Systematic Review Article: Application of Robotic Instruments in Hip Arthroplasty Surgery Based on Practical Tips a Systematic Review

Kamran Hadavand Mirzaei[1], Melika Shojaei[2], Mahdy Saboury[3]*

1. *General Surgeon, Laparoscopy Bariatric Surgery, Tehran, Iran (Email: dr.k.mirzaei@gmail.com)*
2. *MD, Endocrinology & Metabolism Subspecialist, Iran (Email: melika.shojaei@yahoo.com)*
3. *Assistant professor of plastic and Reconstructive Surgery, Iran*

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Citation KH Mirzaei, M Shojaei, M Saboury, **Application of Robotic Instruments in Hip Arthroplasty Surgery Based on Practical Tips a Systematic Review** *EJCMPR* . 2024; 3(2):593-609

https://doi.org/EJCMPR/20240602

Article info:
Received: **26 February 2024**
Accepted: **03 Jun 2024**
Available Online:
ID: EJCMPR-2406-1175
Checked for Plagiarism: **Yes**
Peer Reviewers Approved by:
Dr. Frank Rebout
Editor who Approved Publication:
Dr. Frank Rebout

Keywords:
Arthroplasty Surgery, Robotic Instruments, Practical Tips, Hip Joint, THA.

ABSTRACT

Introduction: The present study examines the use of robotic tools in hip arthroplasty surgery based on practical points. The purpose of this study was to assess the skeletal stability of a one-piece Lefort I osteotomy with auto graft maxillary advancement. In recent decades, with the help of scientific and technological advances, surgery has become a treatment, and the use of tele robots as the most advanced type of third-generation minimally invasive surgery, which has a very advanced system of remote surgery, is being investigated many times. **Method:** The most relevant and important databases of medical resources, such as PUBMED, Google Scholar, and Cochrane Cenral, were thoroughly searched for this purpose, in addition to referring to the papers discovered in electronic search and review. Their sources were reviewed, and a manual search was conducted, as well as communication with specialists in the subject if necessary. To search, the suitable term (Mesh, Free text) was used. **Findings:** The results showed that due to the presence of multiple shearing forces in the common area between the femoral head prosthesis and the conical area of the stem prosthesis, corrosion caused by friction and wear at the interface between the two, which is considered as tiprosis, causes the production of metal ions and particles. **Conclusion:** Very finely released from the existing metal surface, it is placed on the polyethylene liners of the hip joint, which itself causes consequences such as metallosis, bone osteolysis, and the loss of prosthesis stability. Also, limb length difference after hip joint replacement, THA (Total hip arthroplasty) is a common complication that affects the patient's satisfaction with joint replacement.

Introduction

Arthroplasty is a type of reconstructive surgery that is performed in order to reduce pain or increase the range of motion in a joint that has limited motion [1-3]. There are different types of arthroplasties [4], which include: Total joint replacement: It is a type of arthroplasty in which

***Corresponding Author: Mahdy Saboury** (Email: Dr.mahdysaboury@yahoo.com)*

both joint surfaces are replaced with synthetic materials [5-7].

Half joint replacement*:* It is a type of arthroplasty in which only one side of the joint surface is replaced with artificial material [8-11]. Placing the ligament between two joint surfaces is called it. Removal of bone from two articular surfaces without replacing it is called arthroplasty performed today is the first type, which is also called joint replacement surgery [12-15]. The hip joint is one of the largest joints in the body [16]. When this joint becomes problematic, the resulting problem can seriously affect your entire body and ability to perform normal activities [17-20]. When this joint is severely damaged due to arthritis or other possible problems, hip replacement surgery may be suggested to the patient [21-23]. In total hip or hip replacement surgery, parts of the damaged bone and cartilage are removed from the painful hip joint and a prosthesis or an artificial joint is placed in their place. The hip joint is of "Ball and bowl" type [24-26].

The spherical part is located in a part of the femur bone (thigh bone) and the bowl part is located in the hip bone [27-29]. The type and method of total hip replacement surgery is different based on the physical condition of each person. Implant design can bring you stability and new function of damaged joints [30-33]. Hip replacement surgery has a very high success rate and can provide significant quality of life improvement for some patients [34-36].

