Review Article

An Overview of Telehealth in Total Joint Arthroplasty

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Abstract

With the increase in technological advances over the years, telehealth services in orthopedic surgery have gained in popularity, yet adoption among surgeons has been slow. With the onset of the COVID-19 pandemic, however, orthopedic surgery practices nationwide have accelerated adaptation to telemedicine. Telehealth can be effectively applied to total joint arthroplasty, with the ability to perform preoperative consultations, postoperative follow-up, and telerehabilitation in a virtual, remote manner with similar outcomes to in-person visits. New technologies that have emerged, such as virtual goniometers, wearable sensors, and app-based patient questionnaires, have improved clinicians' ability to conduct telehealth visits. Benefits of using telehealth include high patient satisfaction, cost-savings, increased access to care, and more efficiency. Notably, some challenges still exist, including widespread accessibility and adaptation of new technologies, inability to conduct an in-person orthopedic physical examination, and regulatory barriers, such as insurance reimbursement, increased medicolegal risk, and privacy and confidentiality concerns. Despite these hurdles, telehealth is here to stay and can be successfully incorporated in any total joint arthroplasty practice with the appropriate adjustments.

Keywords

total joint arthroplasty, total hip arthroplasty, total knee arthroplasty, telehealth, telemedicine, technology

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Introduction

The utilization of telehealth services has been facilitated in recent decades by the advancement in audiovisual communication technology, including high-speed internet, videoconferencing platforms, and the rise in personal laptop computer and smartphone use [26,38]. Despite increased interest, national usage rates among patients have been cited at <10%, and only 6.6 telemedicine visits per year occurred per 1000 practitioners in the United States in 2017 [25,26]. However, following the outbreak of the coronavirus disease 2019 (COVID-19) pandemic, demand for the use of telehealth services among healthcare providers has grown dramatically, in addition to an expansion of telehealth benefits allowed for Medicare beneficiaries [44,48]. Orthopedic surgery practice in total joint arthroplasty (TJA) has experienced an increased need for the use of telehealth services due to the higher age of the patient population and greater risk of complications and death from COVID-19 [38].

The term *telehealth* is often used interchangeably with *telemedicine* and is defined as the delivery of health-care services via electronic communication covering all aspects of clinical and nonclinical care delivery to improve a patient's health [26,47]. Two major classifications of telemedicine exist: synchronous and asynchronous. Synchronous telemedicine refers to real-time videoconferencing or telephone communication between the patient and provider, whereas asynchronous telemedicine describes the gathering and sharing of medical information for a patient or another provider at a later time [3,24].

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The field of orthopedic surgery is well suited to telehealth services due to its high-value based care. The literature suggests that telehealth services provide comparable patient satisfaction, increased cost savings, improved care access, and greater efficiency [8–10,19,24,26,27,33]. Additionally, success of implementing telehealth services in orthopedic surgery practices has been reported despite some challenges [25,38,42]. The purpose of this review is to discuss current trends in telehealth in TJA, including its use for preoperative consultation, postoperative follow-up, and telerehabilitation following TJA, an overview of novel technologies for improving tele-assessments, and a review of the benefits and challenges of telehealth services.

Performance of Telemedicine Examination

In order to perform an appropriate remote examination, the patient's camera should be well-positioned to allow for proper visualization of the patient in the standing, sitting, and lying positions [44]. The patient should be familiar with the use of technology, and if not, a third person, such as a visiting nurse or family member, should be there to assist the patient. Unobstructed communication is especially important for creating good patient-physician relationships when using telemedicine. The physician should initially spend time explaining the steps of the virtual visit before beginning the examination. Both the patient and physician should ensure that the audio quality is adequate, because during the session the physician will need to verbally indicate to the patient which clinical tests to perform and also be able to clearly hear the patient if any questions or concerns arise. These steps taken at the beginning of the visit are critical to limit any potential technical or audiovisual difficulties.

