

Educational impact of a clinical anatomy workshop on 1st-year orthopedic and rheumatology fellows in Mexico City

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Abstract We aim to study the educational impact of a clinical anatomy workshop in 1st-year orthopedic and rheumatology fellows. First-year rheumatology fellows ($N=17$) and a convenience sample of 1st-year orthopedic fellows ($N=14$) from Mexico City in the 9th month of training participated in the study. The pre- and the post- workshop tests included the same

20 questions that had to be answered by identification or demonstration of relevant anatomical items. The questions, arranged by anatomical regions, were asked in five dynamic stations. Overall, the 31 participants showed an increase of correct answers, from a median of 6 (range 1 to 12) in the pre-workshop test, to a median of 14 (range 7 to 19) in the

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post-workshop test. In the pre-workshop test, the correct median answers were 7 (range 2 to 12) in the orthopedic fellows and 5 (range 1 to 10) in the rheumatology fellows ($p=0.297$). Corresponding scores in the post-workshop were 15 (range 10 to 19) and 12 (range 7 to 18) ($p=0.026$) showing a significant difference favoring the orthopedic group. Our clinical anatomy workshop was efficacious, in the short term, as a teaching instrument for 1st-year orthopedic and rheumatology fellows. The post-workshop scores, although significantly improved in both groups, particularly in the orthopedic fellows, were still suboptimal. Further refinements of our workshop might yield better results.

Keywords Clinical anatomy knowledge · Education · Orthopedic fellows training · Rheumatology fellows training

Introduction

Clinical anatomy is the anatomy that is useful in the care of patients [1, 2]. Within the field of clinical anatomy, superficial structures of the limbs including joints, muscles, tendons, and nerves lend themselves naturally to the use of the clinician's classic senses of sight and touch. Clinicians have the ability to palpate many of the body's well-known superficial arteries such as the radial or carotid artery. Similarly, the identification of superficial anatomical items such as a muscle origin, belly, and insertion need no further validation when performed by one who has mastered this discipline. Examples include muscles such as brachioradialis in the forearm and tensor fascia lata at the lateral hip region. Palpable bone eminences such as the radial styloid and the lateral tubercle (Gerdy) of the tibia and fat bodies such as Hoffa fat pad in the knee and Kager fat in the ankle are hard to miss. Ligaments such as the lateral and tibial collateral ligaments of the knee, and the spring ligament at the ankle, may be identified by a skilled physician. Finally, superficial nerves such as the ulnar at the elbow, the radial in the upper arm, and the common peroneal should be explored by the clinician in the appropriate circumstances. It is our belief that clinical anatomy is a cornerstone in the diagnosis of most rheumatic diseases and critical to the proper and cost effective diagnosis of the regional pain syndromes. These conditions fall within the realm of multiple specialists who see musculoskeletal conditions whether an orthopedist, a rheumatologist, a physiatrist, as well as a generalist. Unfortunately, the undergraduate teaching of anatomy has decayed over time, and a need for improvement has been voiced [3].

The literature has consistently demonstrated inadequate knowledge of clinical anatomy at the graduate and post-graduate levels [4–6]. Indeed, we have previously found that

rheumatology trainees and practicing rheumatologists in seven American countries performed sub-optimally in a pre-workshop test of baseline anatomic identification or demonstration [7].

The current study represents an extension of our initial study to include a parallel investigation in orthopedic trainees as representative of another discipline involved in the care of patients with musculoskeletal conditions. Our decision to include orthopedic trainees was based on the paradigm that anatomic knowledge is central to competence in patient assessment in office orthopedics as well as in orthopedic procedures.

Our primary goal was to study the impact of our clinical anatomy workshop on the learning of clinical anatomy among both rheumatology and orthopedic trainees. Also, this study allowed us to analyze and compare the pre- and post-workshop practical knowledge of clinical anatomy between both groups.

