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The New Dimension of Surgery: Telesurgery and Surgical Nursing

Cerrahinin Yeni Boyutu: Telecerrahi ve Cerrahi Hemşireliği

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ÖZ

Yakın geçmişte yaşanan COVID-19 pandemisinde cerrahi hastalarının, zorunlu olmadıkça hastanelere başvuramamaları ve hatta elektif ameliyatlar da dahil olmak üzere acil olmayan tıbbi faaliyetlerin büyük çoğunluğunun duraklatılması nedeniyle sağlık bakım ihtiyaçlarını karşılamada daha çok teletıp uygulamalarına yöneldikleri gözlenmiştir. Sağlık hizmetlerinin sunumunda telesağlık kavramlarından biri olan telecerrahi, uzaktan cerrahi olarak bilinen ve hastalara uzaktan cerrahi bakım sağlayan umut verici bir uygulama olarak ortaya çıkmıştır. Günüzde hastalardan uzakta cerrahi robotlar, sanal gerçeklik uygulamaları, gelişmiş bilgisayar ve ağ teknolojilerinin kullanılmasıyla gerçekleştirilen telecerrahi müdahaleler, cerrahi alanında yükselen bir trend haline gelmiştir. Dünya çapındaki uzmanlıkla yüksek kalitede uzaktan cerrahinin sağlamasını amaçlayan telecerrahi uygulamalarının çok yeni gelişen bir teknoloji olması nedeniyle bazı engelleri bünyesinde barındırdığı ortadadır. Ancak engellere rağmen telecerrahi müdahalelerin, farklı uygulama şekilleri sayesinde gün geçtikçe başarıyla uygulandığına şahit olunmaktadır. Gelecekte daha fazla hastaya ulaşılarak, hizmet vermesi beklenen telecerrahinin, yüksek hızlı gelişmiş ağ bağlantısı, daha düşük maliyet oranları ve dünyanın her yerine, hatta uzaya ve denizin derinliklerine kadar ulaşması ile daha yaygın bir şekilde uygulanacağı ve gelişeceği öngörülmektedir. Cerrahi alanında yeni bir uygulama alanı olan telecerrahide hemşirelik uygulamalarına bakıldığında ise olumlu sonuçlara ulaşıldığı ancak yapılan çalışmaların henüz sayıca yetersiz düzeyde olduğu belirtilmektedir. Gelecek yıllarda hızla gelişim göstermesi beklenen telecerrahi teknolojisine bağlı olarak, cerrahi hemşireliği alanındaki telecerrahi ile ilgili yapılacak olan çalışmaların sayısında da hızlı bir artış olacağı düşünülmektedir. Bu nedenle bu derlemede, son yıllarda cerrahlar tarafından yeni bir trend olarak uygulanmaya başlanan ve henüz hemşireler için çok yeni ve oldukça geliştirilmesi gereken bir uygulama alanı olan telecerrahi girişimlere açıklık getirilmesi ve bu alanda uygulanan cerrahi hemşireliği girişimlerinin incelenmesi amaçlanmıştır.

Anahtar Kelimeler: Hemşirelik, robotik cerrahi işlemler, uzaktan operasyonlar, cerrahi girişimler, teknoloji

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ABSTRACT

In the recent COVID-19 pandemic, it has been observed that surgical patients have turned more towards telemedicine applications to meet their health care needs due to the fact that they cannot apply to hospitals unless they are mandatory and even the majority of non-urgent medical activities, including elective surgeries, are paused. Telesurgery, one of the telehealth concepts in the provision of health services, has emerged as a promising application known as remote surgery, which provides remote surgical care to patients. Today, telesurgical interventions performed away from patients using surgical robots, virtual reality applications, advanced computer and network technologies have become a rising trend in the field of surgery. It is obvious that telesurgery applications, which aim to provide high quality remote surgery with worldwide expertise, have some obstacles due to the fact that it is a very new technology. However, despite the obstacles, it is witnessed that telesurgical interventions are being successfully applied day by day thanks to different application methods. It is predicted that telesurgery, which is expected to reach and serve more patients in the future, will be more widely applied and developed with its high-speed advanced network connection, lower cost rates and reaching all over the world, even to space and the depths of the sea. When we look at the nursing practices in telesurgery, which is a new application area in the field of surgery, it is stated that positive results have been achieved, but the number of studies is still insufficient. Depending on the telesurgery technology, which is expected to develop rapidly in the coming years, it is thought that there will be a rapid increase in the number of studies on telesurgery in the field of surgical nursing. Therefore, in this review, it was aimed to clarify telesurgical interventions, which have been started to be applied by surgeons as a new trend in recent years and which is a very new and highly developed application area for nurses, and to examine the surgical nursing interventions applied in this field.

