Recall Knowledge of Anatomy for Interns after Graduation from Medical Schools
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ABSTRACT
Background: Educational achievement testing is a challenging area of medical education. The purpose of the medical education is mainly to generate excellent medical physicians. There is several diverse systems of medical education in the world. We do not know which system is the best for training of medical students. It is a big issue in Sudanese medical schools to seek for the most effective medical education system.
Objectives: To analyze how medical education is carried out in medical schools by testing the recall knowledge of the basic sciences after graduation.
Material and Methods: We tested the recall knowledge of anatomy among interns after graduation from our different medical schools that implemented different medical education systems using a self-administered questionnaire consisted of 10 single best answer questions validated by anatomists and surgeons from 3 different universities adopting different types of curricula.
Results: A 365 interns within different training specialties were included for the final assessment. The anatomy was considered a difficult subject by 67.1%, and 67.7% were scored 5-7. The system adopted by participants' school of graduation, number and discipline of the rotation when participating in the study, whether preparing for specialty exam or not, showed high significant correlation with the score attained on answering the basic anatomy questions, (P<0.05). But the score was not influenced by gender and the time lapse since graduation, (P > 0.05).
Conclusion: Interns graduated from schools adopting integrated system or Hybrid system scores better than those graduated from schools adopting the conventional medical system.
Keywords: Anatomy; Medical education; Integrated (Problem-based); Conventional instructional (Discipline-based); Hybrid (Combination).

Medical school curricula reflect how schools conceptualize the relationship between basic and clinical sciences, with courses and learning experiences meant to advance students through the clinical reasoning process from novice to expert. Gross anatomy is the cornerstone of medical education; anatomical knowledge is undoubtedly essential for doctors regardless of their specialty, particularly since they continue to perform physical examinations, make medical decisions, communicate with colleagues and provide explanations to patients. Furthermore, expert knowledge of anatomy is essential in the present day, particularly for surgeons, because of the development of various surgical techniques and emergence of more sophisticated imaging technologies.
The past decade has seen major changes in teaching of anatomy to medical students. Anatomy education has a long history, and it continues to evolve. Recently, many anatomy curricula have been restructured to reflect novel teaching philosophies: problem-based learning (PBL), teaching by organ system and integration with clinical experiences. Training of medical students should enable them to become safe and effective physicians. Medical students preferentially adopt a deep approach to learning, correlated with better outcomes than surface approaches. On graduating from university, each doctor is faced with the task of transforming the theoretical knowledge gained during training into the practical.

While teaching medical students one must carefully put in mind: what portion are they retaining in memory? What are they learning? This seems to be the central question for medical education. Surely if students are not remembering what they have been taught then the effort was wasted; if students cannot make use of the knowledge they have been taught, if that knowledge becomes inert and inaccessible, then why teach it in the first place?

Studies have mostly focused on basic science knowledge and its usefulness in clinical diagnosis, less attention has been given to the transformation of acquired knowledge over time.

A loss of knowledge among senior medical students was confirmed by all the studies conducted. Studies found that medical students show a decline in pre-clinical knowledge of basic science by 21% to 35%. One study stated that the knowledge loss over the ten months was 52% of neuroanatomy.

The integrated PBL approach seems to be associated with uncertainty and perceived deficiencies in terms of basic science knowledge. PBL is used to describe many heterogeneous educational activities. It is therefore hard to prove or disprove the claims made by its advocates. In order to objectify the deficiencies perceived by PBL, we investigated whether PBL and non-PBL graduates in Sudan differ in recall knowledge of anatomy at the period of internship.

**MATERIAL AND METHODS:**

A cross-sectional study recruited interns from seven teaching hospitals in Khartoum state, Sudan. The study was based on a structured questionnaire containing ten validated clinical anatomy single best answer questions (SBA) that the graduates were supposed to recall from their prior knowledge.