Material and methods

Participants and recruitment method

Rheumatology fellows were recruited through personal invitation after approval of the directors of all ten rheumatology training programs in Mexico City (footnote). Of the twenty rheumatology fellows invited, 17 agreed to participate in the study. From the 12 orthopedic training programs in Mexico City, a geographical convenience cohort of residents from four hospitals was chosen. Residents were invited to participate after approval by their respective program directors. Of the 15 orthopedic residents invited, 14 agreed to participate in the study. None of the participating fellows had undergone musculoskeletal ultrasonography training.

Evaluation tool

The anatomical knowledge evaluation tool consisted of a series of questions in which fellows were asked to identify or demonstrate the action of key anatomical items in the examiners' or their bodies. The questions included most of the items used in our previous publications [7, 8]. However, they were selected from a new item list that was compiled to develop an evaluation tool for a workshop held at the 2014 PANLAR meeting in Punta del Este, Uruguay. The procedure was as follows: three members of our group (JJC, RAK, PVO) compiled a list of 112 anatomical items felt relevant to the regional pain syndromes. These included 24 hand/wrist items, 12 elbow items, 14 shoulder items, 10 neck items, 10 spine items, 8 hip/thigh items, 14 knee items, and 20 ankle/foot items.

These items were independently ranked according to their clinical relevance and degree of difficulty. The 50 highest ranked questions were chosen for the pre- and post-seminar Punta del Este examinations (unpublished data). For the present study, from this pool of 50 questions, 5 were excluded because they referred to the spine. Of the 45 remaining questions, 2 were removed because all participants in the workshop answered them correctly, and 3 were removed because all answered them incorrectly, leaving a pool of 40 questions of intermediate difficulty. Of these, 20 questions were randomly chosen to be used in the current pre- and post-workshop examinations. Table 1 shows the anatomical items surveyed, the wording of the questions, and the relevance of each of the chosen anatomical items to the fields of orthopedics and rheumatology. Participants rotated through five different dynamic stations, and in each station four questions were asked. The same examiners (AV, KCG, PVO/JENZ, JJC, CHD) asked the pre- and post-workshop questions.

Instructors

The instructors are members of the Mexican Group of Clinical Anatomy (GMAC) since 2009. They are all board-certified in rheumatology, and three had one or more years of MSK ultrasonography training. GMAC's experience included at the time of this study 32 similar workshops held in 8 American countries and Spain.

Clinical anatomy workshop

The methodology of this workshop has been published [9–14]. The workshop uses clinical vignettes that highlight the involvement of key anatomical items. Following each vignette, the highlighted item is shown diagrammatically, and its relation to the discussed condition is reviewed. After several vignettes that relate to the same anatomical region, the practical part of the workshop takes place. This includes the identification and demonstration of the highlighted items in the instructors and participants' bodies. Since each participant identifies each item in the bodies of 5 or 6 peers plus the instructor, the important issue of anatomical variation is understood. By experience, this teaching system requires an instructor to participant ratio of one to 6–10 per group. Thus, since we had 31 participants in the current study, there were 6 participants per instructor in the practical portions of the workshop. The current workshop consisted of five modules that were presented in sequence, hand/wrist, elbow/shoulder, hip, knee, and ankle/foot. The total duration of this seminar was 7 h including 30 min for lunch and was preceded and followed by a 75-min practical examination.

Institutional review board

The protocol was approved by the institutional review boards of the American British Cowdray Medical Center and the Hospital de Especialidades Dr. Antonio Fraga Mouret, Centro Medico Nacional La Raza, Instituto Mexicano del Seguro Social. All participants signed an informed consent that described the protocol. The examiners were not blinded as to the identity of the workshop participants; however, anonymity was achieved in the interpretation of the results through de-identification of the score sheets.

Statistical analysis

The sample size was calculated to detect a 30 % difference between the pre- and post-workshop tests with a power of 80 % and a two-tail α of 0.05 %. A minimum of 12 participants per subspecialty was required. Age of participants is shown as mean and standard deviation and answers to the individual questions as means and percentages. Overall results are expressed as median and range. Overall and intragroup correct answers in the pre and post-workshop evaluations were compared with the Wilcoxon test. Pre- and post-workshop scores of one subspecialty versus the other were compared with the Mann-Whitney *U* test. Intergroup percentages of correct answers per anatomical item, comparing the pre- and post-workshop evaluations was done with the chi-square test. Differences with a $p < 0.05$ was considered statistically significant. All data were processed using the SPSS statistical package (Chicago, IL) version 20.0.