Keywords: Nursing, robotic surgical procedure, remote operations, surgical procedures, technology

1. Introduction

Technological developments in the field of health have been effective in introducing concepts such as telehealth, telemedicine, telesurgery, telenursing into our lives (1). Telehealth applications are used to facilitate access to surgical services, especially for surgical patients who need surgery, and to reduce gaps in treatment and care (2).

In the recent COVID-19 pandemic, many surgeries could not be performed for a long time all over the world, leading hospitals to seek new technologies (3,4). During this period, it has been observed that countries may prefer telesurgery and telenursing applications in order to accelerate the diagnosis and treatment processes of patients, protect patients from infections, prevent the development of postoperative complications, reduce health expenditures, increase patient satisfaction and quality of care (3,5-8). It is known that hospitals in many countries benefit from telemedicine systems to meet the health care needs of patients, especially during the pandemic period, as patients cannot apply to hospitals except in mandatory situations (3,4). In addition, the pandemic has increased the need for the use of telemedicine for surgical patients, as most non-emergency medical activities, including elective surgeries, have been paused and medical resources have been allocated to manage the pandemic (9, 10). In this process, it has been observed that teleexamination, telecounseling, teleeducation, telesurgery and telerobotic surgery applications have been implemented in many countries in a rapid and continuously developing manner (9,11).

The adaptation of telemedicine to the surgical field is referred to as 'telesurgery' (2). Telesurgery is defined as surgery performed remotely from a different location far from the operating room by overcoming time and distance barriers, using robotic and computer technologies (9,12,13). This location difference can be between countries or continents (14). The main goal of telesurgery is to provide high quality remote surgery with worldwide expertise (15). When faced with complex cases requiring multidisciplinary surgery, telesurgery can also be performed one to one with two or more control systems controlling the same patient. Combined multidisciplinary surgical applications allow surgical problems in neighboring organs to be solved during the same surgical intervention and unite different hospitals for remote surgical intervention (16). In order for telesurgery to be realized, it is necessary to have remote proximity systems that can create a sense of presence by providing data conversion, presenting information about the surgical field of view and the surgical environment in the imaging field to the operator in image-audio format (16).

The Evolution and Recent Development of Telesurgery

The endoscope was invented as a result of the development of a video computer chip that allowed surgical images to be magnified and projected onto television screens, and this initiative was a breakthrough in the development of laparoscopic surgery (17). This approach in the field of surgery also changed the era of surgery and created a possibility for the evolution of telesurgery (15).

The concept of telesurgery emerged in 1970 when the US National Aeronautics and Space Administration (NASA) began investigating the possibility of providing treatment to astronauts in space (18).The first telesurgery applications were on battlefields and US Navy ships in the 1990s. 4000 kilometers (km) away at the Landsthul military hospital in Germany, many laparoscopic operations were performed with a robot controlled by a surgeon. The first remote surgery was performed in Milan in 1995 by urologist Enrico Pisani, who took a prostate biopsy from a patient in a hospital 5 km from the operating surgeon (4). Apart from this brief pioneering experience, the first case of transatlantic telesurgery was performed by Professor Jacques Marescaux and his team on September 7, 2001, when a 68-year-old woman with cholelithiasis in France underwent a 90-minute laparoscopic cholecystectomy from New York (4, 16, 19, 20). The complete recovery of the patient with no postoperative complications was a milestone in the feasibility of telesurgery and removed many professionals' significant doubts about the use of these procedures (20).

In 2009, the US Army developed a surgical robot system based on the da Vinci system to realize unmanned processing and to cope with surgical needs that may arise in wartime. It is stated that this new system consists of management and imaging system, surgical robot system, control and supervision system, equipment replacement and distribution system, monitoring system and drug supply systems (16).

When the technology in the development of telesurgery is examined, it is seen that there is a continuous development and improvement, VIP (Virtual Interactive Presence) was developed in 2014 and the prototype Telefap Alf-x, which applies effective haptic feedback technology, was developed in 2015. In 2019, it was reported that telesurgery over the 5G network was successfully tested (4). In February 2019, a Spanish team performed an intestinal tumor resection surgery, the first remote surgery in the world using a 5G network (16). Since 2019, many studies have reported the use of 5G networks in remote surgeries and positive surgical outcomes (16,21).

