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The Virtual Shoulder Physical Exam

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Introduction

The COVID-19 pandemic has increased the use of remote telehealth evaluations of sports medicine injuries and shoulder injuries [30,35]. The improvement of web-based videoconferencing platforms has allowed for more user-friendly, face-to-face interactions between patients and clinicians [15]. Both patients and providers have been forced to welcome telehealth as an alternative because of recent required social distancing and restrictions on in-person visits. There have been several studies across various medical specialties that have shown telehealth visits have similar patient satisfaction levels compared with in-person visits. In addition, telehealth visits have shown decreased overall visit times, wait times, and health care costs [2,29,32,42,43]. While the use of telehealth had increased in some medical specialties, before the COVID-19 crisis, it had not had a significant role in most orthopedic surgery or sports medicine practices [25]. As we return to a new normal, most musculoskeletal care providers recognize telehealth as an alternative. This becomes particularly relevant because patients and providers have an increasing demand for convenience and proficiency [25,27,30,35]. A common belief among musculoskeletal clinicians is that telemedicine has a limited ability to provide accurate and through physical examination—the keystone of clinical orthopedic evaluation [8,9,17,18,38,39]. Specifically, many providers feel that in a telehealth visit, it is too difficult to perform exam maneuvers that require manual motor testing for strength, motion assessment, and provocative testing for pain. There is a recent study describing basic physical examination components [35]; in addition we have recently pubilshed an overview of the telehealth examination of the shoulder and knee elsewhere [24]. Here, we provide a basic overview.

The purpose of this article is to arm clinicians with a comprehensive shoulder physical examination for the telehealth visit, including easy-to-understand verbal instructions and checklists for documentation.

Preparation for Telehealth Visit

To maximize the efficiency of the telehealth visit, patients should complete all paperwork, including specific questions related to the history of present illness, past histories, and review of systems. Supplemental Table 1 provides specific instructions and guidelines on clothing, patient positioning, exam room setup, camera positioning, and any required common household items. In addition, patients should familiarize themselves with the instructions on how to set up their camera and review the guidelines on microphone settings and proper camera positioning, location, and lighting. At the beginning of the visit, the patient should be seated with the camera at eye level. Throughout the physical exam, the patient and camera will need to reposition, depending on the exam maneuver that the patient is being asked to perform. The position and angle of the camera will change depending

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on the camera type and patient position. In addition, it is important that the patient is dressed in appropriate clothing for the visit. It is also essential to have available support from the information technology department throughout the visit for help with technical difficulties.

Virtual Shoulder Examination

In most instances, a comprehensive shoulder exam can be divided into a basic core exam and a pathology-specific special testing. The basic core exam can be performed on all patients presenting with shoulder pain and includes palpation, inspection, motor testing, range of motion testing, peripheral vascular exam, and sensory testing. Depending on a patient's specific pathology, further special pathology-specific testing can then be tailored by the clinician [17,18,38,39]. Special testing can be performed as needed based on the patient's history and core shoulder exam.

A neurologic cause should be ruled out in a patient who presents with undifferentiated shoulder and neck pain [17,18,40,41,48]. In the setting of cervical disk disease, the Spurling test can be helpful [17,40,41].

Core Shoulder Exam

Once the patient is appropriately positioned in front of the camera, the clinician should inspect the bilateral shoulders and should evaluate for obvious atrophy, deformity, incisions, scars, rashes, swelling, ecchymosis, or erythema. The clinician can also ask the patient to turn to the side and then to turn so their back faces the camera to visualize the entire shoulder and allow for a thorough inspection. This can help identify specific findings including atrophy of the rotator cuff muscle bellies. The location of maximal pain can be pointed out by the patient using 1 finger. Range of motion should be performed looking for symmetry and pain. Shoulder forward flexion should be visualized with the patient facing the side. External rotation and abduction can be evaluated with the patient directly facing the camera. Internal rotation can be assessed with the patient's back to the camera. In addition, technology can be used to assist in acquiring objective information during the physical exam. These include evaluating shoulder range of motion virtual using goniometers, smart-phone applications, and motion sensing technologies like accelerometers and gyroscopes [6,46,48]. A majority of the strength testing can be performed using common household items [35]. The patient can independently do a peripheral vascular exam and sensory testing. These exams can also be compared by the patient with the other side. Scapular positioning and dynamic scapular motion can often accompany shoulder pathologies [4,18,28,36]. Bilateral scapulae can be assessed with the patient's back facing the camera. Bilateral scapular motion can be evaluated by having the patient elevate their arms in the scapular and sagittal planes [23].

