns.

Students generally demonstrated positive perceptions regarding the relevance of oral

histology to histopathological diagnosis. Stage-specific analysis showed that third-stage students had the highest proportion of positive responses (Agree/Strongly Agree) regarding the contribution of cellular differentiation to understanding the histopathological diagnosis of cysts and tumors (87.8%).

The ability to correlate histological findings with biopsy reports showed greater variability between academic stages. The highest positive response was observed among fifth-stage students (79.4%), whereas fourth-stage students showed the lowest positive response (47.8%), suggesting differences in the perceived applicability of histological knowledge to biopsy interpretation across the stages of dental education.

With respect to keratinization and its relevance to the assessment of premalignant lesions before biopsy, second-stage students demonstrated the highest positive response (83.3%). Overall, the findings indicated that students recognized the diagnostic relevance of basic oral histological concepts, although the magnitude of this perception differed according to the specific histopathological application and academic stage.

The responses in this domain showed generally favorable opinions about the use of oral histology in concepts related to implants, developmental abnormalities, salivary gland pathology, and surgical planning. Fifth-stage students showed the highest positive response (85.3%) regarding the relationship between oral mucosal histology, surgical flap design, and wound healing. Most responses pertaining to bone remodeling and resorption were positive throughout the academic stages, suggesting that their importance for implant planning and the treatment of jaw fractures is widely acknowledged.

The clinical relevance of craniofacial embryology was strongly supported. Positive responses regarding the contribution of facial and jaw embryology to the understanding of congenital anomalies such as cleft lip and palate were highest among fourth-stage students (86.6%), followed by fifth-stage (82.4%) and third-stage students (81.6%), whereas second-stage students showed the lowest positive response (66.7%).

Salivary gland histology was also perceived as clinically relevant, with fifth-stage students showing the highest positive response (75%) regarding its role in understanding salivary lesions and their surgical management.

Regarding age-related histological changes, the highest positive response was observed among fifth-stage students (79.4%), whereas the lowest positive response was recorded among third-stage students (63.3%). Similarly, fifth-stage students demonstrated the highest

positive response regarding the usefulness of amelogenesis and dentinogenesis for understanding developmental histopathological abnormalities (79.4%).

For implant-related histology, second-stage students demonstrated the highest positive response (83.3%) regarding the application of histological concepts to understanding osseointegration and the surgical success of dental implants. These results show that opinions of the clinical and surgical value of oral histology are generally favorable, though the degree of favorable opinions varies depending on the application and academic level.

Students' opinions of the educational integration between oral histology and clinical or surgical training were assessed in the third domain. The items covered the following topics: the use of clinical case-based learning, the organization of joint seminars involving oral histology faculty and oral and maxillofacial surgeons, the perceived impact of bridging histology and surgery on clinical confidence, and the dependence on theoretical memorization during the early stages of oral histology education. There was especially clear support for clinical case-based learning. At 83.6%, fourth-stage students showed the highest positive response (Agree/Strongly Agree), followed by fifth-stage students (79.4%) and second-stage students (72.2%). Students in the third stage responded to this statement the least favorably (65.3%). Kruskal–Wallis test was used to evaluate differences in response distributions. The same three domains used in the descriptive analysis were retained for the analytical analysis to ensure consistency in the presentation and interpretation of the study findings. Statistical significance was defined as $p < 0.05$.

Within the Histopathological Diagnostic Integration domain, statistically significant differences across academic stages were observed for the item assessing the contribution of cellular differentiation to the histopathological diagnosis of cysts and tumors ($H = 13.7$, $p = 0.008$).

A statistically significant difference was also identified for the item addressing the importance of different types of keratinization in evaluating premalignant lesions before biopsy ($H = 17.499$, $p = 0.004$).

In contrast, students' ability to correlate histological findings with biopsy reports did not differ significantly across academic stages ($H = 3.159$, $p = 0.532$).

These results indicate that stage-related differences within this domain were more evident for specific conceptual and diagnostic applications of histology rather than for the general correlation of microscopic findings with biopsy reports.