More than 10 clinicians from different disciplines were asked to generate topics that graduates are likely to encounter during clerkship and for which they need anatomical knowledge. On the basis of this list, a team of authors and anatomists from 3 different medical schools developed 10 anatomical questions. All questions were marked out of ten.

Questionnaire included other information; gender, age, year of graduation, medical school and their curriculum system adopted and whether preparing for board exams such as MD, MRCS, USMLE and PLAB. Pre-testing was conducted using a sample of 20 interns who were asked to comment on the content and clarity of the questionnaire. Necessary modifications were made as per the feedback received and two statements were added to test the participant’s perceptions regarding anatomy (Appendix 1). All participants were asked to complete a short questionnaire before taking the anatomy test. To answer anatomy questions the time slot was 10 minutes for each participant and participants were not allowed to open books or talk to colleagues. The obtained results were categorized into 3 score groups; ≤ 4, 5 — 7, and ≥ 8.
Their perception regarding anatomy was tested by 2 questions; how much it is difficult? And how much knowledge retained in your mind, you think? These questions were graded from 0 to 10 (0 easiest score and 10 highest score).

The results were spread in master sheet, entered into computer and managed statistically using SPSS for data analysis. We used Kolmogorov-Smirnov test to investigate the normality of distribution of scores obtained from questions. Since the distribution was normal, we correlated scores using Pearson Chi square between the groups.

Numerical variables were expressed as mean and standard deviation. Categorical variables were expressed as percentage and the association between different variables was performed. Significance level was defined as $p \leq 0.05$.

**RESULTS:**

A total of 379 self-administered questionnaires were distributed among interns after acceptance of the given informed consent (Appendix 1). Out of those, 365 participants answered the questions and filled the questionnaire appropriately. The remaining 14 questionnaires were excluded from the study for being not correctly filled. Out of 365 respondents 262 (71.8%) were females and 103 (28.2%) were males with male to female ratio of 1:2.5.

Two hundred thirty six (64.7%) were from schools adopting integrated system, 83 (22.7%) were graduated from medical schools adopting conventional instructional system and 46 (12.6%) were graduated from medical schools adopting hybrid system. Two hundred thirty eight (65.2%) participants spent between 1 to 2 years since graduation, 74 (20.3%) of the participants spent less than one year, and 53 (14.5%) spent more than 2 years since graduation.

The participants were interns in their training program within different specialties. At the timing of participation in this study, 101 (27.7%) of the participants were in their Obstetrics and Gynecology rotation, 98 (26.8%) were in Medicine, 87 (23.8%) were in Surgery and 79 (21.6%) were in Pediatrics rotation. Hundred thirty eight (37.8%) of participants were preparing for qualifying examinations.

To test participant’s perception we first asked students what they thought about the difficulty of anatomy education and the extent to which they felt they had retained in their mind, into which we scored the difficulties from 0 to 10 (0 is the easiest and 10 is most difficult). The vast majority of the respondents 245 (67.1%) have considered anatomy is a difficult subject and scored $\geq 8$.

In the same way the vast majority of the respondents 231 (63.3%) thought that they retained a fair level of anatomical knowledge in their mind and scored 5-7 (Table 1).

**Table 1: Participant’s perception of anatomy education and retention of knowledge.**

<table>
<thead>
<tr>
<th>Score</th>
<th>How much anatomy is difficult?</th>
<th>Frequency</th>
<th>%</th>
<th>How much knowledge retained in their mind?</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td></td>
<td>033</td>
<td>09.1</td>
<td>057</td>
<td>15.6</td>
<td></td>
</tr>
<tr>
<td>5-7</td>
<td></td>
<td>087</td>
<td>23.8</td>
<td>231</td>
<td>63.3</td>
<td></td>
</tr>
<tr>
<td>8-10</td>
<td></td>
<td>245</td>
<td>67.1</td>
<td>077</td>
<td>21.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>365</td>
<td>100</td>
<td>365</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

*0: Easiest/Minimum score, 10: Most difficult/Maximum score.

