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A survey of anatomical items relevant to the practice of rheumatology: upper extremity, head, neck, spine, and general concepts

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Abstract
This study aimed to identify the anatomical items of the upper extremity and spine that are potentially relevant to the practice of rheumatology. Ten rheumatologists interested in clinical anatomy who published, taught, and/or participated as active members of Clinical Anatomy Interest groups (six seniors, four juniors), participated in a one-round relevance Delphi exercise. An initial, 560-item list that included 45 (8.0 %) general concepts items; 138 (24.8 %) hand items; 100 (17.8 %) forearm and elbow items; 147 (26.2 %) shoulder items; and 130 (23.2 %) head, neck, and spine items was compiled by 5 of the participants. Each item was graded for importance with a Likert scale from 1 (not important) to 5 (very important). Thus, scores could range from 10 (1 × 10) to 50 (5 × 10). An item score of ≥40 was considered most relevant to competent practice as a rheumatologist. Mean item Likert scores ranged from 2.2 ± 0.5 to 4.6 ± 0.7. A total of 115 (20.5 %) of the 560 initial items reached relevance. Broken down by categories, this final relevant item list was composed by 7 (6.1 %) general concepts items; 32 (27.8 %) hand items; 20 (17.4 %) forearm and elbow items; 33 (28.7 %) shoulder items; and 23 (17.6 %) head, neck, and spine items. In this Delphi exercise, a group of practicing academic rheumatologists with an interest in clinical anatomy compiled a list of anatomical items that were deemed important to the practice of rheumatology. We suggest these items be considered curricular priorities when training rheumatology fellows in clinical anatomy skills and in programs of continuing rheumatology education.

Keywords. Clinical anatomy, Physical examination, Regional pain syndromes, Rheumatology education

Introduction

It is generally believed that a skilled musculoskeletal examination is desirable in performing a complete and competent evaluation of patients in the rheumatology setting and is a basic requirement for the proper diagnosis of regional pain syndromes. In turn, the basic science of the musculoskeletal examination is clinical anatomy [1]. Unfortunately, previous data from our group and others revealed a suboptimal knowledge of musculoskeletal clinical anatomy among rheumatologists and rheumatology fellows [2–4]. Musculoskeletal clinical anatomy comprises a staggering number of items. From this universe, it would be desirable to identify those items that are most applicable to the practice of musculoskeletal medicine [5]. Because musculoskeletal medicine encompasses office Orthopedics; Physical Medicine and Rehabilitation, Rheumatology, and Primary Care Medicine, a further step should be taken to adjust the larger field of musculoskeletal clinical anatomy to the basic needs of each of these specialties. Along this line, current efforts to improve the teaching of rheumatology at the pregraduate level highlight the importance of clinical anatomy as the basis of physical diagnosis [6]. The current study is an attempt to prioritize the structures of musculoskeletal clinical anatomy that are potentially most relevant to the learning, practice, and assessment of rheumatologists' clinical skills. This report is limited to structures of the upper extremity and spine.

Methods

Each of the members of the Mexican Clinical Anatomy Task Force (GMAC is an acronym of its Spanish name) was asked to list the anatomical items of the upper extremity and spine felt to be relevant to the practice of rheumatology. These items were combined in a master list that may be obtained from the authors upon request. A total of 560 items were included, of which 45 were general items (8.0 %), 138 (24.8 %) were hand items, 100 (17.8 %) forearm and elbow items, 147 (26.2 %) shoulder items, and 130 (23.2 %) spine items. The list was sent electronically via a one-round, web-supported survey (SurveyMonkey) to all GMAC members plus five international experts from Boston (RAK) and New Orleans (JB), USA); La Coruña, Spain (FJTS); Leeds, UK (DMcG); and Toronto, Canada (SC). The latter, plus one GMAC member (JJC), were considered senior experts, while the remaining GMAC members were considered junior experts, based on their academic experience. The participants were asked to rank for clinical relevance each anatomical item according to a Likert scale as follows: 1, not important; 2, of dubious importance; 3, somewhat important; 4, important; and 5, very important. Thus, if the ten experts considered an item not important (score 1), the score for that item would be 10 (1 × 10), and if all considered an item very important (score 5), the score would be 50 (5 × 10). Therefore, the importance of each item, all participants' scores added, could range from 10 to 50. For the final analysis, items that achieved an added score ≥40 were considered relevant for the practice of rheumatology with this score indicating that the item attained a mean ranking of at least "important".