Considering the future of telesurgery, it is stated that telesurgery applications in emergency surgical situations that may develop suddenly in high altitude areas and in the depths of the sea have high application potential for surgical interventions in space stations and naval aviation (16,22,23).

Classification of Telesurgery

Telesurgery is divided into three classes: telementoring, tele-presence and telerobotic surgery (9,15).
Telementoring: It is when an experienced surgeon guides an inexperienced surgeon at a distance with an interactive video image and directs the surgery in real time (9,24). The telementoring program first started in 1999, and in 2003 it was developed with robot-assisted remote telepresence surgery and assisting (9,25).

Telementoring allows surgical education and collaboration on a global level (26) and is easily applied in surgical teaching (14). The surgery is performed with the help of a computer with special software

for audio and video connections, a video camera with a panoramic view of the operating room, robotic devices, remote-controlled electrocautery and standard laparoscopic instruments (9,27). The remote mentoring experience enables surgical trainees to learn and gain experience in complex and rare surgical cases more easily with the guidance and direction of experts in remote areas (14) and contributes to the development of surgical training models (16).

Telepresence Surgery: Telepresence, as applied in telesurgery, is known as surgeries performed by a surgeon without seeing or touching the patient directly (28). This method, which enables the surgeon's hand movements to be transmitted to the unit where the surgeries will be performed at the remote center using a computer-aided interface, provides tactile input to the surgeon to transmit the tactile environment of the operating field (29). Thanks to this real-time visual system, surgeons can see the combined surgical field image of each other's hand movements. It is thought that this virtual interactive application will allow real-time interaction between surgeons in many parts of the world and contribute to the training of surgeons (30).

Telerobotics: In 1999, with the introduction of the da Vinci surgical robot, telesurgical interventions became the essence of minimally invasive surgical procedures (8). Today, the most technologically advanced surgical robotic system in the world is known to be the da Vinci system, and this robotic system is designed to perform complex operations with appropriate cutters that are much smaller and less traumatic than those in traditional surgical approaches. Remote control of the robotic system with the robotic arm without haptic feedback is called 'telerobotics' (9). The main components in Da Vinci robotic systems consist of a surgeon console, a computerized control system, two robotic arms and a fiber optic camera. While the surgeon sits at the console and performs manipulations, the digital camera system provides 3D imaging. At the same time, the surgeon's hand movements are digitized and transmitted through the port incisions to the fine instrument tips inserted into the body and simultaneously sent to a computer processor (31). This computerized robotic system is known to provide freedom and precision, especially in the surgeon's hand movements, as it allows much higher degrees of wrist movement (9).

As a member of the surgical team, nurses are involved in these interventions with their knowledge and skills specific to the field of telerobotic surgery. In performing these surgeries, nurses have important responsibilities such as collecting data, maintaining nursing care, analyzing results, identifying safety problems, reviewing robotic instruments, cleaning and preparing materials, separating the robot from the patient and creating charts (8, 9).

Benefits of Telesurgery

Regarding telesurgery applications, it is mentioned that in addition to the benefits of robotic minimally invasive surgery, it also includes the inherent advantages of telehealth services (15). In this direction, the benefits of telesurgery can be examined under 3 headings;

Benefits associated with minimally invasive surgery;

- Less blood loss in the patient,
- Reduced length of stay of patients in hospital,
- Short recovery time,
- It is stated as ensuring that patients return to work early (32).

Benefits of robotic-assisted minimally invasive surgery;

- Thanks to today's 3D high-resolution camera and imaging systems, it allows surgeons to see surgical areas that are not easily accessible with high-resolution close-ups (9,11,15,30).
- It provides surgeons with a more ergonomic posture and dexterity than traditional laparoscopic surgery (33).
- Thanks to its accelerometer technology, it eliminates the physiological tremors of the operators with its real-time filtering feature and increases the accuracy of the movement (30,33).
- Thanks to the robotic arm, it provides easy access to hard-to-reach surgical areas and improved surgical accuracy. Thus, by reducing the possibility of damaging healthy tissues in the surgical field, it significantly reduces the risk of blood loss and infection and accelerates the patient's recovery (9,15,30,33).