Results

There were 31 participants in the study, 17 rheumatology fellows and 14 orthopedic fellows, all of them in the 9th month of their 1st year of training. Age and sex of the participants are shown in Table 2. Gender of participants differed in the two groups, reflecting a female predominance in rheumatology trainees and a male predominance in orthopedic trainees. This table also shows the pre- and post-workshop test scores, according to the subspecialty. Orthopedic fellows had significantly greater pre- and post-workshop scores than rheumatology fellows.

Pre- and post-workshop scores

As shown in Table 3, all post-workshop scores showed an improvement that reached statistical significance. In the entire group ($N=31$), a median of 6 of 20 questions (range 1 to 12) were responded to correctly prior to the workshop and 14 (range 7 to 19) in the post-workshop assessment. Orthopedic fellows responded correctly to 7 of 20 questions (range to 2–

Table 1 Anatomical items and questions ask in the pre- and post-workshop tests

Question	Anatomical items	Actual question	Examples of clinical relevance
1	Digital flexor tendons	Fellow is asked to show in his/her index finger the action of the superficial and deep flexor tendons	O, R: Tendon rupture in RA O: Hand lacerations
2	Dorsal interosseal muscles, hand	Fellow is asked to show in his/her hand the action of the dorsal interosseal muscles	O: Evaluation of ulnar nerve pressure neuropathies R: Muscle atrophy in RA hand
3	Radial styloid process	Examiner extends his/her hand and asks fellow to identify the radial styloid process	O: Landmark in tenosynovectomy R: Injection treatment of de Quervain tenosynovitis
4	Dorsal tubercle of radius (Lister's tubercle)	Examiner extends his/her hand and asks fellow to identify the dorsal radial tubercle (Lister)	O Landmark in wrist surgery and arthroscopy R: Landmark for radiocarpal aspiration/injection O, R: Site of tendon rupture in RA
5	Extensor radialis brevis muscle	Examiner, with his/her elbow flexed 90°, asks fellow to identify the origin of extensor carpi radialis brevis muscle	O, R: Landmark for steroid injection in tennis elbow
6	Extensor carpi radialis brevis	Examiner, with his/her elbow flexed 90°, asks fellow to perform the diagnostic maneuver tennis elbow	O, R: Diagnosis of tennis elbow
7	Radial head	Examiner, with his/her elbow flexed 90°, asks fellow to identify the radial head	O: Fracture assessment R: Landmark for lateral injection of elbow joint
8	Subscapularis muscle	The examiner, elbow flexed 90° asks fellow to examine his/her subscapularis muscle action	O, R: Assessment of rotator cuff tendinopathy
9	Tensor fascia lata muscle	The examiner, standing on his/her right foot asks fellow if his/her right tensor fascia lata muscle is balancing his/her pelvis	O, R: Assessed in modified Ober test (for iliotibial band contracture)
10	Gluteus minimus muscle	The examiner, standing on his/her right foot asks fellow if his/her right gluteus minimus muscle is balancing his/her pelvis	O, R: (with gluteus medius) Pelvic balance on standing on 1 foot; Trendelenburg test and gait
11	Piriformis muscle	The examiner, who is sitting, asks fellow to resist the action of his/her right piriformis muscle	O, R: Differential diagnosis of sciatica
12	Biceps femoris	The examiner, who is sitting, asks fellow to identify the insertion site of his/her biceps femoris muscle, and tell the name of the structure	O: Assessment of posterolateral structures of the knee R: Palpation of the common peroneal nerve
13	Semitendinosus tendon	The examiner, who is sitting, applying pressure on the floor with his/her heel, asks fellow to identify the semitendinosus muscle tendon in his/her popliteal fossa	O, R: A boundary of the popliteal fossa; a proxy landmark in popliteal cysts
14	Popliteus muscle	The examiner, who is sitting, asks fellow to point the origin of the popliteus muscle in his/her knee	O, R: Unlocks the knee to initiate flexion; a cause of posterolateral knee pain
15	Pes anserinus	The examiner, who is sitting, asks fellow to indicate the site of the pes anserinus insertion	O, R: Causes medial knee pain; may add to, or explain, pain in knee osteoarthritis
16	Lateral collateral ligament, knee	The examiner, with his/her leg resting on the opposite knee, asks fellow to identify the lateral collateral ligament	O, R: A passive lateral stabilizer of the knee; causes pain in knee varus deformity such as in OA, CPPD
17	Anterior tibial artery, foot	The examiner, showing his/her foot, asks fellow to identify the anterior tibial artery and name the neighboring tendons	O, R: Avoidance of accidental puncture in ankle aspiration
18	Tibial nerve at ankle	The examiner, showing his/her foot asks fellow to identify location of the tibial nerve at the ankle	O, R: Entrapment causes tarsal tunnel syndrome in RA, CPPD
19	Opening of sinus tarsi	The examiner, showing his/her foot, asks fellow to identify the opening of the sinus tarsi	O: Site of tenderness in sinus tarsi syndrome R: Entry site in subtalar joint aspiration/ injection
20	Base of 5th metatarsal	The examiner, showing his/her foot, asks fellow to identify the base of the 5th metatarsal	O: Avulsion and other fractures R: Helps identify peroneus brevis tenosynovitis in RA