Statistical analysis. In addition to descriptive statistics, one-way ANOVA and unpaired *t* test (according to the number within each group) were used to compare individual and grouped experts' scores. A p value <0.05 was considered significant. SPSS for Windows (20.0 version, IBM USA) software was used for statistical analysis.

Results

The entire range of scores was from 20 in for item no. 355 ("indicate origin of the subclavius muscle") to 48 for item no. 64 ("to know that palmaris longus tendon is a useful landmark for carpal tunnel injections"). Three experts scored significantly different from the remaining seven, one higher and two lower. There was a large variation of Likert scores among the experts. The highest mean Likert score for an item was 4.6 ± 0.7; the lowest was 2.2 ± 0.5. The overall added scores per item were score ≥40, 115; between 30 and 39, 367; and between 20 and 29, 78. Tables 1, 2, 3, 4, and 5 show, arranged by regions, the final list of 115 anatomical items that scored ≥40 (20.5 % of the total). Broken down by categories, 7 (6.1 %) of the basic items (Table 1); 32 (27.8 %) of the hand items (Table 2); 20 (17.4 %) of the forearm and elbow items (Table 3); 33 (28.7 %) of the shoulder items (Table 4); and 23 (20.0 %) of the head, neck, and spine items (Table 5) reached the relevance score. When junior experts (PV-O, JEN-Z, MAS, CH-D) were compared with senior experts (JJC, JB, RAK, FJTS, DMcG, SC), the only discrepancy for list inclusion was encountered for item no. 384 ("to identify supraspinatus m. by inspection and palpation"). The senior experts rated this item significantly higher.

Table 1. General concepts of musculoskeletal clinical anatomy that reached consensus

Item no.		Added scores
1	To be able to distinguish neurogenic from vascular claudication	47
2	To understand that imaging procedures such as MRI often identify "lesions" that may be irrelevant to the patients' symptoms	46
3	To be able to distinguish local pain, ischemic pain, nerve pain, radicular pain, and deep pain radiation	45
4	To know the concept of enthesis	44
5	To understand the sagittal, coronal and transverse planes	41
6	To understand the hierarchical anatomy of tendons and ligaments	41
7	To know the function of deep bursae	40

Table 2. Hand items that reached consensus

Item no.		Added scores
1	To know that the tendon of palmaris longus m. is a useful landmark for carpal tunnel injections	48
2	To know how to perform Tinel’s maneuver	47
3	To know how to perform Phalen’s maneuver	47
4	To know that in most individuals the median nerve lies between flexor carpi radialis and palmaris longus m. tendons	46
5	To know that the median n. may be entrapped within the carpal tunnel	46
6	To recognize the carpal bones that lie at the floor of the anatomical snuffbox	45
7	To recognize by inspection and palpation the tendon of. palmaris longus m.	44
8	To know that the dorsal interosseous m. separate the fingers	43
9	To know that palmar interosseous m. bring the fingers together	43
10	To recognize the dorsal and ventral limits of the anatomical snuffbox	43
11	To know that in 20–30 % of carpal tunnel syndrome patients retrograde symptoms may extend proximally in the limb	43
12	To know that median n. (C5–8, T1) innervates the skin in parts of the palmar hand	43
13	To know how to test for rupture of flexor pollicis longus	42
14	To know that the sesamoid bones are useful landmarks for injection in trigger thumb	42
15	To know that the A1 pulleys for the digits 2 to 5 relate to the transverse palmar creases, which in turn serve as landmarks for injection in the trigger finger	42
16	To know the approximate range of motions of the wrist joint	41
17	To know the approximate range of motion of the interphalangeal joints	41
18	To know the major compartments of the hand	41
19	To be able to identify by inspection and palpation the insertional tendon of flexor carpi ulnaris m.	41
20	To know that both extensor carpi radialis longus and extensor carpi radialis brevis tendons occupy the 2nd dorsal tunnel	41
21	To be able to test the strength of flexor digitorum superficialis m. (one finger is flexed at the PIP against resistance while the remaining 3 fingers are held fully extended)	41
22	To know that sensation in the palm of the hand is spared in most cases of carpal tunnel syndrome	41
23	To understand the “claw hand” of ulnar n. palsy	41
24	To understand the “preacher’s” hand of median n. palsy	41
25	To understand that in advanced carpal tunnel syndrome hypoesthesia only involves the fingers	41
26	To know that the deep branch of the radial n, a purely motor branch, innervates extensor digitorum, extensor digiti minimi, extensor carpi ulnaris, abductor pollicis longus, extensor pollicis brevis, and extensor indicis	41
27	To know that in paralysis of the deep branch of radial n. causes the wrist deviate radially on attempted dorsiflexion, and a failure of extension of the long, anular and little fingers simulate tendon rupture	40
28	To know that the “tenodesis effect” (passive wrist dorsiflexion flexes the fingers and passive wrist volar flexion extends the digits) shows tendon integrity	40
29	To know the approximate range of motion of the metacarpophalangeal joints	40
30	To recognize the dorsal tubercle of radius (Lister’s tubercle)	40
31	To be able to determine by palpation the bone anchors of the transverse carpal ligament	40
32	To recognize the ulnar n.-innervated skin in the hand	40