Several statistically significant differences were identified within the Clinical, Surgical and Developmental Applications domain.

The strongest overall stage-related difference was observed for bone remodeling and resorption in relation to dental implant planning and jaw fracture management ($H = 23.876$, $p < 0.001$).

Significant differences were also found for craniofacial embryology and the understanding of congenital anomalies ($H = 12.328$, $p = 0.015$) and for salivary gland histology in relation to mucocele, ranula, and their surgical management ($H = 11.818$, $p = 0.019$).

In contrast, no statistically significant differences across academic stages were observed for oral mucosal histology in relation to surgical flap design and wound healing ($H = 7.212$, $p = 0.125$), age-related histological changes and surgical treatment planning ($H = 4.39$, $p = 0.356$), amelogenesis and dentinogenesis ($H = 3.354$, $p = 0.500$), or the histological basis of osseointegration and implant success ($H = 1.332$, $p = 0.856$).

Thus, academic-stage differences within this domain were concentrated mainly in bone biology, craniofacial embryology, and salivary gland histology.

Within the Educational Integration and Curriculum Development domain, a statistically significant difference across academic stages was identified for the statement supporting the incorporation of clinical case-based learning into oral histology teaching ($H = 15.056$, $p = 0.005$). No statistically significant stage-related differences were observed regarding the perception that oral histology teaching relied predominantly on theoretical memorization rather than integration with surgical cases ($H = 3.582$, $p = 0.466$).

Similarly, no significant differences were found for the statement that bridging oral histology and surgery increases confidence in clinical treatment decision-making ($H = 5.618$, $p = 0.230$) or for the recommendation to organize joint seminars between oral histologists and oral and maxillofacial surgeons during the clinical years ($H = 5.096$, $p = 0.278$).

For questionnaire items showing statistically significant overall differences in the Kruskal–Wallis analysis, Dunn's post-hoc test with Holm adjustment for multiple comparisons was used to determine which academic stages differed significantly. Holm-adjusted p -values below 0.05 were considered statistically significant.

Within the Histopathological Diagnostic Integration domain, a significant pairwise difference was identified for the item concerning cellular differentiation and histopathological diagnosis. Stage 3 demonstrated a significantly higher mean rank than Stage 4 (142.661 vs.

96.223; $z = 3.467$; Holm-adjusted $p = 0.005$; $rrb = 0.438$).

Within the Clinical, Surgical and Developmental Applications domain, significant pairwise differences were observed for craniofacial embryology. Stage 5 showed a significantly higher mean rank than Stage 1 (134.366 vs. 96.586; $z = -2.861$; Holm-adjusted $p = 0.038$; $rrb = 0.313$). Stage 5 also had a significantly higher mean rank than Stage 4 (134.366 vs. 104.143; $z = -3.056$; Holm-adjusted $p = 0.022$; $rrb = 0.283$).

Within the Educational Integration and Curriculum Development domain, significant differences were observed for the item supporting clinical case-based learning. Stage 3 demonstrated a significantly higher mean rank than Stage 1 (162.375 vs. 88.226; $z = -3.137$; Holm-adjusted $p = 0.017$; $rrb = 0.634$). This represented the largest effect size among the statistically significant pairwise comparisons. In addition, Stage 5 had a significantly higher mean rank than Stage 1 (122.728 vs. 88.226; $z = -2.869$; Holm-adjusted $p = 0.037$; $rrb = 0.332$). No additional pairwise comparisons remained statistically significant after Holm correction.

Discussion

The present study showed that dental students generally recognized the clinical relevance of Oral Histology and Embryology to Oral and Maxillofacial Surgery. However, perceptions differed across academic stages for selected topics, particularly cellular differentiation, keratinization, bone remodeling, craniofacial embryology, salivary gland histology, and clinical case-based learning. This suggests that the perceived importance of basic sciences may increase when students are able to relate these concepts directly to clinical problems, diagnosis, and treatment planning [1,2,8].