O orthopedics, R rheumatology

12) prior to the workshop and 15 (range 10 to 19) in the post-workshop assessment. Rheumatology fellows responded correctly to 5 of 20 questions (range 1 to 10) prior to the

workshop and 12 (range 7 to 18) in the post-workshop assessment. Finally, overall results, broken down to upper and lower extremity items, also showed a significant gain (Table 3).

Table 2 Demographics and pre- and post-workshop test scores according to specialties

	Orthopedic fellows (<i>n</i> =14)	Rheumatology fellows (<i>n</i> =17)	<i>p</i> value
Male/female	11/3	6/11	–
Age, mean±SD, years	28.0±2.3	29.1±1.5	0.109 ^b
Pre-workshop, median (range) ^a	7 (2–12)	5 (1–10)	0.297 ^c
Post-workshop, median (range) ^a	15 (10–19)	12 (7–18)	0.026 ^c

SD standard deviation

^a Number of correct answers, 20 questions

^b Unpaired *t* test

^c Mann-Whitney *U* test

Intergroup comparisons per anatomical item

The correct answers per individual anatomical item comparing the subspecialties in the pre-test and the post-test are shown in Table 4. In the pre-workshop test, orthopedic fellows scored significantly higher than rheumatology fellows in questions 11 (piriformis muscle), 19 (opening of sinus tarsi), and 20 (base of the 5th metatarsal). In the post-workshop test, question 18 (tibial nerve at the ankle) was scored significantly higher by the orthopedic fellows, question 20 remained unchanged, and questions 11 and 19 changed to a non-significant difference. For the remaining 16 questions, the lack of statistical significance between specialties in the pre-test was paralleled in the post-test. On the other hand, comparing the pre- and post-test scores for the entire group (*N*=31), there was a significant difference in the percentage of correct answers in 13 of the 20 questions (65 %) (Table 5). Only 5 of the 20 questions were answered correctly by more than 50 % of the 31 fellows in the pre-test, as compared with 16 in post-test. As expected, the items that scored lowest in pre-test were those that increased most in the post-test.

Discussion

Our results indicate that both orthopedic and rheumatology fellows increased their ability to correctly identify key

anatomic structures and functions. Out of a total of 20 questions, the median of correct answers increased from 7 to 15 among the orthopedic fellows and from 5 to 12 among the rheumatology fellows. When the two groups were compared, pre-workshop scores tended to be higher in the orthopedic group and post-workshop scores were significantly higher in the orthopedic group. However, it was disappointing that in the pre-workshop test, the orthopedic fellows answered correctly only 35 % of the questions, and the rheumatology fellows, 25 %. The beneficial effect of the workshop was shown by a significant knowledge gain in both fellows groups. In the post-workshop test, the orthopedic group answered correctly 75 vs. 60 % in the rheumatology group. We consider the pre-workshop results dismal and the post-workshop results sub-optimal. In reviewing the participating rheumatology programs, only one has a formal clinical anatomy course. The three 1st-year fellows in this program had a median pre-workshop score of 8 (range 5 to 9) compared with 5 (range 1 to 10) for the entire group. Their median post-workshop score was 18 (range 16 to 18) compared with 12 (range 7 to 18) for the entire group. Although these findings are encouraging, the small sample size did not allow us to draw valid comparisons.

