ORIGINAL ARTICLE

Contextual, Radiological Anatomy (RA) Learning needs Evaluation for Curricular Improvement

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ABSTRACT

INTRODUCTION: As a part of the MBBS curriculum review exercise, University of Cyberjaya (UoC), Malaysia had come up with a study to investigate the feedback and learning needs pertaining to radiological anatomy (RA) in pre-clinical teaching. **MATERIALS AND METHODS:** A single-institutional survey of all five-year medical students was done using an adapted instrument which had both open and close-ended questions on the radiological anatomy teaching received so far and the perception on the teaching methods and content. 405 respondents out of 503 (80%) (year 1=115, year 2=78, year 3=79, year 4=78, year 5=55) replied. There were totally 136 male and 269 female respondents. **RESULTS:** Though the overall student learning time (SLT) was adequate, year 3 students (62%) reported inadequate radiological anatomy SLT. Pre-clinical students (57.5%) reported more of formal radiological anatomy teaching while clinical students indicated informal teaching (Informal: 15.1 %, Even mix of formal and informal: 56.6 %). Female students reported higher response of adequate SLT (69.1%) and formal teaching (46.9%) compared to males. Small group learning such as gross anatomy practical sessions, problem-based learning, clinical skills teaching, and clinical correlates sessions were recommended. Abdomen and thorax were the most preferred regions where radiological anatomy could be explored further. X-ray followed by CT and MRI were the most favoured radiological modalities to learn topographical anatomy. **CONCLUSION:** The study provided sound feedback on the existing radiological anatomy teaching practices. Data shows stark contrast between the needs of the students and the current practices indicating that it is quite substantial for curriculum review.

Keywords
radiological anatomy, gross anatomy, learning needs, student perception

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INTRODUCTION

Medical education enables effective integrated education across disciplines and years of study that bolsters critical thinking as well as enhances satisfaction of students.[1] Anatomical content taught during the pre-clinical phase is vital for patient examination, image interpretation and surgery.[2] The integrated curriculum has resulted in the reduction of student learning time (SLT) for individual disciplines, especially anatomy whose content is reduced in volume and depth. This together with the rising costs of teaching modalities have urged the faculty to look into alternate ways of teaching the subject.[3] Diagnostic imaging is taught primarily during the clinical years and requires a thorough understanding of topographical anatomy.[4] Ordering unnecessary radiological investigations and faulty interpretations are often attributed to poor knowledge of anatomy.[5,6,7] To increase the content of radiology within pre-clinical teaching, radiological anatomy (RA) was introduced as an innovative sub-field that uses radiological modalities to provide a 3-dimensional (3D) view of gross anatomy.[8] Medical students expressed that radiological anatomy provides a strong foundation for appreciating anatomy in a clinical context.[4,9] Given the advantages of the integration, medical undergraduate radiology teaching is still considered inadequate and poorly structured, pushing the need for a comprehensive curriculum.[10,11] It has been found that there is a considerable variation in the

allocation of teaching hours, amount, delivery methods and teachers of imaging in teaching gross anatomy, not only worldwide but also within institutions in Malaysia, which calls for standardization.[12,13] Malaysian medical schools follow their individual curricula and radiological anatomy is not documented to be well integrated into anatomy teaching.[14,15,16,17,18] Curricular elements are chosen based on the needs of stakeholders, the feasibility of teaching-learning given the resources, as well as clinical and educational evidence.[19] Hence, this study is aimed at getting feedback to evaluate radiological anatomy teaching in a private medical school in Malaysia to collate the data intended for curricular improvement. The study approach of acquiring the perception of students for this research equates to performing the needs analysis while introducing a new curriculum or for continual improvement.[20]

The MBBS curriculum in the school where the study was conducted is integrated, system-based, and spiral in nature with the first two years in pre-clinical, followed by three years of clinical study. Radiological anatomy is incorporated mainly in lectures, with meagre representation in Problem-Based Learning (PBL) sessions, Clinical skills training (CST) sessions and Clinical Correlates (CC) sessions handled by both radiologists and anatomists in the respective systemic module during the pre-clinical phase (years 1 & 2). In the clinical years, students are posted to major clinical postings from year 3 onwards, where they are exposed to the bulk of radiological modalities. A four-week radiology specialty posting conducted by clinical radiologists is placed in the fourth year of the MBBS course.