Table 3. Forearm and elbow items that reached consensus

Item no.		Added scores
1	To know that resisted contraction of extensor carpi radialis brevis m. causes the characteristic pain of tennis elbow	47
2	To know the movements of the elbow joint	45
3	To identify the location of olecranon bursa	45
4	To identify by palpation the medial epicondyle	44
5	To identify by inspection and palpation the bones meeting at the elbow	44
6	To identify by palpation the lateral epicondyle	43
7	To identify by palpation the head of radius	43
8	To know that the origin of extensor carpi radialis brevis m. is the anatomical substrate of tennis elbow	43
9	To know the primary action of extensor carpi radialis longus m.	42
10	To know the tendinous insertions of the lateral epicondyle	42
11	To know the tendinous insertions at the medial epicondyle	42
12	To know that a major nerve lies posteriorly between the medial epicondyle and the olecranon	42
13	To know the elbow action of biceps brachii m.	42
14	To know the forearm action of biceps brachii m.	42
15	To know that the deep motor branch of the radial n. may be entrapped by the upper edge of the superficial part of supinator m.	41
16	To know the main action of triceps brachii m	41
17	To know the muscles that form the “wad of 3” in the lateral forearm (brachioradialis, extensor carpi radialis longus, extensor carpi radialis brevis m.)	40
18	To know the primary action of brachioradialis m.	40
19	To know the joints that participate in pronation-supination motion	40
20	To know the action of pronator teres	40