We have previously shown similar pre-workshop clinical anatomy knowledge in rheumatology fellows and rheumatologists from seven American countries. In this study, there were 170 participants, 84 of them rheumatology fellows, from

Table 3 Overall test score and scores by specialty and anatomical region

	Pre-workshop test, median (range)	Post-workshop test, median (range)	<i>p</i> value ^a
Overall score ^b (<i>n</i> =31)	6 (1–12)	14 (7–19)	<0.001
Orthopedic fellows ^b (<i>n</i> =14)	7 (2–12)	15 (10–19)	<0.001
Rheumatology fellows ^b (<i>n</i> =17)	5 (1–10)	12 (7–18)	<0.001
Upper extremity ^c (<i>n</i> =31)	3 (0–6)	6 (2–8)	<0.001
Lower extremity ^d (<i>n</i> =31)	3 (1–7)	7 (2–11)	<0.001

^a Wilcoxon signed rank test

^b Number of correct answers, 20 questions

^c Number of correct answers, 8 questions

^d Number of correct answers, 12 questions

Table 4 Pre- and post- workshop scores according to question and specialty

Questions, number and item	Pre-workshop scores			Post-workshop scores		
	Orthopedic fellows (<i>N</i> =14) <i>n</i> ^a (%)	Rheumatology fellows (<i>N</i> =17) <i>n</i> ^a (%)	<i>p</i> ^b	Orthopedic fellows (<i>N</i> =14) <i>n</i> ^a (%)	Rheumatology fellows (<i>N</i> =17) <i>n</i> ^a (%)	<i>p</i> ^b
1. Digital flexor tendons	5 (35.7)	3 (17.6)	0.253	11 (78.6)	10 (58.8)	0.242
2. Dorsal interossei, hand	7 (50)	11 (64.7)	0.409	14 (100)	15 (88.2)	0.185
3. Radial styloid process	13 (92.9)	11 (64.7)	0.062	13 (92.9)	13 (76.5)	0.217
4. Dorsal tubercle of radius (Lister)	6 (42.9)	5 (29.4)	0.438	11 (78.6)	13 (76.5)	0.889
5. Extensor radialis brevis	0 (0)	1 (5.9)	0.358	4 (28.6)	10 (58.8)	0.092
6. Tennis elbow	2 (14.3)	2 (11.8)	0.835	12 (85.7)	13 (76.5)	0.517
7. Radial head at elbow	3 (21.4)	3 (17.6)	0.791	10 (71.4)	14 (82.4)	0.469
8. Sub-scapularis muscle	7 (50)	5 (29.4)	0.242	14 (100)	15 (88.2)	0.185
9. Tensor fascia lata muscle	9 (64.3)	11 (64.7)	0.981	10 (71.4)	9 (52.9)	0.293
10. Gluteus minimus muscle	4 (28.6)	7 (41.2)	0.465	8 (57.1)	8 (47.1)	0.576
11. Piriformis muscle	3 (21.4)	0 (0)	0.045	7 (50)	8 (47.1)	0.870
12. Biceps femoris muscle	0 (0)	0 (0)	–	9 (64.3)	9 (52.9)	0.524
13. Semiten-dinosus muscle tendon	5 (37.5)	9 (52.9)	0.337	10 (71.4)	12 (70.6)	0.959
14. Popliteus muscle	0 (0)	1 (5.9)	0.356	6 (42.9)	4 (23.5)	0.252
15. Pes anserinus	7 (50)	11 (64.7)	0.409	13 (92.9)	11 (64.7)	0.062
16. Lateral collateral ligament, knee	5 (35.7)	6 (35.3)	0.981	12 (85.7)	15 (88.2)	0.835
17. Anterior tibial artery, foot	0 (0)	0 (0)	–	3 (21.4)	5 (29.4)	0.613
18. Tibial nerve at ankle	4 (28.6)	3 (17.6)	0.469	10 (71.4)	6 (35.3)	0.045
19. Opening of sinus tarsi	3 (21.4)	0 (0)	0.045	11 (78.6)	9 (52.9)	0.138
20. Base of 5th metatarsal	11 (78.6)	5 (29.4)	0.006	13 (92.9)	8 (47.1)	0.007