The doctor usually suggests this treatment method when the hip joint is damaged and painful, and the use of other treatment methods such as hip replacement physiotherapy [37-39], medication, or movement exercises cannot help solve the problem [40-43]. Hip arthroscopy can relieve the painful symptoms of many problems that damage the labrum, articular cartilage, or other soft tissues around the joint [44-47].

The most important causes of wear of the hip joint are: Blackening of the head of the femur or necrosis of the head of the femur can cause early wear of this joint in young or middle age [48-50]. This disease usually occurs in those who use drugs called coronet [51-53]. Total hip joint replacement is a procedure with the lowest postoperative complications such as hip instability [54-56]. Acetabulum dysplasia is a type of change in the shape of the acetabulum cavity that can cause a person at the age of 30-50 to suffer hip joint destruction and wear [58-60].

Congenital dislocation of the hip joint can cause osteoarthritis of the hip joint. Impingement of femoral head and acetabular cavity can also be one of the causes of early arthrosis of the hip joint [61]. Poor fusion of acetabular fractures can cause destruction and wear of the hip joint. Also, hip instability following total hip joint replacement is the second cause of joint reoperation following previous surgery [62-65]. Displacement of the prosthesis, entrapment, reduction of the elasticity of soft tissue around the joint and polyethylene coating are among the causes of re-surgery [66-69].

The present study examines the use of robotic tools in hip arthroplasty surgery based on practical points. The purpose of this study was to assess the skeletal stability of a one-piece Lefort I osteotomy with auto graft maxillary advancement. The present study investigated the issue by reviewing more than 120 articles with keywords including "Arthroplasty Surgery", "Robotic Instruments", "Practical Tips", "Hip Joint" and "THA" (Figure 1).

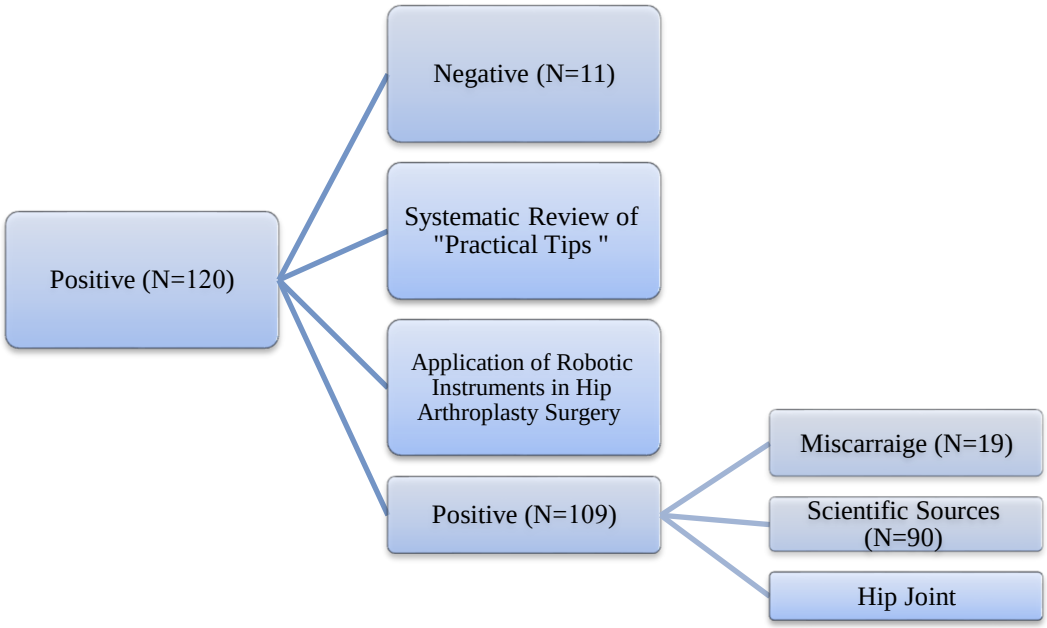

Figure 1. Flow chart of included subjects

Robotic hip replacement surgery

This is a hip replacement surgery using technology. Robotic surgery provides replacement of the rotator cuff joint to the patient's hip joint through a console with the help of a series of cameras and sensors [70-72]. By increasing sensitivity, it helps the surgeon to perform less invasive surgery and reduce risks. Robotic surgery can also speed up the recovery process after surgery. It can shorten the patient's stay in the hospital [73]. It may be especially recommended for patients with more complex problems. However, the appropriate treatment method may be different for each patient. Whether it should be used should be evaluated by a doctor before surgery [74-76].

