Analysis of the Pathology Section of the OITE Will Aid in Trainee Preparation

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Abstract We analyzed the tumor-related questions on the Orthopaedic In-Training Examinations (OITE) over a 5-year period (2002–2006). Each year approximately 27 of the 275 examination questions (10%) are tumor-related. Malignant conditions are tested more than benign ones (1.2:1). Approximately nine questions per year are immediate recall of specific entities, while eight questions tested the examinees' ability to establish a diagnosis from imaging studies with or without biopsy material. Participants were required to establish a diagnosis from imaging studies and/or biopsy material and then choose treatment an average of seven times per examination. The examinees' abilities in evaluation and decision making of patients was only tested an average of twice during each examination. Analysis of the content and type of question on the OITE might enable trainees to prepare more systematically. We determined the content, classified the questions, and quantified the interpretive material.

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Introduction

The Orthopaedic In-Training Examination (OITE) was first administered in 1963 by the American Academy of Orthopaedic Surgeons. The purpose of the examination was to (1) measure the knowledge of residents against a national norm; (2) determine some minimal standards for trainees in a training program; and (3) measure the quality of teaching in a program [7]. The OITE has been administered annually on the second Saturday in November since its inception. The current examination is composed of 275 questions divided into 14 domains. In 2006 the examination was administered to 3382 individuals.

The OITE examination is the only annual national examination uniformly administered to orthopaedic residents. In addition to providing residents with an opportunity to compare their knowledge base with that of their colleagues across the country, the examination itself is provided to the residents along with the preferred responses and a set of references at the time the scores are returned. Thus the examination itself becomes a valuable study tool for future in-training examinations and, ultimately, the ABOS certifying examination.

We analyzed the OITE pathology content to guide trainees in studying for the examination. Review of the content might enable residents to focus their study on diseases judged important by the test-makers. We determined: (1) the average number of pathology questions on each examination over a five year period (the exact period of time each resident participates in the examination) and recorded malignant and benign conditions tested; (2) if any common tumor conditions were excluded; (3) the common pattern of test questions (i.e., patterns related to taxonomic classification; and (4) the specific imaging modalities (individual or in

combination) used to make accurate diagnosis or plan treatment.

Materials and Methods

We analyzed the OITE of the American Academy of Orthopaedic Surgeons over a 5-year period (2002–2006). First we determined and recorded the number of pathology questions and the specific diagnoses for each examination. By breaking down the pathology questions on serial examinations, we presumed we could suggest a more focused and organized way of studying the large body of information. We then classified the questions into one of five categories—tumor knowledge, diagnosis, treatment from diagnosis, evaluation/decision-making, treatment modalities—and labeled each as taxonomy 1 (recall), taxonomy 2 (interpretation), or taxonomy 3 (problem solving). The tumor knowledge questions (taxonomy 1) required the examinee to remember specific facts about the entity tested. For example, the examinee might be asked the most common axial location of giant cell tumor of bone. The questions categorized as diagnosis type (taxonomy 2) were ones that required the trainee to review one or several imaging studies with or without a concomitant histologic section and determine the diagnosis. These questions often would give a short history, and the examinee would be required to interpret plain radiographs, MR images, and a biopsy specimen and then select a diagnosis from five choices. The third type of question requires the highest level of cognitive performance and asks the individual to select a treatment method after interpreting an imaging study with or without a histologic specimen (taxonomy 3). A typical question includes a short history, plain radiographs, MR images, and a histologic section requiring the trainee to both establish a diagnosis and then select the most correct treatment method pertinent to both the history and imaging studies. Similarly, the evaluation/decision-making-type questions (taxonomy 3) require the examinee to choose the next step in management without being able to establish a diagnosis from the given data. An example would be a question about a patient with a soft tissue mass, a T1- and T2-weighted MR image, and no biopsy material. The examinee then selects the most correct treatment option ranging from removing the mass to observation only. The fifth type of question tests the immediate recall (taxonomy 1) of the examinee's knowledge of various oncology treatment modalities. An example would be asking the common mechanism of action of a particular chemotherapy agent.

We recorded the type of interpretative studies for each examination. Imaging studies included plain radiographs, MRI scans, and/or CT scans. The histologic studies

generally included low- and high-power hematoxylin and eosin sections. Occasional questions included an angiogram or clinical photograph for interpretation.