Table 4. Shoulder items that reached consensus

Item no.		Added scores
1	To know the action of supraspinatus m.	45
2	To identify by inspection and palpation the acromioclavicular and the sternoclavicular joints	44
3	To know the location of the subacromial-subdeltoid bursa	44
4	To isolate glenohumeral motion by immobilizing shoulder girdle motion	44
5	To identify by inspection and palpation the greater tubercle of the humerus	44
6	To distinguish glenohumeral, acromioclavicular, sternoclavicular and scapulothoracic motions	43
7	To know that the rotator cuff muscles are the main dynamic stabilizers of the glenohumeral joint	43
8	To know the action of infraspinatus m.	42
9	To know the main actions of deltoid m.	42
10	To identify by inspection and palpation the bones at the shoulder girdle	42
11	To know the approximate arcs of motion of the glenohumeral joint	42
12	To know that axillary n. neuropathy results in a rapid atrophy of deltoid m.	42
13	To identify the acromion by inspection and palpation	42
14	To identify the coracoid process by palpation	42
15	To know that the coracoid process is an important landmark for both the posterior and anterior aspiration and injection of the shoulder joint	42
16	To identify the spine of the scapula by inspection and palpation	41
17	To be able to show, in a living model, the thoraco-scapulo-humeral rhythm	41
18	To know that a damaged long thoracic n. results in a winged scapula	41
19	To identify infraspinatus m. by inspection and palpation	41
20	To know the main action of teres minor m.	41
21	To know that axillary n. (C5,6) innervates the skin over the deltoid m. and the deltoid and teres minor m.	41
22	To know that the radial n. innervates triceps (the 3 heads), brachioradialis, extensor carpi radialis longus, extensor carpi radialis brevis, supinator and anconeus m.	41
23	To know the cord segments you are testing by tapping the tendon of triceps m. (C6–8)	41
24	To know the cord segment you are testing by taping the tendon of. brachioradialis m. (C5–7)	41
25	To know the cord segment you are testing by tapping the tendon of biceps m. (C5, 6)	41
26	To know how to perform Allen's maneuver	41
27	To know that in septic arthritis of the sternoclavicular joint there is a tendency for abscess progression into the anterior mediastinum	41
28	To know the insertion of infraspinatus m.	40
29	To know that the contraction of deltoid m., unopposed by the rotator cuff, would ram the head of the humerus against the coracoacromial arch	40
30	To know that trapezius, rhomboids, levator scapulae, serratus anterior and pectoralis minor m. are dynamic stabilizers of the scapula	40
31	To know which tendon lies in the intertubercular groove	40
32	To understand the concept of the thoraco-scapulo-humeral rhythm	40
33	To identify supraspinatus m. by inspection and palpation	40

Table 5. Head, neck, and spine items that reached consensus

Item no.		Added scores
1	To know where to palpate the superficial temporal artery	45
2	To identify the thyroid gland and determine whether it is absent, normal or enlarged	43
3	To know the dermatomes of the upper extremity from C4 to T1	43
4	To identify sternocleidomastoid m. by inspection and palpation during rotation of the neck	42
5	To know that C7 is the most prominent of the cervical spinous processes	42
6	To know that the radial n. (C6,7,8) innervates the skin in the lateral upper arm, part of the posterior upper arm, a medial strip in the posterior forearm, and dorsally the radial half of the hand	42
7	To know that spinal extension usually increases pain from facet joints	42
8	To recognize the location of the parotid, the submaxillary and the sublingual salivary glands	41
9	To know that the atlanto-occipital joints are synovial joints	41
10	To know the total lateral flexion of the cervical spine	41
11	To know the total rotation of the cervical spine	41
12	To know the total flexion of the cervical spine	41
13	To know the total extension of the cervical spine	41
14	To know that the C3 dermatome encircles the neck	41
15	To understand the sensory innervation of the upper extremity	41
16	To know that the fourth lumbar vertebra is situated in the midline between the iliac crests.	41
17	To know that the 8th cervical nerve root emerges from the spine between C7 and T1	40
18	To know that the C2 dermatome maps in the occiput	40
19	To know that cervical rib, scalenus hypertrophy, fibrous bands and compression by the clavicle all may play a role in thoracic outlet syndrome	40
20	To know that the brachial plexus is comprised of the ventral rami from C5 through T1	40
21	To know the range of motion provided by the atlanto-axial joints	40
22	To know that conus medullaris, the most distal part of the cord, is located at the L1-L2 level.	40
23	To know that spinal extension brings closer the articulating surfaces of the facet joints	40

Discussion

In this survey, 115 of the 560 initial items list (20.5 %) were considered potentially important for rheumatologic practice. It was of interest that for each of the anatomical regions, approximately 20 % of the items reached consensus. This finding suggests that the initial listing was equally weighted and representative of each region and that all regions were considered important. In retrospect, this uniformity may also reflect the workshop-derived knowledge gained by the instructors in their interaction with fellows and practicing rheumatologists. Indeed, the clinical relevancy of the initial 560-item list may reflect the many “Meet the Professor” sessions and workshops given by some of the senior experts at the ACR meetings and elsewhere for over 30 years. Because of the interactive nature of these sessions, which were attended by fellows and rheumatologists from the USA and abroad, the knowledge of the teachers was probably enriched by the participants’ questions, criticisms, and feedback therefore adding a potential bias.

