

Assessment of Oral Histology Knowledge and Its Application in Clinical Orthodontics, Operative Dentistry, Oral Medicine, and Oral Surgery

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Abstract

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Objective: This study aims to assess the knowledge of oral histology among fifth-year dental students in Iraq and evaluate its relevance to various clinical dental disciplines, including orthodontics, operative dentistry, oral medicine, and oral surgery.

Methods: A cross-sectional survey was conducted from February to May 2024 among dental students from both public and private institutions in Iraq. Participants were recruited through targeted online advertisements on platforms such as Telegram, WhatsApp, and Facebook.

Results: The results compare clinical and basic knowledge between younger and older dental students. Younger students scored higher in understanding basic concepts like structural changes in the periodontal ligament, bone remodeling, tooth eruption enamel structure, cavity design and surgical interventions. However, older students excelled in clinical areas such as maxillofacial development, orthodontic appliances, and developmental anomalies.

Conclusion: This study provides insights into the perceived value of oral histology education among dental students and its application in clinical practice. The findings may be encouraging early clinical involvement while reinforcing basic science concepts can lead to a more well-rounded and confident dental workforce.

Introduction

Oral histology is a fundamental discipline in dentistry, providing a microscopic understanding of oral tissues. It serves as a cornerstone for various specialties, including orthodontics, operative dentistry, oral medicine, and oral surgery. A comprehensive grasp of oral histology is essential for diagnosing, treating, and preventing oral diseases [1,2]. Understanding oral histology is

crucial for dental students to comprehend the pathophysiology of oral diseases [3]. Instead of rote memorization, theoretical lectures and clinical application help students to understand histologic specimens. Then, knowledge of oral histology can help dental practitioners to manage patients with oral diseases in the clinic [4,5].

Dental Education program has provided valuable suggestions and

strategies for the integration of histology in the dental curriculum and for teaching the subject in a way that better integrates preclinical education in the clinical years [6]. Some available studies have reported strong correlations between histology students' performance in clinical discipline learning [1]. The competence of dental students in their professional tasks after graduation depends on the acquisition of

knowledge and clinical skills needed to deliver evidence-based dental treatment [7]. Preclinical basic medical information is important for dental students to become qualified dentists [8]. Oral histology is integral to various dental specialties, providing essential insights into tissue structure and function that directly impact clinical practice [9].

In orthodontics, tooth movement relies on the remodeling of alveolar bone and the periodontal ligament, with histological changes in these tissues playing a key role in understanding the effects of orthodontic forces, managing root resorption, and predicting soft tissue responses [10,11].

In operative dentistry, understanding the histology of enamel, dentin, pulp, and cementum is vital for designing effective cavity preparations, selecting appropriate restorative materials, and predicting tissue response and healing [12]. Histological analysis of caries-affected tissues informs the extent of decay and guides intervention strategies [13], while the compatibility of restorative materials with dental tissues ensures long-term success [14].

Oral surgery heavily depends on histological knowledge for understanding wound healing processes, the interaction between bone and soft tissues during procedures like extractions and implants [15], and diagnosing pathological conditions requiring surgical intervention, oral histology is crucial for diagnosing oral lesions, differentiating between various types of pathological conditions [16], understanding oral manifestation of systemic disease manifestations in the oral cavity, and assessing the impact of medications on oral tissues, all of which contribute to informed clinical decision-making and patient care [17].

This study will help in recognizing dental education deficiencies and providing insight that may benefit and improve dental students' performance and education. It appears that no previous study has been conducted in Iraq examining the proficiency of dental students in oral histology, which is a considerable current deficiency in our academic dental counseling. Therefore, our research study will target the fifth year of dental students from specific age groups. The importance of the study arose for measuring dentists' orofacial histological expertise, which has

not previously been published, and for assessing the impact of the teaching process in academic dental institutions students for basic science and undergraduate clinical education.

Material and Methods

Study Method

A cross-sectional survey was conducted from February to May 2024 among dental students in Iraq. Participants were recruited through targeted advertisements online by different social media especially telegram, WhatsApp and Facebook groups, focusing on individuals within the specified age range, different genders and geographic locations.