Preoperative assessment can be performed virtually in spite of the fact that surgeons traditionally have preferred to examine patients in person. The standard hip exam is easily performed. Gait should be assessed by asking the patient to walk toward and away from the camera. Careful examination of the skin should then follow with the patient keeping both hip joints in view of the camera to allow the surgeon to assess for any discoloration or swelling. While the patient is in the standing position, the physician can measure the leg length with the help of a virtual ruler [44]. Next, palpation of the hip is performed by explaining to the patient where to place pressure and asking the patient to indicate where the pain is localized. The surgeon can point out the anterior superior iliac spine (ASIS) on his or her own body to assess for pain at the ASIS. To evaluate hip flexion, the patient can be asked to lie in the supine position and bring the knee to the chest. Then, to evaluate hip extension, the patient can lie in the prone position and extend the leg with the knee in extension. To assess internal and external rotation, the patient should be in the seated position facing the camera. Internal rotation can be measured by asking the patient to rotate the hip with the knee at 90° of flexion and using a virtual goniometer. External rotation can be assessed by asking the patient to cross the legs or place them in a figure-of-4 position [44]. Muscle strength should also be evaluated by asking the patient to perform a straight leg-raise as well as toe- and heel-walking [44].

The remote assessment of the knee joint has many similarities to the examination of the hip. After inspection and palpation, the physician should examine the range of motion (ROM) of the knee joint and can obtain numeric measurements by using a virtual goniometer [44]. Due to the limitations of the virtual exam, only active ROM can be assessed. However, if there is a family member or visiting nurse present, they can assist in examining passive ROM. Flexion can be examined by having the patient in the seated position facing the camera and asking him or her to lift the heel off the floor. Extension can be assessed in standing position with the patient facing sideways to the camera. To evaluate for hyperextension, the patient can be asked to push posteriorly while having the foot planted [44]. Alternatively, the patient can be examined in the prone position while having a pillow under the thigh in order to assess the hyperextension, and in the same position, the patient can be asked to flex the knee to assess the active ROM. The calves should also be examined for venous varicosities and chronic stasis dermatitis.

Appropriate radiographs can be reviewed by the surgeon with the patient virtually. It is recommended that x-rays be taken prior to the examination. Images can be uploaded or copies can be sent so that the physician can review them with the patient during the remote examination. Buvik et al [10] reported no inferiority in care when using telemedicine, yet the authors emphasized the importance of having radiographs taken before the evaluation so that they are available for remote review.

With respect to postoperative follow-up, there are a few differences between the remote preoperative and postoperative examination of a patient following TJA. Whenever possible, the initial postoperative follow-up should be done in person due to the fact that many acute postoperative conditions cannot be managed remotely [38]. However, subsequent follow-up visits can typically be performed remotely. The incision site can be visually inspected to assess for infection or hematoma and to ensure proper healing of the wound. ROM should be carefully assessed and recorded, especially after total knee arthroplasty (TKA). In 2014, Sharareh and Schwarzkopf compared on-site postoperative follow-up visits with remote consultations and concluded that patients who underwent telemedicine follow-up rated their postoperative satisfaction higher [42]. More recently in 2019, Preston et al [37] provided a standardized approach and assessment of virtual follow-up of hip and knee arthroplasty patients. Their approach and methods of documentation were well accepted by orthopedic experts, radiologists, and patients.

Technology for Telemedicine

The evolution of new technologies has significantly improved the ability to appropriately perform virtual patient examinations. Most current laptops and mobile devices are equipped with high-resolution cameras that can depict the elements of a patient's exam with excellent clarity. In addition to virtual goniometers, there are smartphone applications that can also measure ROM. For example, the phone can be placed on the tibia to measure the ROM of the knee. Wearable sensors have also been introduced that can provide digitalized objective data regarding ROM of an operated joint [14]. If the patient is equipped with such devices, ROM can be automatically measured with the patient's movements. Additionally, wearable devices can also be used for gait analysis. Online electronic questionnaires can be used for the assessment of patient-reported outcome measures (PROMs). It has been reported that the app versions of questionnaires have shown a high level of association with the paper-based questionnaires, making their use in clinical practice and for telemedicine visits feasible [21].

Telerehabilitation Following TJA

Preoperative and postoperative physical therapy can be important adjuncts and may be critical in optimizing physical function and mobility, as well as alleviating pain and improving quality of life in patients with degenerative osteoarthritis [40]. With our aging population and expected exponential increase in demand for TJA procedures in the United States in the coming decades, access to postoperative therapeutic exercises to maximize functional outcomes will be mandatory [34,43]. The recent development of specific technologies and greater emphasis on cost-effectiveness and better accessibility for patients in remote locations, as well as the challenges associated with the COVID-19 pandemic, have encouraged a shift in delivery of postoperative rehabilitation to virtual through telerehabilitation [7,23]. In-person physical therapy has traditionally been a staple of the orthopedic patient's postoperative recovery process, whether outpatient or home-based, but remote, virtual rehabilitation is being increasingly relied upon and has shown success in other medical fields [2,6,12,13,49].