^a Number of participants with correct answers in each question, 20 questions

^b Two-tailed chi-square test, Fisher's exact test if expected frequency was <5

Argentina, Chile, Ecuador, El Salvador, Mexico, Uruguay, and the USA. Fellows achieved higher scores than practicing rheumatologists [7]. In this study, time limitations precluded us from assessing the short-term efficacy of the workshop in the majority of sites. In one country, however, conducive conditions allowed us to include a post-workshop test, which showed a score increase from 37.6 ± 15.6 to 78.2 ± 15.5 % in the post-workshop test. These figures are higher than in the present study. However, in this country, the seminar extended to 3.5 days, as compared to 6.5 h in the present study. As suggested by Evangelisto et al. [15], subsequent analysis of our data showed that the highest pre-workshop scores, 60.7 ± 14.2 and 67 ± 16.1 %, were attained by fellows from programs that included musculoskeletal ultrasonography (MSU) as a teaching tool. The usefulness of adding ultrasonography to courses of musculoskeletal clinical anatomy has recently been discussed [16].

The surveyed items in our previous and present studies are basic to an understanding of the regional musculoskeletal pain syndromes. These conditions are not only frequent in the population at large [17] but also comprise approximately 20 % of the patients seen by

rheumatologists in their offices [18]. Generalists, rheumatologists, orthopedic surgeons, and physiatrists share the care of these patients and proficiency in patient assessment become critical to achieving a common standard of care. Therefore, we feel it is of utmost importance that trainees in both primary care as well within the specialties in which musculoskeletal assessment is a primary mandate achieve a higher level of competency in clinical anatomy than what we and others are finding.

In the current study, we attempted to evaluate the efficacy of our workshop in two different groups of participants, all from Mexico City. One group included 1st-year rheumatology fellows and the other, orthopedic fellows, all in the 9th month of their 1st-year training. The design of the study allowed us to compare, as a secondary goal, the scores of both groups of fellows prior to, and immediately after the seminar. To the best of our knowledge, there are no published data comparing the proficiency in clinical anatomy between orthopedic and rheumatology fellows. Thus, the current study represents not only an initial attempt to evaluate these fellows, but more importantly, to determine opportunities for improvement in orthopedic, and rheumatology training.

Table 5 Overall percentage of correct answers for each of the 20 anatomic items evaluated

Questions, number, and item	Pre-test N=31 n (%)	Post-test N=31 n (%)	<i>p</i> value ^a
3. Radial styloid process	24 (77.4)	26 (83.9)	0.520
9. Tensor fascia lata muscle	20 (64.5)	19 (61.3)	0.793
2. Dorsal interossei, hand	18 (58.1)	29 (93.5)	0.001
15. Pes anserinus	18 (58.1)	24 (77.4)	0.103
20. Base of 5th metatarsal	16 (51.6)	21 (67.7)	0.196
13. Semitendinosus tendon	14 (45.2)	22 (71.0)	0.03
8. Subscapularis muscle	12 (38.7)	29 (93.5)	<0.001
4. Dorsal radial tubercle (Lister)	11 (35.5)	24 (77.4)	0.001
10. Gluteus minimus muscle	11 (35.5)	16 (51.6)	0.200
16. Lateral collateral ligament, knee	11 (35.5)	27 (87.1)	<0.001
1. Digital flexor tendons	8 (25.8)	21 (67.2)	0.01
18. Tibial nerve at ankle	7 (22.6)	16 (51.6)	0.01
7. Radial head, elbow	6 (19.4)	24 (77.4)	<0.001
6. Tennis elbow	4 (12.9)	25 (80.6)	<0.001
11. Piriformis muscle	3 (9.7)	15 (48.4)	0.001
19. Opening of sinus tarsi	3 (9.7)	20 (64.5)	<0.001
5. Origin of extensor radialis brevis	1 (3.2)	14 (45.2)	<0.001
14. Popliteus muscle	1 (3.2)	10 (32.3)	0.003
12. Biceps femoris	0 (0)	18 (58.1)	0.001
17. Anterior tibial artery, foot	0 (0)	8 (25.8)	0.02 ^b