Results

The number of pathology questions per OITE averaged 27.2 ± 3.4 (range, 24–32) (Table 1). The percentage of tumor related questions on each examination varied between 8.7% and 10.5% (average, 9.9%). Malignant entities were more commonly tested than benign ones by a ratio of 1.2:1.

The five most common malignant entities tested were osteosarcoma, metastatic bone disease, Ewing's sarcoma, chondrosarcoma, and synovial sarcoma (Table 2). The five most common benign entities evaluated were giant cell tumor, osteomyelitis/septic arthritis, fibrous dysplasia, soft tissue hemangioma, and Paget's disease. Several disorders were tested more than one time on the five examinations (Table 2). Twenty conditions were tested only a single time (Table 3). Of the entities tested only a single time, there were common conditions such as nonossifying fibroma and heterotopic ossification, as well as rare lesions such as adamantinoma and Maffucci's syndrome.

Several common malignancies and benign conditions were not included on the any of the five annual examinations (Table 4). Multiple myeloma, aneurysmal bone cyst, and eosinophilic granuloma are common clinically important entities, but they were not tested over the 5-year period. Less common but important disorders that did not appear included sacral chordoma, Ollier's disease, and malignant fibrous histiocytoma of bone or soft tissues.

Immediate recall of knowledge (tumor knowledge-taxonomy 1) about specific conditions was tested an average of 8.8 times per examination (Table 5). The most common questions required the trainee to interpret imaging studies alone or both imaging studies and a histologic specimen. Following the interpretation of the studies, the examinee was required to select a diagnosis an average of 8.4 times

Table 1. Number of pathology questions and benign/malignant entities by year of examination

Entity	Test year				
	2002	2003	2004	2005	2006
Pathology questions	27	29	24	24	32
Percentage	9.8	10.5	8.7	8.7	9.9
Benign entities	17	13	6	7	14
Malignant entities	10	16	15	15	15
Not classifiable	0	0	3	2	3

Table 2. Entities tested two or more times

Malignant	Test year					
	2002	2003	2004	2005	2006	Total
Metastasis	1	4	1	5	1	12
Osteosarcoma	2	3	3	0	5	13
Ewing's sarcoma	2	3	1	0	3	9
Chondrosarcoma	2	2	2	2	0	8
Synovial sarcoma	0	1	2	3	0	6
Paget's sarcoma	0	0	1	0	1	2
Lymphoma	0	1	1	0	0	2
Benign						
Giant cell tumor	2	1	1	2	3	9
Osteomyelitis	3	1	0	2	1	7
Fibrous dysplasia	1	2	0	0	1	4
Soft tissue hemangioma	1	0	1	1	1	4
Paget's disease	2	1	0	0	0	3
Osteochondroma	0	1	0	1	0	2
Unicameral bone cyst	0	1	1	0	0	2
Synovial chondromatosis	0	1	1	0	0	2
Pigmented villonodular synovitis	0	1	1	0	0	2
Enchondroma	1	1	0	0	0	2
Avulsive cortical irregularity	1	0	0	0	1	2
Osteofibrous dysplasia	1	0	0	0	1	2
Multiple hereditary exostosis	0	0	0	0	2	2

Table 3. Benign and malignant entities tested a single time over a five year period

Benign	Malignant
Elastofibroma	Adamantinoma
Bone hemangioma	Rhabdomyosarcoma
Enostosis	Liposarcoma
Tumoral calcinosis	Squamous cell carcinoma
Schwannoma	Malignant peripheral nerve sheath tumor
Heterotopic ossification	Dedifferentiated chondrosarcoma
Granuloma annulare	
Popliteal cyst (child)	
Maffucci's syndrome	
Nonossifying fibroma	
Chondroblastoma	
Osteopetrosis	
Neurofibroma	

per examination (diagnosis-taxonomy 2). There were 6.8 questions per examination that required advanced cognitive skills or problem-solving skills (taxonomy 3);

Table 4. Entities not tested over the 5-year period

Benign	Malignant
Aneurysmal bone cyst	Myeloma
Ollier's disease	Malignant fibrous histiocytoma (of bone or soft tissue)
Eosinophilic granuloma	Fibrosarcoma of bone
Desmoplastic fibroma	Epithelioid sarcoma
Periosteal chondroma	Periosteal osteosarcoma
	Clear cell chondrosarcoma
	Mesenchymal chondrosarcoma
	Fibrosarcoma of soft tissue
	Chordoma
	Hemangioendothelioma
	Leiomyosarcoma
	Clear cell sarcoma