There are a variety of platforms that providers can use to interact with patients remotely, ranging from simple systems to more complex platforms. Interactions with patients can be done through audio visits via telephone, live video visits and videoconferencing, integrated electronic medical record system platforms, and various other digital platforms utilizing application-based software [28]. Patients may be able to directly message therapists and providers, upload photos for provider evaluation, and interface with physical therapists over video conferencing [45]. For TJA patients, telerehabilitation should include development of a comprehensive in-home exercise program, and a typical session should involve an assessment before and after exercise, a supervised exercise protocol focused on mobility, strengthening, function, and balance, explanation of a detailed exercise regimen to perform on the days between telerehabilitation sessions, and instructions regarding pain management, ambulatory assistive devices, and return to activities [29]. The protocol can also provide a weekly guide on treatment items and goals, focusing on muscle strength, mobility, and ROM [40]. The physical therapist should choose an exercise regimen most tailored to patients' specific needs, with exercise intensity modulated according to tolerance and progression. In addition to physical therapy, virtual physical examination and exercises can be performed under supervision of the caregiver, though primarily based on inspection and ROM analysis [4]. Strength testing may be conducted with the use of weights and body weight maneuvers, such as sit-to-stand transfers [28].

Several studies have demonstrated the effectiveness of in-home telerehabilitation following primary TJA, more specifically as an effective alternative that is noninferior to in-person physical therapy [29,35,40,46]. Additionally, patient satisfaction with telerehabilitation is important to consider when determining efficacy of intervention, and questions have been raised about steep learning curves associated with the use of technology, particularly in the elderly population. However, studies have reported positive perceptions and satisfaction with the use of telerehabilitation and that the inability to use technology is not a significant detractor from patient satisfaction [22,30]. Routine discussion of patients' level of satisfaction is important, as telehealth relies on patients' reports of satisfaction as one of the few sources of information in determining treatment efficacy and whether the interventions are meeting patients' care expectations [22]. The rehabilitation paradigm can thus be dynamically modified to meet patients' needs and fulfill expectations. A strong patient-provider relationship must be maintained despite the virtual nature of the interaction.

Age and social factors can influence compliance with remote rehabilitation, due to ability to access and adapt to technology. Additionally, difficulties with equipment installation, patient safety, and treatment adherence are additional challenges. With appropriate planning, however, these barriers can be overcome. Internet connection and an intuitive user interface are necessary in order for patients to successfully and reliably access the platform and complete the at-home therapy protocol. Technical assistance with in-home equipment set-up can be arranged, and with provider-led demonstrations over video visits, appropriate utilization of the equipment with safe technique can be assured. Nonetheless, it is important for telerehabilitation platforms and applications to be user-friendly in design, simple, and quick to access. Telerehabilitation also promises the benefit of cost-effectiveness over in-person rehabilitation visits, considering the decreased transportation costs for those with disabilities that need assistance or those living in more rural or remote

locations [18,23,31]. From the provider's perspective, there are cost savings associated with the added benefits of being able to continuously monitor patients, standardize exercise protocols and regimens, and evaluate multiple patients during the same session, improving efficiency and decreasing missed appointments [7,23,28].

Despite the emergence of technology, the aforementioned challenges associated with the implementation of virtual care have slowed widespread adoption. However, the advantages and accessibility of virtual rehabilitation programs, as well as current pandemic-associated emphasis on physical distancing and avoidance of in-person encounters, have warranted an accelerated paradigm-shift in postoperative therapy to telehealth-based rehabilitation.