METHODOLOGY

All the students who were pursuing MBBS in the private medical university were invited to participate voluntarily in the survey-based cross-sectional study. The feedback of students was investigated using a questionnaire from a study conducted at Newcastle University.[21] The instrument consisted of both closed-ended and open-ended questions. The permission to use the questionnaire was obtained from the authors and was adapted to suit the requirements of this study. The instrument comprised three sections; demographic data, feedback on radiological anatomy teaching received so far and the perception of students on the content and teaching-learning methods that should be employed in pre-clinical radiological anatomy teaching. Since the instrument was adapted from a Western study, a few changes were made and pre-tested among the faculty members and students for content and construct validity.[22] The final version of the questionnaire was pilot tested among 30 students and the Cronbach alpha obtained was 0.674. The response process validity, item-level and scale-level validity were above 0.8, ensuring the language and content clarity of the instrument.[23] The ethical approval for the study was procured from the university ethics committee [UOC/CRERC/EXTERNAL/05/2020 [UM. TNC2/UMREC-959]]. The questionnaire was administered through separate Google forms for Year 1 to Year 5, followed by a reminder, a week later. The objectives of the study were explained and informed consent was sought. After receiving the responses, the students were informed of the closure of the data collection process. Data were coded, entered, and analysed using SPSS version 25.

RESULTS

The responses provided an insight into SLT and the quality of radiological anatomy teaching that has been received so far as well as the preferred teaching modalities, regions and radiological modalities to be incorporated in gross anatomy teaching. The response rate (RR) was 80% (n=405) with Year 1 being the highest (RR=92.74%) and Year 5 being the lowest (RR=55%). The alpha value of the instrument was 0.764 (21 items) and was considered satisfactory.[24] The demographic data indicated the mean age of students was 21.91 (SD 1.84) and the respondents were predominantly females (Males n=136, Females n=269).

The overall impression of the participants is that the SLT for radiological anatomy is adequate as shown in Table 1. Even though the clinical students revealed adequate learning time (61.8%), a breakdown of data indicates that 49 out of 79 Year 3 students (62%) felt that radiological anatomy teaching is too little, indicating that minimal radiological anatomy teaching and radiology posting only in year 4 MBBS has left them deficient in image interpretation. The results indicate that the type of

radiological anatomy teaching was predominantly formal or even a mix of both formal and informal teachings. More than half of the clinical students (n=120, 56.6 %) indicated that the teaching they received is mixed with 15.1%, indicating that it is informal. This explained the fleeting nature of teaching during the clinical phase and substantiates the strengthening of knowledge at the pre-clinical level emphasizing equal opportunities for all students. This was further proven in all three clinical years, where more than 50% of the students felt that the teaching is a mix of both formal and informal.

When queried on the details of the quality of teaching, irrespective of their choice, majority of the students considered that the teaching was good. The participants have denoted that both anatomists and radiologists taught radiological anatomy except for year 4 students (78.2%) who receive information from radiologists only, owing to their postings during that academic year. Contradictory information provided by radiologists and anatomists lies in the context and presentation methods, where anatomists provide basic information, whereas, radiologists concentrated on more clinical aspects.

Table 1: Chi Square analysis by gender, pre-clinical and clinical years and years 3, 4 & 5 on perception on radiological anatomy teaching received

Amount of radiological anatomy teaching received so far						
Variables	**Total n**	**Too little n**	**Adequate n**	**Too much n**	**Pearson Chi-square**	***p****
Gender						
Male	136	68	68		16.002	.000*
Female	269	81	186	2		
Phase of study						
Pre-clinical	193	68	123	2	2.500	.286
Clinical	212	81	131			
Years 3, 4 & 5						
Year 3	79	49	30		30.667	.000*
Year 4	78	17	61			
Year 5	55	15	40			