Thirty-eight (10.41%) participants scored $\geq8$ in the assessment, 247 (67.7%) scored between 5-7 and 80 (21.9%) scored $\leq 4$ (Figure 1). The mean for all participant’s
marks was found to be $5.72 \pm 1.61$, and for those who graduated from medical schools adopting conventional instructional system was $4.86 \pm 1.65$, for graduates from medical schools adopting integrated system was $6.33 \pm 1.33$ and for graduates from medical schools adopting hybrid system was $5.9 \pm 1.72$. Building on these facts, there is significant correlation between integrated system and the high score attained by the participants ($P=0.000$).

Correlations of scores attained by the participants with other parameters in the questionnaire were elucidated. The system adopted by participants' school of graduation, number and discipline of the rotation when participating in the study, whether preparing for specialty exam or not, showed high significant correlation with score of the participants on answering the basic anatomy questions in the study questionnaire, ($P$ values $<0.05$). The score of the participants was not influenced by their gender and the time lapse since graduation, ($P$ values $> 0.05$) (Table 2).

**DISCUSSION:**

While education system and curriculum are diverse among medical schools in our country, the aim of almost all medical school is focused on generating excellent clinical physicians. Therefore, considerable number of medical schools uses to pay more attention in early delivery of clinical education.

Assessment in medical education is essential for ensuring competence and evaluating the quality of training. Anatomical knowledge can be assessed by written, practical or oral methods. Written assessments typically consist of extended matching questions (EMQs), single best answer questions (SBAs) and short answer questions (SAQs)\(^{14}\). Built on this basic, assessment of the retained anatomical knowledge among respondents was carried out by SBA modality.

Medical students build their clinical knowledge on the grounds of previously obtained basic knowledge. There is a growing concern among medical educators that traditional programs of teaching medical students have not provided better outcomes of learning. In the conventional system of medical education, basic medical sciences (anatomy, biochemistry and physiology) are taught in the early years of medical course with least interdisciplinary interaction. Such a system is teacher centered with minimal active participation from the students\(^{15}\).

Worldwide trends in medical education have influenced medical education for decades by the introduction of an integrated curriculum, implementation of problem-based learning, early exposure to clinics, and so on. These reforms have changed basic science education including anatomy\(^{2}\). Though whole of the syllabus cannot be covered by this approach and a hybrid approach has to be adopted in which few topics are covered by traditional didactic lectures and the rest as clinical cases\(^{16}\). Moreover, it requires greater coordination among different basic and clinical departments and a motivated faculty committed to improvement in standard of medical education\(^{17}\).

The vast majority of respondents (77.3%) were graduated from medical schools adopting problem-based and hybrid systems, this explain the trend in medical education in Sudan towards changes from classical conventional instructional (Discipline-based) into integrated (Problem-based) to hybrid (Combination) systems.

The majority of the respondents (67.1%) had considered anatomy is difficult to be learnt. In the other way, study in Korea\(^2\) among students’ perception of anatomy education at a Korean medical college 58.7% of students felt that their anatomy
Figure 1: Scores of participants in the knowledge test of anatomy recall