Hip replacement robotic surgery technology

In recent years, it has undergone rapid development. First used in the early 2000s, robotic surgery is now routinely used in many hospitals [77-79]. This allows surgery to be performed in a less invasive, more accurate and precise manner than previous surgeries [80-82]. In recent years, the systems used have become more advanced. For example, some robotic surgery systems use artificial intelligence, deep learning technologies [83-85]. Therefore, it provides more support to the surgeon. In addition, some recovery systems also offer specialized software and programs for patient tracking and data analysis [86-89]. These developments help make robotic hip replacement surgery safer, more effective, and more patient-specific. However, it is not yet used in all hospitals. The appropriate treatment method for each patient should be determined by the doctor [90-93].

Who is robotic hip replacement surgery suitable for? It is suitable for people who need hip arthroplasty (hip replacement surgery) due to hip pain or injury [94]. This often includes conditions such as osteoarthritis, rheumatoid arthritis, post-traumatic deformities. For complex hip joint cases, robotic surgery is performed [95-97]. It can often be more accurate and precise than traditional surgery. This occurs in young and overweight patients with previous surgical intervention and

anatomical deformation [98-100]. It is used when hip joint surgery requires high precision. Robotic surgery can achieve better results by allowing the surgeon to work with greater precision and control. Compared to traditional surgery [101-103], it is associated with less tissue damage and less blood loss. This may shorten patients' recovery time and increase the likelihood of a quicker return to normal activities [104-107]. However, it is important to remember that robotic surgery is not right for every patient. Surgical options are determined for each patient individually, taking into account general health status, age and body mass index. In situations requiring robotic hip replacement surgery, an evaluation with an orthopedic surgeon is important [108-110].

Recovery process after robotic hip replacement surgery

Surgery is usually performed in a hospital. The patient may stay in the hospital for several days. During this process, the general health status of the patient and the recovery of the surgical area are monitored [111-113]. Medicines may be prescribed to control pain and reduce the risk of infection. Physiotherapy after surgery is important to ensure proper function of the prosthesis. Physiotherapists provide specific exercises and manipulations to increase the patient's muscle strength and range of motion. This process helps improve the patient's ability to return to daily activities. After discharge from the hospital, the patient should continue the healing process at home [114-116]. It is very important to regularly do the exercises recommended by your doctor or physiotherapist. It may help reduce pain and increase muscle strength [117-119].

In addition, it is important to take care of the wounds and monitor for signs of infection. The recovery process after robotic hip replacement surgery varies depending on the patient's age, health status, and the success of the surgery. However, most patients can return to their normal activity level after surgery. He can experience the benefits of mobility and pain relief provided by the prosthesis. During this process, it is necessary to follow the doctor's recommendations. It is very important to have regular check-ups and to help diagnose the problem early [120-122].

History of surgical robots

The history of surgical robots' dates back to the 1980s when the first robotic surgery system was developed by the US Department of Defense [123]. The system was designed to allow surgeons to remotely operate on soldiers on the battlefield. However, due to technical limitations and high cost of equipment, this system was not widely used. In the 1990s, a series of technological advances led to the development of the first surgical robot for use in hospitals [124].

The first surgical robot was the PUMA 560, developed by Unimation in 1985. The PUMA 560 was designed to help perform neurosurgery, but the technology was not widely used due to technical limitations and the high cost of the equipment. In the following years, several other companies began to develop surgical robots, resulting in the da Vinci Surgical System, one of the most widely used surgical robots today [125].

The reason for using hip arthroplasty

There are many reasons for performing this surgical procedure. Some of them include:

- Treatment of bone necrosis;
- Treatment of diseases such as cancerous tumors;
- Treatment of hip fracture and severe hip injuries [126];
- Treatment of rheumatoid arthritis;
- Treatment of infectious diseases.

When to perform hip arthroscopy: This surgery can be performed in the elderly and when other methods such as painkillers and cartilage building drugs, physiotherapy, hip arthroscopy have no effect on recovery, can be used. This surgery is mainly performed after the age of 65.