Type of radiological anatomy teaching						
Variables	**Total n**	**Mostly informal n**	**Even mix of both n**	**Mostly formal n**	**Pearson Chi-square**	***p****
Gender						
Male	136	17	72	45	7.450	.024*
Female	269	25	118	126		
Phase of study						
Pre-clinical	193	12	70	111	36.649	.000*
Clinical	212	32	120	60		
Years 3, 4 & 5						
Year 3	79	23	43	13	23.061	.000*
Year 4	78	5	44	29		
Year 5	55	4	33	18		

Teachers of radiological anatomy					
Variables	**Total n**	**Both anatomists & Radiologists n**	**Either one n**	**Pearson Chi-square**	***p****
Gender					
Male	136	69	67	1.213	.27
Female	269	152	117		
Phase of study					
Pre-clinical	193	119	74	7.476	.006*
Clinical	212	102	110		
Years 3, 4 & 5					
Year 3	79	39	40	.550	.759
Year 4	78	17	61		
Year 5	55	28	27		

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Contradictory information in radiological anatomy						
Variables	**Total n**	**Taught by both with contradiction n**	**No contradiction**		**Pearson Chi-square**	***p****
			Taught by both n	**Taught by either one only n**		
Gender						
Male	136	3	66	67	2.009	.36
Female	269	4	150	115		
Phase of study						
Pre-clinical	193	5	116	72	9.535	.009*
Clinical	212	2	100	110		
Years 3, 4 & 5						
Year 3	79	1	37	41	1.094	.895
Year 4	78	1	35	42		
Year 5	55		28	27		

*p<0.05
Based on Chi Square for independence

The Chi-square test for independence indicated a significant association between gender and perception towards radiological anatomy teaching received so far, with X^2 (1, n=405)=16.002, p=.000, Cramer's V=.199 (small effect size), the Fischer's exact test for 2 x 3 contingency table using thse Freeman-Halton extension with an exact probability of 0.000016. This indicates a significant association between gender and the type of radiological anatomy teaching received so far among female students (n=186, 69.1%) where they quoted that the SLT is adequate.

The Chi-square test also indicated a significant association between gender and the type of radiological anatomy teaching received, with X^2(1, n=405)=7.450, p=.024, Cramer's V=.136 (small effect size). Male students (n=72, 52.9%) expressed that a mix of formal and informal teaching is more, whereas, female students (n=126, 46.8%) felt that it was more formal teaching. A significant association was also found between the pre-clinical and clinical years of study and the type of radiological anatomy teaching received so far, with X^2 (1, n=405)=36.649, p=.000, Cramer's V=.301 (medium effect size), teachers of radiological anatomy with X^2 (1, n=405)=7.476, p=.006,

Cramer's V=.136 (small effect size), and contradictory information on radiological anatomy with X^2 (1, n=405)=9.535, p=.009, Cramer's V=.153 (small effect size), the Fischer's exact test for 2 x 3 contingency table using the Freeman-Halton extension, with the exact probability of 0.3387. Half of the pre-clinical students (n=111, 57.5%) indicated that formal and informal teachings are common during the clinical years. Pre-clinical students (n=119, 61.7%) indicated that they received teaching from both radiologists and anatomists.

The Chi-square test for independence indicated a significant association between the clinical years of study and the amount of radiological anatomy teaching received so far, with X^2 (1,n=405)=30.667, p=.000, Cramer's V=.380 (large effect size) and the type of radiological anatomy teaching received, with X^2 (1, n=405) =23.061, p=.000, Cramer's V=.136 (medium effect size). Year 3 students (n=49, 62%) have revealed that the amount of radiological anatomy teaching they received is too little. Even though most of the students in all three years have mentioned that there is an even mix of formal and informal teachings, Year 3 students (n=23, 29.1%) have mentioned that they receive informal teaching compared to Year 4 (n=5, 6.4%) and Year 5 students (n=4, 7.3%). The perception of students on the teaching methods, content and radiological modalities yielded the following results as shown in Table 2.