Table 2: Characteristics of studied groups

<table>
<thead>
<tr>
<th>System adopted</th>
<th>≥8</th>
<th>Attained score</th>
<th>≤4</th>
<th>Total (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Integrated (Problem-based)</strong></td>
<td>28 (11.9%)</td>
<td>184 (78.0%)</td>
<td>24 (10.1%)</td>
<td>236 (64.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>Conventional instructional (Discipline-based)</strong></td>
<td>6 (7.20%)</td>
<td>31 (37.4%)</td>
<td>46 (55.4%)</td>
<td>83 (22.7%)</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Hybrid (Combination)</strong></td>
<td>4 (8.70%)</td>
<td>32 (69.6%)</td>
<td>10 (21.7%)</td>
<td>46 (12.6%)</td>
<td></td>
</tr>
<tr>
<td><strong>Gender performance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>24 (9.20%)</td>
<td>177 (67.6%)</td>
<td>61 (23.2%)</td>
<td>262 (71.8%)</td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>14 (13.6%)</td>
<td>70 (68.0%)</td>
<td>19 (18.4%)</td>
<td>103 (28.2%)</td>
<td>0.110</td>
</tr>
<tr>
<td><strong>Discipline of rota</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Obs. &amp;Gynae.</strong></td>
<td>10 (9.90%)</td>
<td>65 (64.4%)</td>
<td>26 (25.7%)</td>
<td>101 (27.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>Medicine</strong></td>
<td>3 (3.10%)</td>
<td>66 (67.3%)</td>
<td>29 (29.6%)</td>
<td>98 (26.8%)</td>
<td></td>
</tr>
<tr>
<td><strong>Surgery</strong></td>
<td>17 (19.5%)</td>
<td>53 (61.0%)</td>
<td>17 (19.5%)</td>
<td>87 (23.8%)</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>Pediatrics</strong></td>
<td>8 (10.1%)</td>
<td>63 (79.8%)</td>
<td>8 (10.1%)</td>
<td>79 (21.6%)</td>
<td></td>
</tr>
<tr>
<td><strong>Number of rota</strong></td>
<td></td>
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<td></td>
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<tr>
<td><strong>1st</strong></td>
<td>6 (6.50%)</td>
<td>36 (39.1%)</td>
<td>50 (54.4%)</td>
<td>92 (25.2%)</td>
<td></td>
</tr>
<tr>
<td><strong>2nd</strong></td>
<td>4 (7.02%)</td>
<td>40 (70.17%)</td>
<td>13 (22.8%)</td>
<td>57 (15.6%)</td>
<td>0.000</td>
</tr>
<tr>
<td><strong>3rd</strong></td>
<td>15 (14.6%)</td>
<td>85 (82.5%)</td>
<td>3 (2.90%)</td>
<td>103 (28.2%)</td>
<td></td>
</tr>
<tr>
<td><strong>4th</strong></td>
<td>13 (11.5%)</td>
<td>86 (76.1%)</td>
<td>14 (12.4%)</td>
<td>113 (31.0%)</td>
<td></td>
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<tr>
<td><strong>Preparation for specialty exam</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Non</strong></td>
<td>8 (3.50%)</td>
<td>152 (67.0%)</td>
<td>67 (29.5%)</td>
<td>227 (62.2%)</td>
<td></td>
</tr>
<tr>
<td><strong>Medicine/Pediatrics</strong></td>
<td>3 (5.70%)</td>
<td>43 (81.1%)</td>
<td>7 (13.2%)</td>
<td>53 (14.5%)</td>
<td></td>
</tr>
<tr>
<td><strong>Surgery/ orthopedics</strong></td>
<td>16 (37.2%)</td>
<td>25 (58.1%)</td>
<td>2 (4.70%)</td>
<td>43 (11.8%)</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Obs. &amp;Gynae.</strong></td>
<td>10 (28.6%)</td>
<td>22 (62.8%)</td>
<td>3 (8.60%)</td>
<td>35 (9.60%)</td>
<td></td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>1 (14.3%)</td>
<td>5 (71.4%)</td>
<td>1 (14.3%)</td>
<td>7 (1.90%)</td>
<td></td>
</tr>
<tr>
<td><strong>Time since graduation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 year</td>
<td>8 (10.8%)</td>
<td>51 (68.9%)</td>
<td>15 (20.3%)</td>
<td>74 (20.3%)</td>
<td></td>
</tr>
<tr>
<td>1 - 2 years</td>
<td>23 (9.6%)</td>
<td>162 (68.1%)</td>
<td>53 (22.3%)</td>
<td>238 (65.2%)</td>
<td>0.200</td>
</tr>
<tr>
<td>&gt; 2 years</td>
<td>7 (13.2%)</td>
<td>34 (64.2%)</td>
<td>12 (22.6%)</td>
<td>53 (14.5%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>38 (10.4%)</td>
<td>247 (67.7%)</td>
<td>80 (21.9%)</td>
<td>365 (100%)</td>
<td></td>
</tr>
</tbody>
</table>
education had been helpful for clinical clerkship in spite of that it is difficult. In contrary, students in general consider anatomy a very important subject for their future as practicing doctors. There is a widespread belief among physicians and medical educators that a substantial portion of the basic science information learned in the traditional preclinical years in medical school is lost during the clinical years. This has been supported by many studies. Miller flagged that it is not uncommon for students to retain around 10% of the anatomy offered in their traditional course. Things have not changed since then. Another cross-sectional study in Saudi Arabia reported that 21% of their students were able to recall anatomy in their clinical years. The current study showed better results with recall knowledge of anatomy being 78.1% among respondents. Approximately eighty-four (84.4) of respondents felt that they were able to recollect the facts related to anatomy during their clinical practice. The general picture is that gross anatomy shows a modest loss. Krebs discovered that medical students retained 65% of the simple basic science knowledge.