Benefits and Challenges of Telehealth Services

The advantages of telehealth services include patient satisfaction, cost-savings, increased access to care, and greater efficiency. Sharareh and Schwarzkopf reported that postoperative TJA patients at their institution who were seen via telemedicine using Skype had significantly higher satisfaction rates than those undergoing in-clinic visits [42]. Patients in the telemedicine group rated their postoperative care at an average of 9.88 out of 10, compared to 8.1 out of 10 in the standard in-clinic visit group. Additionally, the majority of both groups preferred telemedicine over in-clinic visits (58.8% of telemedicine group and 63.6% of standard group) [42]. A study carried out in the United Kingdom that investigated the effectiveness of a virtual joint replacement clinic found that 89% of patients were either satisfied or very satisfied with their virtual follow-up [16]. Buvik et al [9] conducted a randomized controlled trial (RCT) in Norway comparing real-time orthopedic video consultations to standard in-person visits and reported that 99% of the telemedicine group rated the encounter as very satisfactory or satisfactory. Also, 86% of the telemedicine group preferred a video consultation at the next visit [9]. A study comparing web-based assessment to outpatient clinical visits following TJA in Canada found that 95% of patients preferred the eClinic assessment to regular outpatient visits [51]. On the contrary, a recent RCT carried out by Marsh et al [27] reported that 76% of TJA patients in the web-based follow-up group were either extremely or very satisfied as compared to 82% in the clinic group, and patients in the usual care group were more satisfied with the surgeon's care they received than those in the web-based group (93% versus 74%, respectively). Yet, interestingly, according to the questionnaire 44% of the patients preferred the web-based method and 36% preferred the in-person clinic visits [27].

Rosner et al [39] investigated the cost effectiveness of using an automated digital patient engagement (DPE) platform on TJA patients over a 120-day perioperative time period compared to standard care. They found that among the patients who avoided any postoperative complications (93% of study cohort), the mean savings was $656.52 per patient when using the DPE platform [39]. El Ashmawy et al [16] found that virtual TJA visits in the United Kingdom cost 56 pounds less than outpatient follow-up appointments, saving an estimated 42,644 pounds per year at their institution. A cost-analysis study conducted in Norway concluded that tele-orthopedic visits carried out at a remote clinic site with the assistance of nurses were found to be less costly than standard consultations at the hospital, with no difference in reported health outcomes [8]. Using a Cisco videoconferencing platform, they found the cost per consultation to be 65 euros less per patient than standard consultations, and the total number of consultations needed per year to break even from a societal perspective was 151 [8]. Another study conducted in Finland obtained cost data from an RCT comparing conventional outpatient visits at the university hospital with videoconferencing from a primary care center 160 km away [32]. They found the total cost per consultation to be 26 euros less per patient in the telemedicine group, and that 80 patients per year was the threshold for telemedicine to be less costly to society [32]. However, despite the evidence, the limitations and heterogeneity of these cost-analysis studies make these conclusions difficult to extrapolate. Therefore, more studies are needed that investigate the cost-savings associated with orthopedic telehealth services within the U.S. health care system, especially those studying at-home telehealth visits.

Multiple studies have shown that orthopedic telemedicine increases access to care among patients in remote areas. In an RCT, Buvik et al [10] found that video-assisted orthopedic consultations offered to patients living in remote locations were satisfied with their encounters and were given non-inferior care to the in-person visit group. Aarnio et al [1] prospectively studied orthopedic patients in Finland that used a videoconferencing system from a location 240 km away from a central hospital. They discovered that 69% of this telemedicine group were given definitive treatment, avoiding the need for them to travel to the hospital [1]. Moreover, a study conducted in the United Kingdom found that in the orthopedics group, virtual outreach increased the number of patients who were offered follow-up appointments (54% versus 34% in the standard group) [50]. The increased access to care that telemedicine offers patients in remote areas is especially beneficial to postoperative TJA patients who are in significant pain or who have limited mobility to travel to and from appointments.

Telemedicine has also been shown to be more efficient by reducing patient wait times and number of visits needed. One study showed that virtual follow-up after TKA that consisted of a patient questionnaire and x-rays at 5 yearly intervals avoided 1814 clinic appointments, which was equal to greater than 300 hours of clinic time without compromising patient safety [17]. El Ashmawy et al [16] found that 86% of patients undergoing virtual TJA consultation reported they

had saved time and/or money, with 23% saying they saved travel time and 21% reporting less wait time. A recent study conducted in Chile investigating the effect of telemedicine on efficiency and wait times found that 70% of orthopedic consultations were resolved after 2 telemedicine evaluations, and wait times for orthopedic referrals were decreased on average from 201 days to 40 days [36]. Furthermore, Buvik et al [10] reported no significant difference in the time of evaluation among the telemedicine encounters compared to in-person visits.