The mean values from Table 2 showed that the clinical correlates/clinical skills sessions, gross anatomy practical sessions, videos and problem-based learning were the student-preferred teaching methods to incorporate radiological anatomy in the pre-clinical years (Mean value of ≥4.00/5.00). As for the regions to be taught, students prefer radiological anatomy to be incorporated into all topics that cover regional anatomy (Mean value ≥4.00/5.00). However, the mean of the thorax (*M=4.39±.742)* and abdomen (*M=4.34±.772)* were comparatively higher with their minimum values in the Likert scale being 2. The respondents overwhelmingly have chosen X-ray (*M=4.49±.766*) with a minimum value of 2 as the most important one apart from CT scan (*M=4.02±.903)* to be taught in the pre-clinical years.

To analyze the preferred teaching methods, the regions and radiological modalities, the data were subjected to non -parametric analyses as the Kolmogrov-Smirnov and Shapiro-Wilk tests were statistically significant (Sig. value=.000), suggesting a violation of the assumption of normality. The Mann-Whitney U-test for gender preferences of teaching modalities, regions and radiological modalities showed a significant difference as females prefer PowerPoint lectures and self-directed e-learning modules more than males as shown in Table 3. However, the effect sizes were small at 0.12 and 0.10 for both genders.

Table 2: Descriptive statistics of the choice of teaching learning methodologies, regions and radiological modalities *

Variables	M	SD	Min	Max	Skewness	Kurtosis
Teaching learning methodologies†						
Power point lecture	3.74	.924	1	5	-.664	.471
Gross anatomy practical and videos	4.28	.829	1	5	-.1.137	1.255
Problem-based learning	4.21	.835	1	5	-1.108	1.437
Dedicated self-directed e-learning modules	3.42	1.061	1	5	-.407	-.362
Self-directed learning from textbook/ atlas	3.24	1.035	1	5	-.180	.617
Clinical correlates/clinical skills sessions	4.38	.761	1	5	-1.380	2.538
Anatomical regions ‡						
Head and Neck	4.11	.842	1	5	-.788	.470
Brain and spinal cord	4.26	.832	1	5	-1.034	.922
Limbs	4.20	.848	1	5	-.956	.606
Thorax	4.39	.742	2	5	-.982	.261
Abdomen	4.34	.772	2	5	-.990	.404
Pelvis	4.15	.769	1	5	-.588	.0.19
Radiological modalities §						
X-ray	4.49	.766	2	5	-1.522	1.632
Ultrasonogram (USG)	3.97	.955	1	5	-.596	-.390
Computed tomography (CT)	4.02	.903	1	5	-.656	-.081
Magnetic resonance imaging (MRI)	3.76	1.045	1	5	-.519	-.437

Note. Based on 5-point Likert scale
*n = 405
† Data derived from 6 items of teaching learning methodologies
‡ Data derived from 6 items of the anatomical regions
§ Data derived from 4 items of the radiological modalities

Table 3: Mann-Whitney U test results for preferences by gender

Variables	Male (n =136) Mean Rank	Female (n = 269) Mean Rank	z	p*
Teaching-learning methodologies [a]				
Power point lecture	183.13	213.05	2.59	.01*
Gross anatomy practical and videos	195.14	206.98	1.048	.294
Problem-based learning	201.9	203.55	.145	.885
Dedicated self-directed e-learning modules	186.23	211.48	2.138	.033*
Self-directed learning from textbook/atlas	191.95	208.59	1.407	.160
Clinical correlates/clinical skills sessions	200.92	204.05	.283	.777
Anatomical regions [b]				
Head and Neck	196.56	206.26	.844	.399
Brain and spinal cord	205.00	201.99	.266	.79
Limbs	199.16	201.94	.507	.612
Thorax	210.7	199.11	1.046	.295
Abdomen	201.49	203.76	.203	.839
Pelvis	200.83	204.1	.286	.775
Radiological modalities [c]				
X-ray	204.74	202.12	.251	.802
USG	194.85	207.12	1.048	.295
CT	203.71	202.64	.091	.927
MRI	207.65	200.65	.593	.553

[a] Based on 5-point Likert scale from 1 = Not effective to 5 = Very effective
[b] Based on 5-point Likert scale from 1 = Irrelevant to 5 = Highly relevant
[c] Based on 5-point Likert scale from 1 = Not important to 5 = Very important
*p < 0.05

The Mann U-test for significant differences among the pre -clinical and clinical students indicated that the pre-clinical students preferred radiological anatomy of limbs, head, neck and pelvis as well as the teaching of MRI more than clinical students. Clinical students preferred PowerPoint lectures as well as the thorax and abdominal regions. However, the effect size was small for all variables except for X-ray, where the effect size was moderate (r=0.38) as shown in Table 4.