Anatomy is essential for all branches of medicine. The anatomical knowledge gathered is used by a doctor throughout his life. Whatever methods of instruction used and whatever types of questions examined, the findings had pointed to a loss of knowledge. This is in agreement with the results obtained in the current study as the accumulative knowledge loss was 21.9%. This loss was observed in all respondents irrespectively. We cannot completely rule out the possibility of pre-existing systematic differences between students from different medical schools. However, given the homogeneity of Sudan high school education and the national admission procedure to medical school, significant differences between schools in student levels are unlikely.

In fact, the respondents from schools adopting problem-based learning found to have the highest level of anatomy recall knowledge as compared to the graduate from other medical schools adopting the classical conventional system. In contrary, Prince et al. in Netherlands had concluded that problem-based learning students were found to have the same perceived level of anatomy knowledge as students at other medical schools. Differences in actual levels of knowledge were found between schools. No significant effects on knowledge levels were found for PBL schools versus non-PBL schools.

The level of basic science knowledge used in clinical diagnosis differs depending on the discipline and mirrors to some extent the content of clinical clerkships: anatomy appear more susceptible to substantial decay.

In conclusion, up to 78.1% of preclinical knowledge of anatomy can be memorized by all intern doctors after graduation irrespective to differences in curricula. In modern curricula, the early integration of anatomy and clinical skills education at undergraduate level is seen as important. The findings of this study reflected that medical doctors graduated from schools adopting integrated instructional system or Hybrid system scores better than those graduated from schools adopting the conventional medical system.

**FUNDING:**
There was no external funding for this paper.

**CONFLICT OF INTEREST:**
The authors declare that there is no conflict of interest.
ACKNOWLEDGEMENTS:
The author’s words of appreciation and gratitude were transmitted to the department of anatomy in Alzaeim Alazhari, Omdurman Islamic, and Khartoum Universities as well as to surgeons from Khartoum North and Bashair Teaching Hospitals for critically reading, revising and validating questionnaire, and the anonymous reviewers for their helpful comments.

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Appendix (1)

The questionnaire is designed for research purposes - (Recall Knowledge of Anatomy for House Officers).

Consents and data will be of use only in the purposes of the research and any deviation will not be allowed.

The responsibility of data collection, analysis and confidentiality of the results is the responsibility of the researchers who prepared the questionnaire.

Please tick in all fields as appropriate:

<table>
<thead>
<tr>
<th>Questionnaire No. ( )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Male 0</td>
</tr>
<tr>
<td>Female 0</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Graduation year</td>
</tr>
<tr>
<td>UNIVERSITY</td>
</tr>
<tr>
<td>System adopted in university</td>
</tr>
<tr>
<td>Integrated) 0</td>
</tr>
<tr>
<td>Other completed training specialty:</td>
</tr>
<tr>
<td>Medical 0</td>
</tr>
<tr>
<td>Pediatrics 0</td>
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<tr>
<td>Ob/Gyn 0</td>
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<tr>
<td>Surgery 0</td>
</tr>
<tr>
<td>Have you tried to do postgraduate study?</td>
</tr>
<tr>
<td>Yes 0</td>
</tr>
<tr>
<td>No 0</td>
</tr>
<tr>
<td>Preparing/previous attempt for publishing exam (NBME, SBME, PLAB, USMLE, etc.)</td>
</tr>
<tr>
<td>Yes 0</td>
</tr>
<tr>
<td>No 0</td>
</tr>
</tbody>
</table>