Special Testing

Pathology-specific special testing can be broken down into subtesting for biceps-labrum complex (BLC) disease, glenohumeral instability, acromioclavicular (AC) joint arthrosis, impingement/rotator cuff pathology, generalized ligamentous laxity, and thoracic outlet syndrome [17,18,38,39]. Most of the shoulder special testing can be completed by the patient with minor alterations to the originally described techniques (Fig. 1). The use of an additional remote examiner can help facilitate some provocative maneuvers but is not a prerequisite. We have included the sensitivities, specificities, and likelihood ratios for the in-person version of these exams or test/maneuvers.

Rotator Cuff and Impingement

The Neer and Hawkins tests are excellent screening tests to identify rotator cuff pathology. The patient can also use their contralateral arm and hand for assistance to perform some of the maneuvers [16,17,20,26,29,38]. Strength testing of the rotator cuff can be assessed using household items. Our modification of strength testing involves using a combination of 2 plastic grocery bags and multiple cans of soup or beans (each weighing approximately 16 ounces each). Adding or removing cans to the plastic grocery bag allows the provider to do a modified strength testing as the resistance increases or decreases. This modifications allows for a modified assessment of a strength grade. Furthermore, the handles on the plastic grocery bag allow for strength testing to be performed while the thumb is pointed upward or downward. This allows the clinician to perform a Jobe test with modification. This modification to the Jobe test is completed with the patient holding the grocery bag with soup cans with the thumb pointed down at the shoulder level in the scapular plane [16,17,20,26,29,38]. With the patient facing the camera, additional rotator cuff–specific testing can be completed including testing of the teres minor using the hornblower test or Patte test [11,16,44]. With the patient facing their affected side to the camera, the subscapularis can be tested using the belly press and liftoff tests [3,16,20,34,47]. These maneuvers can be performed almost completely by the patient (Supplemental Table 2).

Acromioclavicular Joint

Tenderness to palpation directly over the AC joint is an excellent screening tool to identify AC joint pathology. Palpation and localization of pain over the AC joint can be completed by the patient using their uninvolved contralateral side [16,17,38,45]. In addition, with the patient facing the

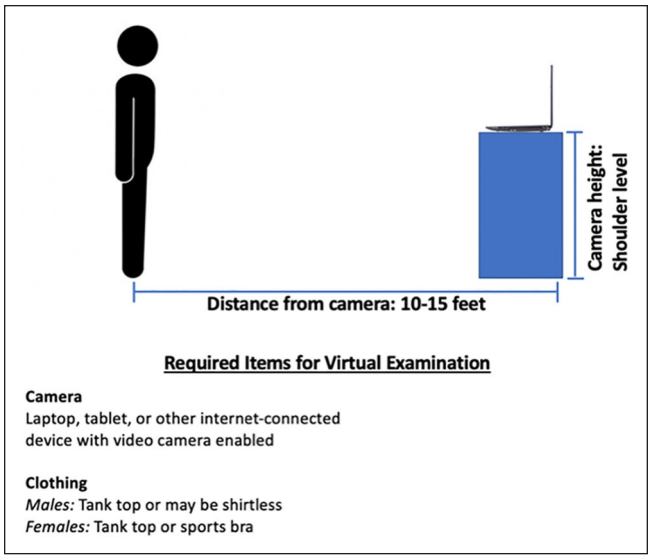

Fig. 1. Schematic of virtual shoulder examination.

camera, a cross-body adduction test can also be completed [10,16,45] (Supplemental Table 3).

The Biceps-Labral Complex

Identification of pain to palpation over the bicipital groove can be completed by the patient using the patient's contralateral arm. Good confirmatory test for proximal biceps pathology including the Speed and Yergason [5,14,17,19,23,38]. Both of these tests can be completed using modifications by the patient. The O'Brien test is also another screening test for BLC disease [37]. Our modification of the O'Brien test can be performed by the patient using a plastic grocery bag with addition or removal of soup cans (Supplemental Table 4).

Glenohumeral Instability

The anterior apprehension test is an excellent screening and confirmatory test for anterior shoulder instability [12,18,38]. The anterior apprehension test can be performed by asking the patient to place their involved extremity into a thrower's position. Our modifications also allow the posterior stress test for posterior instability and sulcus test for inferior or multidirectional instability to be performed by the patient (Supplemental Table 5).

When completing a comprehensive shoulder exam, generalized joint hypermobility and evaluation for thoracic outlet syndrome should be completed. Facing the camera, the patient can independently complete the Beighton score and Roos test [7,21] (Supplemental Table 6).