Table 4: Mann-Whitney U test results for preferences by pre-clinical and clinical years

Variables	Pre-clinical (n=193) Mean Rank	Clinical (n=212) Mean Rank	*z*	*p**
Teaching-learning methodologies [a]				
Power point lecture	188.97	215.77	2.454	.014*
Gross anatomy practical and videos	202.25	203.68	.134	.893
Problem-based learning	203.85	202.22	.152	.879
Dedicated self-directed e-learning modules	210.32	196.33	1.253	.210
Self-directed learning from textbook/atlas	213.85	193.13	1.852	.064
Clinical correlates/clinical skills sessions	193.86	211.32	1.668	.095
Anatomical regions [b]				
Head and Neck	215.21	191.88	-2.146	.032*
Brain and spinal cord	192.32	212.72	-1.901	.057
Limbs	223.72	184.14	-3.668	.000*
Thorax	178.83	225.00	-4.406	.000*
Abdomen	181.28	222.78	-3.921	.000*
Pelvis	217.37	189.92	-2.546	.011*
Radiological modalities [c]				
X-ray	178.57	225.24	-7.749	.000*
USG	204.9	201.27	-.328	.743
CT	197.01	208.46	-1.041	.298
MRI	225.31	182.69	-3.813	.000*

[a] Based on 5-point Likert scale from 1 = Not effective to 5 = Very effective
[b] Based on 5-point Likert scale from 1 = Irrelevant to 5 = Highly relevant
[c] Based on 5-point Likert scale from 1 = Not important to 5 = Very important
*p<0.05

The results of the Kruskal Wallis test for significant differences among the clinical years indicate a significant difference among the preferences for clinical students for the anatomical regions of the limbs and the radiological modality of ultrasound as shown in Table 5.

Table 5: Kruskal Wallis test results for preferences by among clinical years

Variables	Year 3 (n=79) Mean Rank	Year 4 (n=78) Mean Rank	Year 5 (n=55) Mean rank	*p**
Teaching-learning methodologies [a]				
Power point lecture	95.41	113.22	112.90	.097
Gross anatomy practical and videos	105.51	107.69	106.25	.970
Problem-based learning	104.28	105.07	111.72	.725
Dedicated self-directed e-learning modules	107.02	104.87	108.04	.949
Self-directed learning from textbook/atlas	100.30	108.70	112.28	.468
Clinical correlates/clinical skills sessions	105.61	102.43	113.55	.500
Anatomical regions [b]				
Head and Neck	106.32	112.10	98.82	.416
Brain and spinal cord	106.82	105.33	107.70	.969
Limbs	92.26	117.96	110.71	.017*
Thorax	108.37	103.75	107.71	.841
Abdomen	108.01	102.78	107.71	.733
Pelvis	103.26	111.47	109.60	.624
Radiological modalities [c]				
X-ray	106.12	103.58	111.19	.638
USG	121.17	96.71	99.03	.018*
CT	111.73	98.76	109.95	.325
MRI	117.53	101.68	97.49	.104

[a] Based on 5-point Likert scale from 1 = Not effective to 5 = Very effective
[b] Based on 5-point Likert scale from 1 = Irrelevant to 5 = Highly relevant
[c] Based on 5-point Likert scale from 1 = Not important to 5 = Very important
*p<0.05

To examine where the differences occurred in the groups, post hoc tests using the Mann-Whitney U-test were used as shown in Table 6. The Bonferroni adjustment for significance was 0.017. A significant difference was seen with Year 4 students preferring radiological anatomy of limbs at a higher mean rank than Year 3 students. On the contrary, Year 3 students opted to learn about USG more than Year 4 students. Both tests had a small effect size.