Anatomy

From 0 to 10. How much is it difficult? (0 easiest, 10 highest score)

How much knowledge retained in your mind you think?

1. The muscular triangle:
   - ( ) A. It is bounded medially by the rectus femoris muscle
   - ( ) B. It is bounded laterally by the adductor longus muscle
   - ( ) C. Femoral artery that is the lateral to the femoral vein
   - ( ) D. Femoral vein is fixed to the femoral nerve
   - ( ) E. Femoral arteriole is the most medial of the neurovascular bundle in the triangle

2. The veins supplied by blood from:
   - ( ) A. Right subclavian and external carotid arteries
   - ( ) B. External carotid and vertebral arteries
   - ( ) C. Internal carotid, external carotid and vertebral arteries
   - ( ) D. Internal carotid artery and direct branch from the aorta

3. The thyroid gland:
   - ( ) A. It is located from the middle line
   - ( ) B. Receives a major blood supply from the middle thyroid artery
   - ( ) C. Receives some blood supply via the superior thyroid artery and a branch of the internal carotid artery
   - ( ) D. Receives some of its blood supply via the thyrocervical artery

4. The brain:
   - ( ) A. Its base extends over 2/3 of its neurocranium space
   - ( ) B. Has an arterial supply derived from the brachial artery
   - ( ) C. Has a supply in the T2 dermatome
   - ( ) D. The neurocranium space has the petrosal sinus
   - ( ) E. It is enclosed by the outer cranial fossa

5. The oesophagus:
   - ( ) A. 25 cm in length
   - ( ) B. Enters the abdomen through a diaphragmatic hiatus at the level of the T5 vertebral
   - ( ) C. Is supplied by one of the intrathoracic stomachs
   - ( ) D. It is used more closely related to the anterior vaso and the posterior vaso in its abdominal course

6. The vein superior vena cava:
   - ( ) A. Terminates at the spheno-vestibular vein at mid-thigh
   - ( ) B. Passes behind the lateral border of the pectoralis
   - ( ) C. Communicates with the deep veins of the lower limb
   - ( ) D. Lies in the bifurcation of the aorta
   - ( ) E. Has one tributary in the groins

7. A patient presents with an inability to adduct and abduct the fingers, positive Frenze’s sign, loss of sensation of the medial 1.5 digits and clawing of the ring and little fingers. The nerves involved:
   - ( ) A. Median nerve
   - ( ) B. Radial nerve
   - ( ) C. Ulnar nerve
   - ( ) D. Median and median nerves
   - ( ) E. Median, radial and ulnar nerves

8. Levator ani:
   - ( ) A. Forms the roof of the rectal tract
   - ( ) B. Is supplied by L4/L5
   - ( ) C. Lies at the bifurcation of the aorta
   - ( ) D. Divided into deep and superficial parts
   - ( ) E. Originates from the ischial spine eight

9. In the inguinal canal the inguinal and lacunar ligaments from:
   - ( ) A. Anterior wall
   - ( ) B. Posterior wall
   - ( ) C. Roof
   - ( ) D. Flap
   - ( ) E. Posterior wall and roof

10. Liver:
    - ( ) A. The left lobe is in direct contact with the left supramedial
g    - ( ) B. Is covered completely with peritoneum
    - ( ) C. Is attached to the diaphragm by the falciform ligament
    - ( ) D. May be divided into 6 anatomical segments
    - ( ) E. Left lobe is larger than the right lobe

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