Table 5. Question classification

Classification	Test year					Average (SD)
	2002	2003	2004	2005	2006	
Tumor knowledge (T1)	9	5	5	12	13	8.8 (3.76)
Diagnosis (T2)	10	15	5	3	9	8.4 (4.67)
Treatment from diagnosis (T3)	6	7	10	6	5	6.8 (1.92)
Decision-making evaluation (T3)	2	1	3	1	3	2.0 (1)
Treatment modalities (T1)	0	1	1	2	2	1.2 (.84)

T1 = Taxonomy 1, immediate recall; T2 = Taxonomy 2, interpretation; T3 = Taxonomy 3, problem solving.

these required interpretation of the imaging studies, establishment of a diagnosis, and selection of the proper treatment method. Evaluation and or decision making (taxonomy 3) was only tested an average of two times per examination. There was an average of 1.2 questions per examination that required the examinee to have immediate recall knowledge concerning treatment modalities such as chemotherapy, radiation therapy, or surgical principles.

Eleven combinations of imaging studies required interpretation (Table 6). The most common grouping involved interpretation of a radiograph, MRI, and a histologic specimen (average, 5.2 questions per examination). The second most common study was a plain radiograph alone (3.4 times per examination). The trainee needed to evaluate a histologic specimen an average of 9.6 times per examination (range, 4–17 times).

Table 6. Interpretive studies

Study to interpret	Test year					Total
	2002	2003	2004	2005	2006	
XR/MRI/BX	5	8	6	3	4	26
XR	4	4	1	3	5	17
MRI/BX	0	4	2	1	1	8
XR/CT/BX	2	4	1	0	0	7
XR/BX	1	1	1	0	3	6
MRI	3	0	2	0	0	5
XR/MRI	0	1	1	0	1	3
XR/CT	1	0	0	0	0	1
CT/BX	0	0	1	0	0	1
CT	1	0	0	0	0	1
CP/Angio						1
Total histology	8	17	11	4	8	48

XR = radiograph; BX = histologic specimen (biopsy material); Angio = angiography; CP = clinical photograph; CT = computed tomography; MRI = magnetic resonance imaging.

Discussion

The Orthopaedic In-Training Examination of the American Academy of Orthopaedic Surgeons was the first specialty examination for residents [7, 8]. This examination was first administered in 1963 to 1118 residents at 171 centers. Mankin [7] credits Carroll B. Larson for establishing three objectives of the examination: to (1) measure the knowledge of residents against a national norm; (2) determine some minimal standards for trainees in training programs; and (3) measure the quality of training in a program. The examination has been administered annually since its inception and was scored for 3382 examinees in 2006. The major questions posed in this study were: (1) what portion of questions are related to bone and soft tissue tumors; (2) what benign and malignant entities appear in the examination; (3) whether a classification system could be established to aid in taking the examination; and (4) what was the distribution of interpretive studies such as radiographs, three dimensional imaging and biopsy specimens.

The major limitations of this study include a relatively short time span (5 consecutive years) of our assessments and the subjectivity of our classification system. We presume, however, a 5-year period is reasonably representative for current tests, although the areas of interest may vary over longer periods. While the material we recorded may help when studying for the OITE exam, it is less clear it would help with the ABOS exams because the latter exams are confidential. Educators can only hope there is a correlation between the two examinations; some evidence (noted below) suggests this is the case. Further, because of copyright issues

it was impossible for us to try to determine the exact nature of the exam each year.

Designers of the examination have historically attempted to test complex cognitive processes such as interpretation and problem-solving skills. Questions are designed and classified using Bloom/McGuire's cognitive taxonomy: Level 1 questions address simple recall of information; Level 2 questions require interpretation of imaging studies and/or histologic material; Level 3 questions examine the test takers' ability to apply interpretation in directing further treatment [2, 11]. A previous study that examined whether the OITE succeeds in testing each of the three levels found very close agreement in resident taxonomic classification of questions and the level of classifications defined by designers [2]. This close agreement suggested the OITE succeeds in examining different levels of cognitive function [2].