Table 6: Mann Whitney U test for comparison of 3 groups

Years of study	*z*	*p*§	*r*
Limbs			
Year 3- Year 4*	-2.732	.006*	0.218
Year 4- Year 5†	-.782	.434	
Year 3- Year 5‡	-1.872	.061	
USG			
Year 3- Year 4*	-2.617	.009*	0.209
Year 4- Year 5†	-.197	.844	
Year 3- Year 5‡	-2.164	.030	

Note. Based on 5-point Likert scale
*n = 157
†n= 133
‡n = 134
§p<0.017

The analysis of open-ended questions provided insights into why the students expressed their perceptions in a certain way and supported the quantitative data. The suggestions of the students to enhance the radiological anatomy teaching can be grouped into themes, such as teaching-learning methods, teaching-learning materials, curriculum, assessments, and teachers. The themes that emerged for choosing practical teaching are effective management of cognitive load through the incorporation of student-centred learning methods and the validation of knowledge by teachers. The learning materials consist of a comprehensive radiological guide/module with clear and concise notes and images of clinical cases, which are well-labelled and are preferred apart from the multiple film sessions.

The clinical students emphasized an increase in SLT of radiological anatomy during the pre-clinical phase for curricular improvement. Formative assessments remained the method of choice for students due to the feedback received after the assessments. Majority of the students asked for anatomists to teach the correlation between the basic and clinical content. However, overwhelming voices were also heard to involve radiologists in the pre-clinical radiological anatomy teaching with the scope being the clinical interpretation of radiological investigations.

DISCUSSION

This study aimed to receive feedback and evaluation of radiological anatomy teaching for MBBS students based on the Johari window framework.[20] In the process of providing feedback, students explored their blind spots to provide truthful answers and the faculty taps the learner's needs to plan curricular development.[25] SLT for radiological anatomy seemed adequate but 62% of Year 3 students indicate inadequate SLT, with male students (n=68, 50%) expressing the need for more SLT than female students. Poor representation of radiology in the pre-clinical curriculum has led to students' hesitance in interpreting radiological investigations and difficulty in correlating radiological anatomy with clinical examinations.[26]

Radiological anatomy as an integral part of pre-clinical teaching effectively bridges the time lapse between the pre-clinical and clinical years, enabling knowledge transfer.[26,27] 56.6% of clinical students indicated that the nature of teaching is an even mix of both formal and informal teachings, which is statistically significant among all three clinical years (Year 3=54.4%, Year 4=56.4%, Year 5=60%). It was evident that male students perceived an even mix of both, compared to female students who reported that they received only formal teaching. The interest of male students in procuring knowledge through informal methods has been translated to their increased confidence in knowledge.[2] Less documented learning outcomes lead to poor knowledge since unstructured learning environments are non-conducive for novice learners.[7,28]

The incorporation of radiological anatomy into formal teaching with specified learning outcomes guides the process of teaching and assessments.[7,29] and ensures equal opportunities.[30] Radiologists, or radiology residents and anatomists trained in ultrasonogram (USG) are preferred as the teachers for radiological anatomy.[11,31] Radiologists tend to provide more clinically relevant knowledge and anatomists have factual knowledge.[21] The advantages of radiologists as teachers are, being able to provide a comprehensive overview of a case, holistic knowledge, radiological research interest and training of doctors with the right knowledge, skills and attitude for clinical practice.[4,21,29,32] The challenges in involving radiologists as teachers include cost and prioritization of time for teaching and patient service.[4,8] On the contrary, anatomists as radiological anatomy teachers carry the advantages of uniformity in anatomical content taught across various sites and tools.[33] The future of radiological anatomy education lies in the collaborative work between radiologists, anatomists, and management, that support to realise vertical integration.[5] Students prefer teaching radiological anatomy through hands-on practical sessions, CST, CC and PBL (*Mean>4.00*). Even though it is not the overall preferred mode of teaching, female students and clinical students preferred PowerPoint lectures. Lectures provide extensive guidance and explanations that arms students with introductory knowledge useful for practice.[21,34,35] The base for life-long learning is not welcomed due to the traditional teaching-learning that favors rote learning.[12,36]