Survey design

At the beginning of the survey, as part of the demographic data, respondents were asked about their gender in addition to their age, which was divided into two groups. The first group ranged from 22 to 24 years old, considered the fresh group, representing the typical age for graduation. The second group ranged from 25 to 28 years old, considered the old group. This questionnaire was designed for fifth-year dental students in Iraq, including both

governmental and private educational institutions.

The survey contains 40 items addressing key questions that connect oral histology to various clinical dental branches, aiming to evaluate how much students benefit from studying oral histology as a basic science and its application in clinical dentistry. Consultation was made with the heads of relevant departments and teaching staff involved in the research to identify the questions they deemed important for the fifth-year stage, which should be addressed before starting the practical component. Improving reliability of online surveys is crucial for precise data gathering. The validity of the content was evaluated by professionals in orthodontics, operative dentistry, oral surgery, oral medicine, and oral histology.

Data collection

The validity of the content was evaluated, obscurity was ensured

throughout the data collection process. The fifth-year representatives in both public and private universities have been contacted to ensure that the questionnaire reaches the largest number of students.

The responses designated as: Extensive Knowledge (Score 4), Limited Knowledge (Score 3), Moderate Knowledge (Score 2) and Knowledge Unimportant (Score 1).

Statistical analysis

The data analysis was conducted using Jeffreys’s Amazing Statistics Program (JASP), version 0.19.0. The methods applied included descriptive statistics, such as the mean and standard deviation, along with the independent samples t-test to compare the two categories under study

Results

The sample consisted of approximately 1,265 students from Iraqi public and private universities. The number of

students aged 22-24 was around 731, representing about 57.7% of the sample, while students aged 25-28 numbered around 534, making up about 53.3%. The female students in the overall responses were approximately 735, representing about 58%, while the male students were around 530, accounting for 41.7%.

Students’ knowledge in Orthodontics

The older students consistently demonstrated a higher level of knowledge in clinical areas (Table 1), while fresh students, however, displayed a stronger understanding of basic knowledge areas like tooth eruption. The Independent Samples T-Test results show significant differences between Fresh and Older Students across various orthodontic knowledge areas. As shown in Table 2.

Table 1. Scores of responses regarding the students’ knowledge in orthodontics.

Question	Group	Valid	Mean	Standard Deviation
To what extent do you know about the structural changes in the periodontal ligament during orthodontic movement?	Fresh Students	731	2.412	0.856
	Older Students	534	2.011	0.893
To what extent do you know about the cells involved in bone remodeling during orthodontic treatment?	Fresh Students	731	2.31	0.848
	Older Students	534	2.11	0.979
To what extent do you know about maxillofacial development?	Fresh Students	731	2.238	0.818

	Older Students	534	2.521	0.976
To what extent do you know about orthodontic appliances?	Fresh Students	731	2.022	0.747
	Older Students	534	2.264	0.943
To what extent do you know about tooth eruption and shedding sequences?	Fresh Students	731	2.23	0.810
	Older Students	534	1.83	0.996
To what extent do you know about developmental anomalies that need orthodontic intervention?	Fresh Students	731	2.093	0.891
	Older Students	534	2.300	1.014
To what extent do you know about the importance of mixed dentition in orthodontic treatment?	Fresh Students	731	2.083	0.769
	Older Students	534	2.272	0.883
To what extent do you know about tooth development and teeth anomalies?	Fresh Students	731	1.973	0.769
	Older Students	534	2.124	0.837
To what extent do you know about procedures to accelerate tooth movement?	Fresh Students	731	2.226	0.826
	Older Students	534	2.331	0.864
To what extent do you know about the effect of age on orthodontic treatment?	Fresh Students	731	1.921	0.832
	Older Students	534	1.963	0.883

Table 2. Comparison of orthodontic responses between two age groups.