A systematic review of the pathology content of the examination may aid trainees in focusing their preparations for the examination and aid educators in developing their pathology curriculum. The OITE has 275 questions, and approximately 10% of the examination is composed of pathology questions. After completing a 5-year residency, orthopaedic residents are tested on approximately 137 pathology questions. To score well on the OITE, examinees have to possess sufficient knowledge of both the common and uncommon conditions tested (Tables 2, 3). The majority of pathology questions require the examinee to interpret imaging studies alone or imaging studies and histologic material (diagnosis or Taxonomy 2). Trainees need to establish the interpretative skills necessary to establish a diagnosis from these studies. Tumor knowledge (8.8 questions), diagnosis (8.4 questions) from imaging and imaging/histologic material, and selection of treatment from the diagnosis (6.8 questions) comprise 88% of the pathology section of the examination. There is an average of only two questions per examination on evaluation and decision-making. These questions require the examinee to select the next step in evaluation or management when a diagnosis has not been established.

Question content on the OITE has already been studied by Mankin et al. [8] in 1978. They formulated a computer data bank using questions sampled over a 7-year period and reported "the cognitive content of the In-Training Examination has broad distribution and is remarkably constant [8]." Again, they found old OITE examinations provided a useful study tool and guide for appropriate topics. Though individual questions are rarely repeated, pathology topics recur on a consistent basis, and knowledge of these topics benefit the resident. Given the nature of the grading of the examination and the relatively small difference between residents' gross scores, adding five to 10 correct answers influences the examinee's percentile rank.

Scoring well on the OITE does not necessarily correlate with overall resident performance as subjectively evaluated by attending physicians [3, 4, 5, 10]. Indeed, it has been noted residents selected as the best in their class by the faculty do not always pass Step 1 of the ABOS Part I examination [3]. However, residents who do well on the OITE also typically perform at a high level on Part 1 of the ABOS examination [5]. This is in agreement with other specialties including radiology [1], gynecology [14], oral and maxillofacial surgery [6], internal medicine [12], and general surgery [13], all of whose in-training examinations correlate with their written board certification examinations.

Besides preparing residents to be practical, knowledgeable orthopaedic surgeons, it is also each residency program's responsibility to provide an education that allows residents the best opportunity for success on their ABOS examinations. The pathology questions asked on the OITE are a good testing ground for residents to improve their score. While the contents of the examination are not defined, recurrent themes appear. Test takers should be prepared to interpret various modalities of imaging studies and understand the different treatment regimens. Knowing this, residents and their programs can direct their focus of study on those subjects most likely to appear on the examination. That a certain subset of questions reappears on the examination from time to time seems evident; taking advantage of this to formulate a tailored study guide would benefit orthopaedic educators in helping their residents succeed on the OITE and, later, the written ABOS examination.

Mankin et al. [9] called attention to errors in decision-making during the biopsy of malignant bone and soft tissue tumors in 1982. Because of the high rate of complications, altered treatment, and amputation, the authors recommended that biopsies of potentially malignant bone and soft tissue lesions be performed at specialized centers. Mankin et al. [10] reported a followup study in 1996 and reported the rates of error were almost identical to the previous study [9]. There has never been a study to determine if the Evaluation Committee of the American Academy of Orthopaedic Surgeons is effective in designing yearly examinations which will test the "core knowledge" necessary to become a prudent and effective orthopaedic surgeon and also allow residents to pass part I of the ABOS certifying exam. This current study may be useful to committee members in formulating the test topics. As an example, the committee members might consider placing greater emphasis on evaluation and decision-making skills with the goal of reducing decision-making errors by practicing orthopaedic surgeons in the biopsy of malignant bone and soft tissue tumors.

The pathology section of the OITE should examine trainees for important "core knowledge" and test their ability to make important diagnostic and therapeutic decisions. Our study demonstrates the examination covers a broad spectrum of disorders, testing the trainee's ability to recall important facts and recognize common benign and malignant entities. Selecting treatment after establishing a diagnosis is an important decision-making exercise. Orthopaedic surgeons who are not oncologists must often make evaluation and diagnostic decisions. Examples of scenarios often encountered in practice include the following: (1) the presentation of a patient with a primary malignant bone tumor, metastatic disease, or multiple myeloma, or (2) choosing observation, needle or incisional biopsy, or excisional biopsy for a patient with a soft tissue mass. The ultimate goal of training orthopaedic residents in pathology is to allow safe treatment of patients and avoidance of errors that risk life or limb.

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