According to Histopathological Diagnostic Integration, there were significant differences in cellular differentiation and keratinization among academic stages, but no differences were observed in the correlation of histological findings with biopsy reports. These results may suggest that some histology concepts become more salient to students when they see the associated pathologies during their clinical education. Previous studies show that understanding of the basic biological mechanisms can support clinical reasoning, as students are able to form meaningful connections between underlying mechanisms and clinical findings [10].

The greatest disparity in the Clinical, Surgical and Developmental Applications domain was for bone remodeling and resorption with significant disparities also seen for craniofacial embryology and salivary gland histology. These topics have obvious clinical applications in the

fields of implant dentistry, maxillofacial trauma, congenital anomalies and salivary gland lesions. The results therefore support a higher integration of basic and clinical sciences throughout the dental education and not a limitation of basic sciences to the initial academic years [1,2,8].

One of the most important findings was related to clinical case-based learning. This was the only item within the Educational Integration and Curriculum Development domain that showed a significant difference across academic stages. In addition, the post-hoc analysis demonstrated the largest observed effect size for this item. This finding supports the use of clinical cases in teaching Oral Histology, as case-based approaches can help students connect microscopic concepts with diagnosis and clinical management [8,11].

Interestingly, the differences between academic stages did not show a simple pattern of students in higher stages always showing stronger agreement. Some of the important differences were at an intermediate stage and some were more advanced. This may reflect differences in the timing of exposure to specific clinical subjects and how recently students have encountered related histological concepts. Similar variation between academic years has been found in studies examining students' perceptions of basic-clinical science integration [1,2,12].

Overall, the results support closer integration of Oral Histology and Oral and Maxillofacial Surgery. Later in the academic training, there are clinical examples that are relevant to the histological concepts introduced during the early academic years, e.g., bone remodeling can be related to fractures and dental implants, craniofacial embryology can be related to cleft anomalies, and epithelial changes to biopsy and premalignant lesions. This incorporation may help students to see Oral Histology as a continuing base for clinical practice rather than as an isolated preclinical subject [8,13]. The findings should be interpreted considering some limitations. The study was conducted at a single dental college and evaluated students' perceptions rather than objective clinical competence. Furthermore, the cross-sectional design cannot determine whether differences between academic stages resulted directly from progression through the curriculum. Future multicenter and longitudinal studies could assess whether stronger integration between

basic and clinical sciences improves knowledge retention, clinical reasoning, and clinical performance [1,2].

Conclusion

This study showed that dental students generally recognized the clinical relevance of Oral Histology and Embryology to Oral and Maxillofacial Surgery. Histological knowledge was perceived as useful in understanding several clinical and surgical concepts, particularly histopathological diagnosis, bone remodeling, craniofacial development, salivary gland conditions, and implant-related topics.

However, students' perceptions varied across academic stages for some concepts, suggesting that the connection between basic histological knowledge and its clinical application is not always maintained consistently throughout dental education. The findings also showed student support for greater integration of clinical cases into Oral Histology teaching. Strengthening the link between Oral Histology and OMFS through case-based learning and revisiting relevant histological concepts during the clinical years may help students better connect basic science with clinical practice. Further studies involving multiple dental schools are recommended to evaluate whether such integration improves knowledge retention, clinical reasoning, and clinical performance.

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Table 1. Distribution of participants according to academic stage.

Academic Stage	Frequency (n)	Percentage (%)
Second Stage	36	16.3
Third Stage	49	22.2
Fourth Stage	67	30.3
Fifth Stage	68	30.8
Total	221	100

Table 3. Distribution of questionnaire items across the three study domains.