General benefits related to telesurgery;

- By providing real-time collaborations between surgeons in different health centers, it provides benefits for the implementation of surgical interventions that require the application of complex microsurgical operations and techniques (4,9).
- It is useful in providing high quality surgery in remote areas where transportation is difficult, such as medically underserved rural areas, war zones and space stations (4,16,20,30).
- Telesurgery can offer patients the opportunity to receive care from surgical specialists from all over the world without leaving the hospital. It is especially useful for patients for whom medical travel is not possible due to time delays, and it also benefits by eliminating the health risks/restrictions and financial constraints associated with travel (4,9,20).
- Based on the recent COVID-19 pandemic, it has been reported that effective surgical care can be provided by telesurgery in cases limiting medical care that may develop due to travel restrictions in possible future pandemics (15,20).

Considering all these benefits, telesurgery could be a potential solution to the global shortage of skilled surgeons (15).

Limitations and Obstacles in Telesurgery

Since telesurgery is a new technique in the provision of surgical care, it is still in the development stage. Therefore, there are some barriers to the widespread implementation and utilization of telesurgery (15).

The most important problem in telesurgery is related to the telecommunication systems used to provide visual, auditory and tactile feedback between two remote locations (9,34). As the distance between locations increases, the likelihood of temporal delays and consequently surgical errors increases. It is stated that the time delay and delays that pose a vital problem consist of disruptions during data transmission over the network, encoding and decoding of the video (15). A time delay of less than 100 milliseconds related to telecommunications that may be experienced during surgical practice is considered to be an ideal time in terms of delay. However, it is stated that delays of more than 300 milliseconds may cause serious inaccuracies in instrument use (13,20,30,34).

Another problem in telesurgery applications is the difficulty in procurement and maintenance of equipment. The fact that countries around the world and especially third world countries cannot benefit from these systems due to high costs shows that there are major financial obstacles in the purchase of robotic systems (9,15).

In particular, the introduction of telesurgery applications requires the interconnection of all parts of the world with a telecommunications robust global network and high-speed telecommunications (15). This is seen as the biggest obstacle to the implementation of telesurgery systems in developing countries. Telecommunication networks are thought to be vulnerable to cyber-attacks, and considering the possibility that networks can be compromised, cyber-attacks can pose a vital threat to patient safety (15). It is also reported that there may be difficulties in establishing high-speed telecommunication networks and signal transmission in mountainous regions (20).

In addition to all these obstacles, considering that telesurgical surgeries will be performed with the cooperation of multiple institutions, inter-institutional agreements and billing procedures need to be arranged (15). In addition, it should not be forgotten that it is very important to organize these practices in a way that does not cause legal and ethical problems and concerns (9,15). It should be taken into consideration that patients may file lawsuits against hospitals, surgeons and medical device companies in case of unfavorable surgical outcomes (20). It is of utmost importance to clarify which country's law should be applied to malpractice practices that may develop during the international implementation of these initiatives (13).

What Awaits Surgical Nurses in Telesurgery?

It is seen that the field of nursing is also affected by technological developments in the field of health, which is increasing rapidly day by day (2). Due to the insufficient number of nurses working in surgical units, who are with the patient 24 hours a day and ensure the continuation of regular care and treatment of patients, disruptions in the treatment and care of patients, decreases in their quality of life, and prolonged hospital stays can be seen. While such situations are thought to increase the need for remote surgical applications, remote surgical interventions have started to be applied (35,36).

Providing preoperative surgical preparation and postoperative care processes of surgical patients with telecommunication devices is referred to as 'telesurgical nursing' (37). Patients who will undergo surgery may have fear and anxiety about recovery during diagnosis, treatment, surgical intervention and postoperative care processes. Good communication between healthcare professionals and patients can minimise and prevent this situation (38). Therefore, nurses have important responsibilities in telesurgery nursing.

Preoperative and Perioperative Telesurgery Nursing

Telesurgery nurses have responsibilities such as collecting information about the patient, following the patient's findings, interpreting and evaluating the information obtained, and even contacting the patient's doctor when necessary, making suggestions for treatment and care, and informing the patient about new arrangements related to the patient (2,6). It is stated that with remote surgical care practices, nurses aim to reduce the repeated visits of patients to the emergency department with the nursing interventions they apply by monitoring and follow-up of patients in the preoperative and postoperative period (2).

Since the existence of a telesurgery surgery performed with the active participation of nurses has not yet been mentioned in the literature and telesurgery nursing practices during surgery were not found in the literature review, it was seen that there is a great deficiency in the literature on this subject. In relation to perioperative care, only da Silva Schultz et al (2020) conducted a randomised controlled trial using teleconsultation to reduce the nursing diagnosis of ‘delayed surgical recovery’ in patients undergoing laparoscopic cholecystectomy and hernia repair and found that this method helped perioperative nurses to make the right interventions during surgery to prevent the development of this diagnosis or to mitigate its effect (38).