Benefits of hip arthroplasty: The benefits of this method include reducing severe pain in the hip and pelvis, improving the patient's movements, and improving the range of motion in the joint [127].

Complications due to hip arthroplasty: If this surgery is performed by a good and skilled specialist, it will not cause any complications (Table 1). Possible side effects include infection, swelling, and bruising, which are normal and resolve within a few days after the operation [128-130].

Table 1. Forest plot showed the Application of Robotic Instruments in Hip Arthroplasty Surgery Based on Practical Tips a Systematic Review

Raw	Study	Year		Proportion Wight 98%		Weight %
1	Abdollahi et al.	2014		0.68	[0.52 – 1.06]	6.02
2	Aldulaim et al.	2022		0.74	[0.31 – 1.08]	5.92
3	Aldulaimi et al	2022		0.89	[0.19 – 1.01]	5.65
Heterogeneity t^2=0.00, I^2= 0.02, H^2=1.01				**0.98**	**[0.20 – 1.06]**	
Test of θ= θ, Q (4) =4.00, P= 0.71						
1	Ansari et al.	2022		0.92	[0.39 – 1.06]	5.03
2	Baghestani et al.	2018		0.87	[0.54 – 1.02]	6.02
3	Bauer et al.	2022		0.88	[0.63 – 1.01]	5.57
Heterogeneity t^2=0.02, I^2= 0.03, H^2=1.02				**0.95**	**[0.22 – 1.07]**	
Test of θ= θ, Q (4) =2.09, P= 0.74						
1	Beiranvandi et al.	2022		0.84	[0.27 – 1.08]	6.08
2	Danesh et al.	2022		0.76	[0.36 – 1.06]	5.82
3	Eskandar et al.	2020		0.69	[0.28 – 1.05]	5.85
Heterogeneity t^2=0.01, I^2= 0.04, H^2=1.03				**0.0.95**	**[0.29 – 1.06]**	
Test of θ= θ, Q (4) =4.09, P= 0.40						

Discussion

The results of a recent study by researchers from University College London and University of Sheffield have shown that robotic surgery is less risky and the recovery period is shorter for patients. The first clinical trial of the procedure, conducted by scientists at University College London and the University of Sheffield, has

shown that robot-assisted surgery to remove and repair bladder cancer allows patients to recover much faster and in significantly less time. spend in the hospital [131]. During the study, whose findings were published in the journal JAMA and funded by the Urology Foundation with a grant from the Champniss Foundation, researchers also discovered that robotic surgery cut the chance of readmission in half (52 percent) and the risk of blood clots quadrupled (77 percent) decreases. In fact, thrombus/blood clot is a natural response to a wound to stop bleeding, but it can lead to thrombosis, which is dangerous and occurs when clots in a healthy blood vessel block blood flow [54]. The researchers found that as a result of the shorter recovery period, the endurance and quality of life of the patients also improved and their physical activity also increased, because during this study and experiment on the patients, the researchers found that the daily steps of the patients increased after the recovery period. The data of the step taken by patients is measured on a smart wearable sensor. But robotic surgery may also have risks. For example, we can mention a small infection in the surgical site and some other complications. It should be noted that the option of robotic surgery is not suitable for everyone, and people should talk to their doctor about the benefits and risks of robotic surgery and its comparison with other techniques [132].

Despite robot-assisted surgery being widely available, there has been no significant clinical evaluation, researchers from University College London said. In this study, we wanted to determine whether robot-assisted surgery is superior to open surgery in terms of reduced hospital stay, reduced readmissions, and better recovery and quality of life. An unexpected finding was a significant reduction in blood clots in patients who underwent robotic surgery [56]. This represents a safe surgery, with patients benefiting from far fewer complications and a quicker return to normal life. The results of this study are important. Using this advanced surgery, hospitalization time is reduced and recovery is faster. Finally, it allows patients to return home faster. In another study, researchers conducted an experiment in 9 British hospitals and on 338 patients with non-metastatic bladder cancer who were randomly divided into two groups. 169 patients underwent cystectomy or radical cystectomy with the help of a robot (bladder removal) with intra corporeal reconstruction (the process of removing part of the intestine to make a new bladder) and another 169 patients underwent open radical cystectomy [133].