Questions	t	Degrees of freedom	p
To what extent do you know about the structural changes in the periodontal ligament during orthodontic movement?	-4.786	1263	< .001
To what extent do you know about maxillofacial development?	-5.590	1263	< .001
To what extent do you know about the cells involved in bone remodeling during orthodontic treatment?	-4.126	1263	< .001
To what extent do you know about orthodontic appliances?	-5.092	1263	< .001
To what extent do you know about the effect of age on orthodontic treatment?	-0.862	1263	0.389
To what extent do you know about developmental anomalies that need orthodontic intervention?	-3.841	1263	< .001
To what extent do you know about procedures to accelerate tooth movement?	-2.205	1263	0.028
To what extent do you know about tooth development and teeth anomalies?	-3.321	1263	< .001
To what extent do you know about tooth eruption and shedding sequences?	-4.305	1263	< .001
To what extent do you know about the importance of mixed dentition in orthodontic treatment?	-4.033	1263	< .001

Students' knowledge in Operative

As shown in Table 3, fresh students generally demonstrate higher knowledge in basic concepts such as enamel structure, cavity design while older students tend to have

better understanding in more advanced clinical. The independent samples t-test reveals that fresh students have significantly higher knowledge in basic areas such as enamel structure and cavity design compared to older students. In

contrast, older students show significantly better understanding of the pulpal response to caries progression and root canal as shown in Table 4.

Table 3. Scores of responses regarding the operative knowledge.

Question	Group	Valid	Mean	Standard Deviation
To which extent do you know about the structure of enamel and its significance in cavity preparation?	Fresh Students	731	2.323	0.990
	Older Students	534	1.981	0.777
To what extent do you know about cavity design?	Fresh Students	731	2.361	1.046
	Older Students	534	2.021	0.847
To what extent do you know about the structure of carious dentin?	Fresh Students	731	2.264	0.749
	Older Students	534	2.154	0.786
To what extent do you know about the pulpal response to caries progression?	Fresh Students	731	2.114	0.888
	Older Students	534	2.416	0.808
To what extent do you know about root canal configuration?	Fresh Students	731	2.397	0.867
	Older Students	534	2.599	0.943
To what extent do you know how to read radiographic films in operative procedures?	Fresh Students	731	2.273	0.773
	Older Students	534	2.289	0.777
To what extent do you know about advancements in adhesives?	Fresh Students	731	2.405	0.764
	Older Students	534	2.483	0.774
To what extent do you know about the materials used in crown and bridge?	Fresh Students	731	2.441	0.889
	Older Students	534	2.549	0.849
To what extent do you know about the treatment of discolored teeth?	Fresh Students	731	2.040	0.782
	Older Students	534	2.139	0.868
To what extent do you know about the interaction of restorative materials with the pulp-dentin complex?	Fresh Students	731	2.218	0.780
	Older Students	534	2.290	0.849

Table 4. Comparison the scores of responses of operative knowledge between two age groups.

Questions	t	Degrees of freedom	p
To which extent do you know about the structure of enamel and its significance in cavity preparation?	6.620	1263	< .001
To what extent do you know about cavity design?	6.185	1263	< .001
To what extent do you know about the structure of carious dentin?	2.536	1263	0.011

To what extent do you know about the interaction of restorative materials with the pulp-dentin complex?	- 1.578	1263	0.115
To what extent do you know about advancements in adhesives?	- 1.789	1263	0.074
To what extent do you know about the treatment of discolored teeth?	- 2.121	1263	0.034
To what extent do you know about the materials used in crown and bridge?	0.178	1263	0.859
To what extent do you know about the pulpal response to caries progression?	- 6.209	1263	< .001
To what extent do you know how to read radiographic films in operative procedures?	0.221	1263	0.825
To what extent do you know about root canal configuration?	- 3.953	1263	< .001

Students’ knowledge in Oral Medicine

The responses indicate that fresh students seem to perform better in foundational areas, such as recognizing challenges in reading pathological slides and

distinguishing between cysts and tumors. In contrast, older students exhibit a stronger understanding of clinical aspects, particularly in areas like TMJ disorder knowledge, as shown in Table 5. The comparison of scores through

Independent Samples t-test (Table 6), fresh students demonstrated a significantly higher difficulty in reading pathological slides, while older students outperformed in understanding TMJ disorders.

Table 5. Scores of responses regarding the students’ knowledge in oral medicine.