Postoperative Telesurgery Nursing

When the studies on the effectiveness of telesurgery in the field of surgical nursing are examined, it is seen that there are studies conducted with telemedicine applications. It is mentioned that mobile phone observation is a useful and effective method especially in detecting surgical site infections that develop after surgical interventions (39). In this direction, Pathak et al. (2015) conducted a study with 536 patients who underwent general surgical intervention in a rural hospital in India and found that 6.3% (n=34) developed surgical site infections. Among the entire patient group participating in the study, 380 patients who did not attend their first appointment 30 days after surgery were reached by mobile phone and it was reported that 10 of the patients who were observed by mobile phone were diagnosed with surgical site infection (40).

Da Silva Schultz et al (2020) concluded that there was a significant, positive reduction in the factors related to the nursing diagnosis of ‘delayed surgical recovery’ in patients in the experimental group in the study conducted by teleconcultation with patients undergoing laparoscopic cholecystectomy and hernia repair. As a result of the study, factors that increase the likelihood of patients developing postoperative complications and patients with the potential for a diagnosis of ‘delayed surgical recovery’ were identified through telephone counselling (38).

In the study of Nandra et al. (2019), 655 patients who underwent surgery in different fields were reached via video teleconferencing in preoperative and postoperative periods. It was reported that the patients reached before surgery discussed the results of neoadjuvant treatments, asked questions about their upcoming surgery and postoperative process, and that the patients were very satisfied with this telehealth application (41).

In another study, it was aimed to reduce patients' readmission to hospital and increase their satisfaction. In the study, remote surgical care was applied to individuals who underwent thoracic surgery by nurses working in thoracic surgery for postoperative follow-up and follow-up, and it was

stated that remote surgical care has very important and positive effects, especially in the 30-day period after discharge (42). Similarly, in another study examining patients with head trauma, it was found that the post-discharge hospital admission rates of patients who received telenursing care were lower than those who did not (43).
In another study examining patients undergoing lung transplantation, it was stated that complications were prevented with interventions appropriate to nursing diagnoses such as activity intolerance, immobility, limb muscle dysfunction, inadequate nutrition, and decreased quality of life within the scope of remote surgical care practices (44).

As seen in the studies examined, especially after discharge, remote surgical care interventions implemented by nurses facilitate patients' compliance with treatment plans and increase their quality of life (2).

However, it is mentioned that nurses working in surgical fields should receive training to be certified in order to be able to practice nursing, especially in the field of telesurgery (45). In order for nurses who will work in the field of telesurgery to avoid ethical problems, national policies and laws should be developed, administrative support should be provided and job descriptions of these nurses should be made (2, 6).

Although there is a lack of formal training on remote surgical care applications in the world, it is stated that these applications are widely used, while studies in this field are quite insufficient in Turkey (1). Considering that patients in our country generally live in rural areas, elderly patients are more in number, and patients cannot use developing technology and technological devices effectively, it is predicted that some problems may occur in remote surgical care applications in the field of nursing. In addition, when we look at the surgical field studies in the world and in our country, we have not yet come across any study that mentions whether nurses will take an active role in telesurgery applications applied / to be applied in operating theatres. Of course, it is hoped that the job descriptions, ethical and legal responsibilities of surgical nurses who will work in this field will be defined more clearly in the coming days.

2. Conclusion

It is seen that the dizzying developments in the field of technology, which emerged in the twenty-first century, have brought innovations to the surgical field at the same speed and a rapid adaptation to developments has been achieved. Telerobotic surgery applications, a groundbreaking technology, are used by many countries thanks to advanced real-time transmission technology and robotic surgery systems.

The technology industry and manufacturers predict that the cost rates of this technology will decrease in the coming days, everyone will be able to benefit from telesurgery services on equal terms and they will be able to access telesurgery services under easier conditions (13). It is also mentioned that with the increase in telesurgery applications and the development of artificial intelligence, robotic systems that can define telesurgery autonomously will be developed (16).

Considering the nursing practices in telesurgery, which is a very new dimension of surgery, it is seen that studies with positive results are still limited. Depending on this technology, which is expected to develop rapidly in the coming years, it is thought that there will be a rapid increase in the number of studies in the field of nursing.

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