^a McNemar's two-tailed chi-square test^b Fisher's exact test

There are several weaknesses in our study. One is the limited number of orthopedic residents evaluated. The reason was the logistical difficulty in assembling a larger sample. However, of the 15 invited orthopedic fellows, only one did not participate. A second limitation was the immediacy of the post-workshop test. Although the protocol design includes an assessment at 1 year, this is a tenuous possibility in Mexico City because of expected difficulties in re-assembling the group, particularly the orthopedic fellows given their multiple rotations and research time. Nevertheless, we have indirect evidence from a competence survey obtained in our previous study, which indicates a positive impact of our seminar 1 to 3 months after it took place [8]. Additional efforts to determine the persistence of the acquired knowledge, and whether an increased knowledge of clinical anatomy translates into an improved delivery of rheumatology and orthopedic care, are warranted. A further limitation is the relatively short duration of the workshop for the large number of items included. Counteracting this weakness, is the practical and fun nature of our workshop, based on the cross-examination of participants and instructors, which we hope helps the retention process. Our positive results contrast with a recent study in medical students in which a lecture-enhanced musculoskeletal

medicine course appeared to have a negative impact on the learning process [19]. A fourth limitation in our study is its pre-test/post-test nature. This is a weaker evidence than could be obtained, for instance, in a controlled trial. However, we still feel there is validity in demonstrating acquisition and retention of the ability to identify a taught anatomic identification, even if only in the short-term, with practical considerations of recruitment and scheduling of busy fellows precluding a true controlled study in our setting.

There are several strengths in our study. One was the painstaking process to select the questions. The selection process included a field test that led to the exclusion of those questions that were uniformly answered correctly and incorrectly by all participants. A second strength is that there were five dynamic stations, with four questions each. This method allowed a uniform wording of the questions and a uniform assessment of the answers with a single examiner able to assess each participant.

The task of better educating our trainees in the area of clinical anatomy is a challenge but one that could be achievable with a well-designed curriculum that could be disseminated through the literature or professional organizations. We could envision for example a course in which trainees are provided a review of anatomic structures in advance and then participate in an all day practical workshop such as ours followed by a post-test for reinforcement and a structured OSCE on real or standardized patients months later. Variations and enhancements would be possible to the workshop that could be program specific including a musculoskeletal ultrasound or fresh cadaver component [20]. Alternatively, the workshop could be structured in smaller segments that could be implemented on a weekly basis over a longer period of time if that would better fit a particular program. Though it would take skilled and persistent coordination, as a next step, long-term outcomes could be assessed by randomizing clinical anatomy training among training programs, and then performing utilization studies based on procedures performed, quality measures including outcomes and patient satisfaction, and cost analysis. Medicare and insurance companies' data could potentially be used in the comparison.

In conclusion, we have observed a short-term positive impact of our clinical anatomy workshop in both orthopedic and rheumatology fellows. There was a trend towards greater knowledge in orthopedic fellows that reached statistical significance in the post-workshop test. However, when the absolute number of correct answers is considered, ample room for improvement in both groups of fellows is apparent. We believe that a more substantial course of clinical anatomy, of several days duration or spread through the 1st year of training, practical in nature, and reinforced throughout all subsequent years of training should be useful in orthopedic and rheumatology training programs. The long-term impact of the workshop remains to be established. Whether or not an

increased knowledge of clinical anatomy results in a better or less expensive patient care is unknown. Finally, whether expertise in clinical anatomy is useful not just in regional rheumatology, but also in systemic rheumatic disorders, beyond the regional pain syndromes, is another important question that remains to be answered [21].

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