Domain	Questionnaire Items
Histopathological Diagnostic Integration	The histopathological diagnosis of cysts and tumors in oral surgery is made easier by an understanding of cellular differentiation in oral tissues.
	I can correlate histological findings with biopsy reports in the surgical clinic.
	Evaluating premalignant lesions prior to biopsy is made easier by being able to distinguish between different types of keratinization in the oral mucosa.
Clinical, Surgical and Developmental Applications	Understanding the oral mucosa's microscopic structure enhances comprehension of wound healing and surgical flap design.
	Understanding bone remodeling and resorption is essential for dental implant planning and management of jaw fractures.
	Studying craniofacial embryology improves understanding of congenital anomalies such as cleft lip and palate.
	Knowledge of salivary gland histology helps in understanding lesions such as mucocele and ranula and their surgical management.
	Knowledge of age-related histological changes in oral tissues influences surgical treatment planning for older patients.
Educational Integration and Curriculum Development	Understanding amelogenesis and dentinogenesis facilitates understanding of developmental abnormalities encountered in jaw surgery.
	Histological concepts help explain osseointegration of dental implants and their surgical success.
	Oral histology teaching in the early academic stages relied more on theoretical memorization than on integration with surgical cases.
	Bridging the gap between oral histology and surgery increases confidence in clinical treatment decision-making.
	Clinical case-based learning should be incorporated into oral histology teaching.
	Joint seminars between oral histologists and oral and maxillofacial surgeons should be organized during the clinical years.

Table 4. Kruskal–Wallis analysis of questionnaire responses according to academic stage.

Category	Questionnaire Item	Kruskal–Wallis H	p-value
Histopathological Diagnostic Integration	Understanding cellular differentiation in oral tissues facilitates the histopathological diagnosis of cysts and tumors in oral surgery.	13.700	0.008
	I can correlate histological findings with biopsy reports in the surgical clinic.	3.159	0.532
	Distinguishing between types of keratinization in the oral mucosa helps in evaluating premalignant lesions before biopsy.	17.499	0.004
Clinical, Surgical and Developmental Applications	Knowledge of the microscopic structure of the oral mucosa improves understanding of surgical flap design and wound healing.	7.212	0.125
	Understanding bone remodeling and resorption is essential for dental implant planning and management of jaw fractures.	23.876	<0.001
	Studying craniofacial embryology improves understanding of congenital anomalies such as cleft lip and palate.	12.328	0.015
	Knowledge of salivary gland histology helps in understanding lesions such as mucocele and ranula and their surgical management.	11.818	0.019
	Knowledge of age-related histological changes in oral tissues influences surgical treatment planning for older patients.	4.390	0.356
	Understanding amelogenesis and dentinogenesis facilitates understanding of developmental abnormalities encountered in jaw surgery.	3.354	0.5
	Histological concepts help explain osseointegration of dental implants and their surgical success.	1.332	0.856
	Oral histology teaching in the early academic stages relied more on theoretical memorization than on integration with surgical cases.	3.582	0.466
Educational Integration and Curriculum Development	Bridging the gap between oral histology and surgery increases confidence in clinical treatment decision-making.	5.618	0.23
	Clinical case-based learning should be incorporated into oral histology teaching.	15.056	0.005
	Joint seminars between oral histologists and oral and maxillofacial surgeons should be organized during the clinical years.	5.096	0.278

Table 5. Dunn's Post-hoc pairwise comparisons between academic stages.

Category	Questionnaire Item	Academic Stage Comparison	Mean Rank – First Stage	Mean Rank – Second Stage	z-value	Effect Size (rrb)	Holm-adjusted p-value
Histopathological Diagnostic Integration	Understanding cellular differentiation facilitates the histopathological diagnosis of cysts and tumors.	Stage 3 vs Stage 4	142.661	96.223	3.467	0.438	0.005
Clinical, Surgical and Developmental Applications	Craniofacial embryology improves understanding of congenital anomalies such as cleft lip and palate.	Stage 1 vs Stage 5	96.586	134.366	–2.861	0.313	0.038
	Craniofacial embryology improves understanding of congenital anomalies such as cleft lip and palate.	Stage 4 vs Stage 5	104.143	134.366	–3.056	0.283	0.022
Educational Integration and Curriculum Development	Clinical case-based learning should be incorporated into oral histology teaching.	Stage 1 vs Stage 3	88.226	162.375	–3.137	0.634	0.017
	Clinical case-based learning should be incorporated into oral histology teaching.	Stage 1 vs Stage 5	88.226	122.728	–2.869	0.332	0.037