Small group sessions, such as hands-on practical and CC sessions are proven to be preferred by the students.[11,15,27,37] Factual classes that instill the right knowledge also help correlate the anatomy and pathology processes, which is a must for radiological anatomy, but must be augmented by additional tools.[32,38,39,40] PBL is an effective way to introduce radiological anatomy for pre-clinical students with a radiologist participating in the course and PBL design.[32,41,42] Live teachers are preferred over web-based teachers as the students are not so keen on e-modules since the teachers ensure personal communication, active engagement of students and track individual progress.[32,38] Lectures, small group learning in practicum, PBL, clinical skills sessions and film sessions are cost-effective choices in developing nations too.[43,44,45]

Students in our study expressed their need for imaging modules/normal and pathological film sessions with labels for radiological anatomy learning, which are similar to medical students in UK and junior doctors in Ireland.[9,12,46] Even though radiological anatomy of all regions was preferred, the highest mean was scored by the thorax (Mean=*4.39±.742*, *Min=2, Max=5*) and abdomen (*M=4.34±.772, Min=2, Max=5*), indicating that those regions are the contexts where radiological anatomy is

mostly sought.[36,37] Pre-clinical students preferred the head and neck, limbs and pelvic regions for understanding anatomical orientation and clinical students preferred the thorax and abdomen to interpret radiological investigations, indicating varied needs. Specifically, Year 4 students have an increased preference for limbs since they undergo orthopedics and emergency medicine postings where identifying limb injuries is pertinent. Students in Germany have asked to increase radiological anatomy content in the nervous system and reproductive modules, similar to our study, to help learn topographical anatomy.[34] Similarly, medical educators in Canada launched a radiological anatomy programme for pre-clinical students with topics focusing on neuro, thorax, abdomen, and limb imaging.[35]

A 3-round Delphi consensus study among experts in Canada on the inclusion of USG topics for undergraduate curriculum focused on the thorax and abdomen as emergent topics alike the perception of our students.[19] X-ray (*M=4.49±.766, Max=5, Min=2)* and CT (*M=4.02±.903, Max=5, Min=1)* are the preferred radiological modalities as shown by the results. Even though there is no difference in the perception among the genders, clinical students preferred X-ray teaching compared to MRI since the peripheral teaching hospitals lack MRI facilities, which is indicative of budget constraints in developing nations that resulted in different needs.[44] Studies report that radiological anatomy was best if introduced in Years 1-2 in medical school and X-rays can be the single tool for effective teaching.[47]

CT and MRI followed X-ray as the choice of radiological anatomy tools rather than USG, which also scored the lowest mean in this study (*M=3.97±0.955*).[12,28,33,37,48,49] The non-preference to USG as a teaching tool might be due to the difficulty in the orientation, culminating in the inability to recognise anatomical structures in the USG images.[31,39] The three most important topics included in undergraduate teaching in the UK were chest X-ray, CT, and abdominal X-ray, which matches the needs of our students as expressed by their responses to the open-ended questions.[11] USG is only preferred by Year 3 students to equip them with the USG principles and anatomy to enable its use at the bedside.[50]

CONCLUSION

The study provides vital information on the needs of the students concerning radiological anatomy content, teaching methods, teachers and radiological anatomy modalities. The pre-clinical radiological anatomy teaching curricula must be restructured to achieve effective vertical integration of anatomy and radiology and transferable knowledge.

Limitations

The limitations include being a single institutional study and potential self-reporting and recall bias. Nevertheless, the findings of this study provide a glimpse of the impending needs and aid in curricular design and improvement.

Scope for future work

The current study explores the perceptions towards the radiological anatomy module only from the student's point of view of a single medical institution in Malaysia. With the limitations in mind, there is potential for future work, such as a Delphi study in the faculty to achieve consensus on designing and implementing a revised radiological anatomy module. Furthermore, implementation of the revised radiological anatomy module, followed by an investigation of the potential benefits and exploring the possibility to extend this study across other medical institutions would be potential future studies.

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