Questions	Group	Valid	Mean	Standard Deviation
To what extent do you know about the anatomy and histology of the Temporomandibular Joint (TMJ)?	Older Students	729	2.044	0.841
	Fresh Students	534	2.086	0.911
To what extent do you know about differentiating between cysts and tumors in the oral cavity?	Fresh Students	729	2.303	0.734
	Older Students	534	2.243	0.761
To what extent do you know about the anatomy, histology, and abnormalities of the salivary glands?	Fresh Students	731	2.212	0.697
	Older Students	534	2.155	0.671
To what extent do you know about oral mucosal abnormalities (growths, ulcers, infections, allergies, immune-mediated and autoimmune disorders)?	Fresh Students	731	2.238	0.735
	Older Students	534	2.193	0.716
To what extent do you know about apththous ulceration?	Older Students	731	2.274	0.850
	Fresh Students	534	2.193	0.823
To what extent do you know about TMJ disorder?	Older Students	731	2.460	0.737
	Fresh Students	534	2.296	0.724
To what extent do you know about differences between benign and malignant lesions?	Older Students	731	2.408	0.766

	Fresh Students	534	2.446	0.748
To what extent do you know about oral manifestation of systemic diseases?	Fresh Students	731	2.230	0.763
	Older Students	534	2.238	0.759
To what extent do you observe difficulties in reading pathological slides?	Older Students	714	2.444	0.791
	Fresh Students	502	2.654	0.855
Based on your previous academic year, to what extent do you have knowledge about common premalignant lesions?	Fresh Students	727	2.329	0.789
	Older Students	532	2.333	0.866
To what extent do you know about gingival tissues in healthy individuals versus those with gingivitis or periodontitis?	Fresh Students	731	2.285	0.786
	Older Students	534	2.365	0.777

Table 6. Comparison the scores of responses of oral medicine knowledge between two age groups.

Questions	t	Degrees of freedom	p
To what extent do you know about the anatomy and histology of the Temporomandibular Joint (TMJ)?	0.248	1261	0.805
To what extent do you know about differentiating between cysts and tumors in the oral cavity?	1.407	1261	0.160
To what extent do you know about differences benign and malignant lesion?	1.811	1263	0.03
To what extent do you know about the anatomy, histology, and abnormalities of the salivary glands?	1.450	1263	0.147
To what extent do you know about apththous ulcers?	1.091	1263	0.276
to which extent you observed difficulties in reading pathological slides?	2.305	1214	0.021
Based on your previous academic year, to what extent do you have knowledge about common premalignant lesions?	0.084	1257	0.933
To what extent do you know about TMJ disorder?	1.691	1263	0.044
to what extent do you know about oral manifestation of systemic diseases?	0.185	1263	0.853
To what extent do you know about oral mucosal abnormalities?	1.535	1263	0.125

Students' knowledge in Oral and Maxillofacial surgery

The result reveals that fresh students performed better in

foundational areas such as knowledge of the histological concept of dental implants, the mechanism of bone remodeling after extraction as shown in Table

7. In contrast, older students demonstrated stronger knowledge in areas, including suturing techniques as demonstrated in Table 8.

Table 7. Scores of responses regarding the students’ knowledge in Oral and Maxillofacial Surgery.

Questions	Group	Valid	Mean	Standard Deviation
To what extent do you know the regional anatomy of the oral cavity?	Fresh Students	731	1.914	0.804
	Older Students	533	1.961	0.908
To what extent do you know about developmental anomalies that need surgical intervention?	Fresh Students	731	1.885	0.945
	Older Students	534	2.028	1.091
To what extent do you know about the mechanism of bone remodeling after extraction?	Fresh Students	729	2.23	0.792
	Older Students	534	2.092	0.875
To what extent do you know about grafting materials?	Fresh Students	731	1.828	0.844
	Older Students	533	1.816	0.813
To what extent do you know about histopathological correlation with clinical presentation in oral cysts?	Fresh Students	731	2.34	0.681
	Older Students	534	2.12	0.747
To what extent do you know about the number and distribution of roots before extraction?	Fresh Students	730	2.136	0.767
	Older Students	534	2.12	0.829
To what extent do you know about complications and delayed healing after extraction?	Fresh Students	731	1.949	0.820
	Older Students	534	2.131	0.852
To what extent do you know about suturing techniques and types of sutures?	Fresh Students	730	2.036	0.773
	Older Students	534	2.369	1.011
To what extent do you know about the histological concept of dental implants?	Fresh Students	731	2.35	0.795
	Older Students	534	2.067	0.810
To what extent do you know about the stages of healing following a surgical incision in the oral cavity?	Fresh Students	731	2.314	0.756
	Older Students	533	1.681	0.978

Table 8. Comparison the scores of responses of Oral and Maxillofacial Surgery.