Postoperative Shoulder Exam

A potential great application for the virtual visit is for postoperative appointments for patients who have had shoulder surgery. The purpose of the immediate postoperative virtual visit would be to identify any potential red flags that would prompt an in-person visit. Patient should be asked to position their camera to fully visualize their operative shoulder. This would allow for assessment of the incision, surrounding ecchymosis, drainage, and erythema. In addition, when appropriate, range of motion can be assessed as outlined above. Using technology like virtual goniometer or wearable technology can help facilitate and document the assessment of the change in range of motion between postoperative visits [13,35].

Discussion

After completing the "core shoulder exam," additional pathology-specific special testing is performed, depending on the clinical suspicious and differential diagnoses. The pathology-specific special testing should be directed by the patient's history of present illness, and core shoulder exam findings. Regardless of workflow or the exam approach of the physician, we have provided a standardized approach that is comprehensive to the virtual shoulder exam. This includes previsit setup, and modifications to in-person physical exam testing. As these modified exam maneuvers are used more, there will be improved standardization allowing for improved reliability and validity of these virtual exam maneuvers. While there are certain physical exam tests such as load and shift for glenohumeral instability that cannot be performed virtually, there are many portions of the shoulder physical exam that can be effectively be completed using a video-based Telehealth application. This does require physicians to expand their choice of exam maneuvers to include some minor modifications and alternatives to classic exam maneuvers, such as our modification to the Jobe test (Figure 2) [16,17,20,26,29,38]. Using these modifications, we are still able to acquire useful data through the virtual shoulder exam to allow for accurate and appropriate clinical decision making. After total joint arthroplasty, Sharareh and Schwarzkopf [33] reported that patients had increased patient satisfaction when compared with customary in-person outpatient clinic visits. This observation has been similar with the recent clinical experience, in the setting of a high-volume total shoulder arthroplasty, of the senior author (S.A.T.). When looking at postoperative patients after rotator cuff repair, Kane et al [22] showed in a randomized controlled trial that these patients received safe and effective postoperative follow-up care using telehealth when compared with traditional in-person outpatient postoperative clinic visits. In addition, postoperative wound complications and breakdowns can be easily identified during telehealth encounters [15]. The advancement, use, and access of video-based online applications have changed the way that telehealth visits are conducted. Over the last decade, there has been a drive to leverage new technologies to help better treat and understand patients [1]. As more video-based online platforms become accesible to patients, these tenchnologies

Fig. 2. Modifications to common exam maneuvers for virtual shoulder exam: (a) Jobe's test (thumbs down abduction) with soup cans in grocery bag for resistance. (b) Resisted external rotation testing. (c) Resisted internal rotation testing. (d) Hawkins test using contralaternal hand to push abducted shoulder into internal rotation. (e) Cross-body adduction using contralaternal arm. (f) O'Brien (active compression) test with the thumb pointed down and resistance provided by soup cans in grocery bag (Supplemental Table 7). (g) O'Brien test with thumb pointed up [24].

can be further leveraged and modified to help standardize the virtual patient encounter. They can be potentially levereaged to identify at-risk patients, and to improve the reliability and validity of the virtual physical exam. A number of studies have assessed inter- and intra-observer reliability and validity of shoulder physical exam data points like acceleration, velocity, and range of motion [31]. Identification and sourcing of these data points have included the use of wearable accelerometers, gyroscopes, camera-based motion software, and inertial sensor monitoring units [31]. At some point in the future, we imagine a collaboration of motion sending technologies, video-based online applications, and data analytic software to help supplement and standardize the virtual visit and physical exam.

Conclusion

Telemedicine has the potential to change care delivery, increase health care savings, increase geographical expansion, and improve time-efficiency. While an in-person exam can be considered a gold-standard, we maintain that a majority of the customary in-person shoulder physical exam can be completed virtually with little to no modification of exam maneuvers. In addition, we maintain that the data points acquired from a virtual visit for shoulder pathology can allow for and enable the provider to make meaningful clinical decisions. We have provided a comprehensive description of the shoulder physical examination for sports medicine telehealth visits including (1) verbal instructions in layman's terms, (2) annotated images of each exam maneuver that can be provided to patients via screen share options, and (3) a checklist for documentation. Additional studies need to be completed in the future to validate the virtual shoulder physical exam presented here.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Sridhar Pinnamaneni, MD; Joseph D. Lamplot, MD; Stephanie Swensen-Buza, MD; Cort D. Lawton, MD; and Warren K. Young, MD, declare they have no conflicts of interest. Scott A. Rodeo, MD, reports relationships with Advance Medical and Ortho RTI, outside the submitted work. Joshua Dines reports relationships with Arthrex Inc, Thieme Inc, Linvatec, Wolters Kluwer Health, American Shoulder and Elbow Surgeons, and the *Journal of*

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