Despite the benefits of telemedicine in orthopedics, challenges still exist, which include familiarity and inefficiencies with the technology, the inability to complete a proper hands-on physical examination, and regulatory barriers. In a 2019 J.D. Power [20] survey, some patients reported they were either not familiar with or did not have access to computers, smartphones, or high-speed internet. The same survey also showed that 29% of patients who had not used telemedicine were unaware of the availability of those services and 37% believed that their health care providers did not offer telemedicine services [20]. A 2013 survey found that 96% of clinicians reported little knowledge of telemedicine [5]. Additionally, the reliance on new technologies that accompanies the use of telehealth services comes with audiovisual issues that may lead to delays or frustrations, ultimately causing increased workloads for clinicians [26].

Orthopedic surgery is a specialty that greatly relies on the hands-on physical examination to accurately assess a patient's musculoskeletal health. Therefore, telehealth visits make it difficult to perform necessary maneuvers, such as manual strength testing of motor function, sensory examination including 2-point discrimination, reflex testing, and palpation of painful areas [26]. However, technologies discussed previously, such as the virtual goniometer and integration of at-home weights to assess strength testing, are effective methods of carrying out parts of the physical examination remotely [44].

Regulatory barriers are associated with the use of telehealth services, including insurance reimbursement, increased medical-legal risk, and patient privacy and confidentiality concerns. For billing purposes, the types of telemedicine services that the U.S. Centers for Medicare & Medicaid Services (CMS) considers are telehealth visits, virtual check-ins, and electronic E-visits. Telehealth visits are real-time virtual encounters that use an interactive audiovisual telecommunications system, virtual check-ins are brief communications with patients via telephone or other technology to avoid unnecessary trips to the office or hospital, and E-visits refer to non-face-to-face communications initiated by the patient via online patient portals [11,24].

Traditionally, before the COVID-19 pandemic, reimbursement of telehealth services was limited. Medicare only paid for video consultations if the patient resided in a specific rural area or traveled to a designated health-care facility, and private payer reimbursement also varied compared to in-person services. Certain states' lack of parity led to providers being reimbursed less for telemedicine encounters than in-person visits. Lower compensation associated with care billed without completing a detailed physical examination further complicated physician reimbursement. Healthcare facilities may also be prone to income losses from missing out on onsite ancillary testing despite decreased overhead [26]. Furthermore, many states added logistical complexity for the provider by requiring written consent from patients prior to telemedicine visits. Providers were also not allowed to offer telehealth services to patients who lived in states in which the provider was not licensed [24,26].

However, the COVID-19 pandemic shifted these policies dramatically. CMS, as well as many private insurers, authorized virtual visits to be paid at the same rate as in-person visits or waived telehealth copays. Additionally, telehealth services are now allowed to be carried out via more accessible platforms like FaceTime and Skype, providers are allowed to treat patients via telemedicine in states in which they do not hold medical licenses, and there is increased legal protection for clinicians by waiving penalties for certain Health Insurance Portability and Accountability Act (HIPAA) violations [11,24,26].

Conclusion

The idea of telehealth has been around for some time, and several authors have advocated for the use of telemedicine and telerehabilitation even before the onset of the COVID-19 pandemic [15,42]. In 2017, 88% of 184 health care executives believed they would invest in telehealth in the near future [41]. Yet, in previous years, the vast majority of clinicians were not fully aware of telemedicine, and a percentage of patients did not even know these services existed [20,26]. However, the recent global pandemic has raised the need for remote assessment of patients due to social distancing mandates. Nowadays, telemedicine has become very popular for the vast majority of routine visits, and as people become more familiar with using these new technologies, telemedicine will be established even after the end of the pandemic.

The development of validated, modified examination techniques that allow for improved and interactive virtual physical examinations will likely be the next wave of progress as we move into this new realm. The execution of telemedicine will also improve as technology evolves. For example, the use of haptic devices may offer the opportunity for physicians to examine patients remotely using a form of digital touch, giving them the ability to feel the resistance when evaluating muscle strength. Lastly, a distant innovation in this new era could be the development of telesurgery, where a patient would be able to be operated on remotely by a surgeon who may be off site.

The use of telemedicine in TJA is quickly becoming more widespread. Nevertheless, improvements are needed to reduce the cost of using these technologies and further

improve the quality of care for patients. More well-controlled studies are also required to better assess the effectiveness of telehealth services in TJA. Ultimately, the successful adoption of telemedicine is contingent on coordinated initiatives between doctors, patients, insurance companies, private enterprises, and health-care systems.

Declaration of Conflicting Interests

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