Questions	t	Degrees of freedom	p
To what extent do you know the regional anatomy of the oral cavity?	-0.967	1262	0.334
To what extent do you know about developmental anomaly needed surgical intervention?	-2.489	1263	0.013
To which extent do you know about grafting materials?	0.243	1262	0.808
To what extent do you know about the mechanism of bone remodeling after extraction?	-0.288	1261	0.774

To which extent do you know about the histological concept of dental implant?	-10.023	1262	< .001
To what extent do you know about the stages of healing following a surgical incision in the oral cavity?	-3.271	1263	0.001
" To what extent do you know about suturing techniques and types of sutures?	-6.644	1262	< .001
To which extent do you know about Histopathological correlation with clinical presentation in oral cysts?	-3.871	1263	< .001
To what extent do you know about the complications and delayed healing after extraction?	-3.828	1263	< .001
To which extent do you know about number and distributions of tooth before extraction?	-4.494	1262	< .001

Discussion

Students from various Iraqi colleges participated in this survey, which focused on their professional experience and the role of oral histology in clinical dentistry. These students had completed preclinical training and were actively engaged in clinical practice. Clinical-based education is a complex process where students apply the theoretical knowledge acquired during their preclinical studies to real patient cases. Since dentistry plays a crucial role in healthcare, improving the quality of clinical dental education is vital for enhancing overall oral and dental health in the population.

Oral histology forms the basis for clinical dental science including main branches like: orthodontics, operative, oral medicine and oral and maxillofacial branch moreover other dental branches, the histology plays a crucial role in oral

diagnosis and treatment planning. However, students often find oral histology challenging and perceive it as less significant for their future dental careers. Similar findings were observed by Johnson et al. (2015) [18] who compared the learning approaches of dental and medical students.

The results of this study declares that in comparing the clinical and basic knowledge between two groups, younger scored higher in understanding structural changes in different studied branches such as the periodontal ligament, bone remodeling during orthodontic treatment and tooth eruption and shedding, enamel structure and cavity design in operative, distinguishing between tumors and cysts, reading pathological tissue slides, and understanding the anatomy and histology of the temporomandibular joint (TMJ) in oral medicine, while in oral and maxillofacial branch their responses indicated understanding

of surgical interventions such as tooth extractions and dental implants. They also consistently recall histological, anatomical, and physiological fundamentals, linking clinical signs to the cysts and tumors that are seen in the maxillofacial surgery clinic at the college. This is finding supported by a previous study Naruishi et al. (2022) [19], when showed younger students often come into dental school with strong basic knowledge due to recent educational experiences. However, they may struggle to apply this knowledge effectively in clinical settings, which can affect their confidence and patient interactions.

This foundational knowledge can be advantageous in theoretical assessments and initial learning phases. However, as they transition into clinical training, they may face challenges in applying this knowledge effectively in real-world scenarios. The lack of clinical experience can lead to reduced

cooperation and confidence when interacting with patients and performing procedures. Younger learners may not yet fully appreciate the clinical relevance of histological details, such as the importance of knowing the vascularization of the periosteum or how bone tissue reacts to extractions or implants. This may lead to a gap in their ability to relate histological knowledge directly to oral surgery. This finding is supported by a previous study [20], that reported that the unprepared for the hands-on aspects of surgical procedures, which can lead to anxiety and decreased self-confidence among young dental student.

However, older students demonstrated superior knowledge in areas related to clinical requirement, in orthodontics they showed good understanding of maxillofacial development, orthodontic appliances developmental anomalies requiring orthodontic intervention and mixed dentition. Statistical analysis revealed significant differences, indicating that older students generally have stronger clinical knowledge, while younger students excel in certain basic concepts.