To the best of our knowledge, our survey is the first to list and prioritize the anatomical structures of the upper extremity and head, neck, and spine that may be relevant to the practice of rheumatology. A similar study on the pelvis and lower extremity is underway. These findings may be useful for curricular development in rheumatology training, as well as to design postgraduate education programs aimed at upgrading the clinical skills of participants. Establishing a repository of anatomic items that have been vetted as most central to the competent practice of rheumatology has direct relevance to mandates of the Accreditation Council for Graduate Medical Education’s (ACGME) Next Accreditation System (NAS) of milestone reporting for rheumatology trainees.

Similarly, our work dovetails well with the rheumatology Entrustable Professional Activities (EPA) established by a workgroup convened under the auspices of the American College of Rheumatology that include reference to skills in physical examination and performance of procedures, both of which depend significantly on an adequate knowledge of clinical anatomy [7].

In our view, mastering clinical anatomy may improve diagnosis in the regional pain syndromes and upgrade the assessment of the musculoskeletal system in patients with systemic rheumatic disease. Furthermore, joint and soft tissue injection skills may be increased by a more accurate knowledge of the involved structures. Also, as perceived by the GMAC members (CH-D and PV-O) who pursued full training in musculoskeletal ultrasonography (MSU), clinical anatomy and MSU nurture each other: the former gives the larger picture, and the latter, the details. We further believe that an improved anatomical understanding of musculoskeletal disorders may result, where they are scarce, in a lesser utilization of expensive imaging procedures.

There are several strengths to our study. First, the initial items list was prepared independently by members of a group devoted to the teaching of rheumatologic musculoskeletal clinical anatomy. A second strength is that the item list was circulated for scoring to internationally recognized experts in academic clinical rheumatology who are not members of our core GMAC group. A third strength is the high concordance between the ratings of senior and junior experts indicating consistency and validity in the ranking of anatomic importance independent of seniority. A fourth albeit indirect strength is that a rather similar percentage of relevance was found in each of the surveyed anatomical regions. This similarity suggests that the list of candidate items was correctly weighted.

There are also several limitations to our study. One is that only one round of answers took place. However, additional rounds would have had the undesirable consequence of decreasing the number of items, which as it is, appears small enough from a practical viewpoint. Another limitation of our design is that the survey is only applicable to rheumatology but misses other specialties that overlap in the care of patients with musculoskeletal conditions, such as Orthopedics, Physical and Rehabilitation Medicine, Neurology, and Primary Care Medicine. However, in a recent study, in which we compared the practical knowledge of clinical anatomy of orthopedic and rheumatology fellows, the preworkshop knowledge was similar in the two groups [4]. This finding suggests the applicability of the surveyed items to the orthopedic group as well. Furthermore, many attendees of our clinical anatomy workshops in Latin America have been Physical and Rehabilitation Medicine fellows and specialists, and the feedback we have received has been consistently favorable. Formal studies including Physical and Rehabilitation Medicine fellows and General and Family Medicine fellows would be of great interest. A final limitation is that many potentially important items in a clinical setting did not reach consensus. This is an inherent limitation of Delphi studies, and those items may be subsequently added if there is group agreement.

We believe our study contributes to a virtuous paradigm, the promotion of rheumatologic clinical anatomy to a higher level often reserved in rheumatology training programs for training fellows in immunology or advanced therapeutics. A deeper knowledge of clinical anatomy can only help in the care of the 7 to 30 % of patients with regional pain syndromes seen in outpatient rheumatology practices [8–12]. Furthermore, and probably just as important, is our belief that a deeper knowledge of the involved structures may improve the clinical evaluation of patients with systemic rheumatic diseases in whom bone landmarks, joints, tendons, entheses, bursae, vessels, and nerves are often involved [13]. Thus, many benefits may be derived from an enhanced knowledge of clinical anatomy among rheumatologists. It is our hope that this Delphi exercise, in which a range of international experts participated, will contribute to highlight the clinical anatomy that underlies rheumatology training and practice.

Compliance with ethical standards

Disclosures None.

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