The analysis of operative question scores shows that older, employed students exhibit a more advanced grasp of complex clinical issues like treating discolored teeth, pulpal responses to caries, and root canal anatomy. On other hand the results showed that there were significant differences in responses scores for distinguishing between tumors and cysts, reading pathological tissue slides, and understanding the anatomy and histology of the temporomandibular joint (TMJ) while the older student reported significant differences related to TMJ disorder. Students working in the healthcare sector excel in the clinical aspects of any surgical intervention in surgical department, as they often perform these procedures in their jobs, which grants them strong clinical skills. Older students likely benefit from more clinical exposure, allowing them to observe a wider range of cases, especially those related to maxillofacial development.

Older students' extensive clinical exposure helps them grasp the relationship between facial growth, dental development, and orthodontic outcomes. While younger students may excel in basic sciences, older students

benefit from their additional clinical experience. This emphasizes the importance of integrating both theoretical knowledge and clinical practice in dental education to ensure a well-rounded learning experience.

In Iraq, the laws and regulations allow individuals over the age of 18 to enroll in Iraqi dental colleges, provided they meet the high academic standards and mental qualifications required for admission, whether the institutions are governmental or private. Additionally, the regulations permit individuals up to the age of 28 to join these colleges, often those who are already employed in governmental or private positions. Such individuals are generally motivated by a passion for the profession. These roles offer them valuable hands-on experience in clinical procedures, patient care, and the operation of dental equipment. Supporting this, Agrawal's et al. (2015) study [21] found that older students accumulate more clinical experience as they progress, which is crucial for applying orthodontic principles effectively. According to previous studies [22,23], most errors in root canal treatments were related to the obturation process. The study showed that

dental students were less skilled in performing root canal treatments, with many mistakes being made in contrast to cases managed by more experienced students at higher educational levels. Once more, various studies revealed that the change from preclinical to clinical dentistry education can be emotionally upsetting and stressful, which can result in less-than-optimal learning outcomes [24], diminished stimulus for learning [25] and, in the worst case, signs of anxiety and depression [26]. Building and maintaining motivation seems to be essential to averting poor outcomes, the older age students can overcome these situations due to large mentality and easier communication with seniors and patients [27,28]. The result determined that fifth-year students' lack of clinical proficiency was particularly noticeable in the clinical procedures; these issues are currently being resolved.

The older group highly engagement with professors and experts tend to have greater interactions with professors and experts in the field, which enhances their understanding and knowledge in addition to clinical experience. In addition to that they may work in some institution that related to health care where they

are often immersed in clinical practice and developing their skills in other branches that support the services of the Iraqi Ministry of Health and private clinics.

Conclusion

The results of this investigation demonstrate the various degrees of knowledge and clinical skills between younger and older dental students across various disciplines. Younger students tend to excel in basic concepts, in contrast, older students and those with clinical experience demonstrate a deeper understanding of complex clinical scenarios. Younger students often possess a strong foundation in oral histology and basic sciences, they may struggle to translate this knowledge into clinical practice, as seen in the challenges faced in operative and surgical procedures. To bridge this gap, dental education programs should aim to integrate both theoretical knowledge and clinical exposure throughout the curriculum. By doing so, students can develop a more comprehensive understanding of how oral histology informs clinical decision-making, which is critical for achieving proficiency in various dental specialties. Encouraging early clinical involvement while

reinforcing basic science concepts can lead to a more well-rounded and confident dental workforce. A deficiency in the clinical competence of fifth-year students was particularly noted in the clinical procedures.

Conflicts of Interest

The authors state that there are no conflicts of interest.

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None.

Authors' Contributions

In this study, Salma Merza Hasan developed the questionnaire sections in partnership with the heads of different branches and distributed it to the majority of fifth-year representatives. Concurrently, Zainab A. Almashhadi gathered the data and performed the statistical analysis, and both contributed to writing the introduction, materials, and methods sections. Amjed F. Hussein and Heider Hemeed Abbas were responsible for drafting the results and discussion all the results of research. All participants consented to all aspects of the research.

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