The highlight of this trial was the length of hospital stay after surgery. On average, the group that underwent surgery with the help of a robot stayed in the hospital for eight days, while the other group was hospitalized for 10 days. Another secondary outcome was evaluated at 90 days, 6 and 12 months after surgery. These items included examination of blood clots, wound complications, quality of life, disability, endurance and activity level. All secondary outcomes were reduced or improved with robot-assisted surgery or, if not improved, were approximately equal to open surgery [58].

Wang Jianchen, CEO of Edge Medical Robotics, said: "Performing surgeries with the help of this robot is a big step in medical technology." However, due to some problems in the field of technology, our domestic surgical robot development industry was dominated by foreign products for a long time, and surgical robots were only used in the obstetrics and gynecology departments of a few hospitals, and the cost of using them was too high for many patients. It was not possible and these issues hindered the progress of robotic surgery in China. Also, Ji Mei, an obstetrics and gynecology specialist at the hospital affiliated to Zhengzhou University, said: Surgical robots made in China are more cost-effective compared to similar robots made in

other countries and have a high potential for performing tasks and primary care [59].

Meng Yuanguang, director of the Obstetrics and Gynecology Department of the Chinese People's Liberation Army General Hospital, also agreed with Jay Mei and added that surgical robots can play an important role in increasing the capacity of hospitals and allow doctors to provide better medical services to patients. Researchers say that snake-like robots can be used in various surgeries to save human lives and are not limited to this field and have many useful applications. When it comes to robotics, engineers often seem to draw inspiration from snakes. In 2024, this miniature surgical robot will be launched to the space station, where it will demonstrate its ability to cut simulated tissue. The robot "MIRA" was created by Professor "Shane Farritor" (Shane Farritor), a professor at the University of Nebraska College of Engineering in Lincoln (UNL). Scientists claim that "MIRA" will one day be able to perform surgery on the ruptured appendix of astronauts during a mission to Mars. Or take shrapnel out of wounded soldier thousands of miles away when hit by explosives. In April, NASA announced that it had donated $100,000 to the university to prepare the surgical robot for its test mission in 2024 [60].

Conclusion

An artificial hip joint is not a monolithic structure, but consists of several separate parts that are placed together and form a movable joint that is placed in place of the natural joint and must be similar in function. Of course, there are differences from it, such that the natural hip joint has two main parts, one is the head of the femur and the acetabular cavity. There are grooves on the top of the femur, the highest part of the bone is called the head of the bone, and it is in the shape of a sphere. There is a cavity in a part of the pelvis called acetabulum. There are two acetabular cavities in every human being, in which the head of the femur is placed. These two bones are held together by ligaments. The artificial hip joint is also designed in its natural shape to perform the same function. Also, wear and corrosion in the variables of design and production of implants in hip joint replacement has always been discussed. Due to the presence of multiple shearing forces in the common area between the femoral head prosthesis and the conical area of the stem prosthesis, corrosion caused by friction and wear at the interface between the two, which is considered as tiprosis, causes the production of metal ions and very fine particles released from existing metal surface is hinged on the polyethylene liners of the hip joint, which itself causes consequences such as metallosis, bone osteolysis and loss of prosthesis stability. The clinical significance of tiprosis is still unknown, but the role of tiprosis in destructive reactions has been observed and is increasing. The difference in limb length after hip joint replacement, THA (Total hip arthroplasty) is a common complication that affects the patient's satisfaction with joint replacement. The difference in limb length is one of the most common causes of patient complaints from doctors after hip replacement surgery. Patients accept short stature more easily than tall stature. The difference in limb length can cause pain and lameness of the patient and premature loosening of the prosthesis and back pain. For this reason, the surgeon should try to prevent this complication by using templating before the operation and various methods during the operation. Total hip replacement is an advanced surgical procedure to reduce the suffering of patients with hip pain due to joint degenerative changes. Total hip joint replacement is a procedure with the lowest postoperative complications such as hip instability. Hip instability following total hip replacement is the second reason for joint reoperation following previous surgery. Displacement of the prosthesis, entrapment, reduction of the elasticity of the soft tissue

around the joint and polyethylene coating are among the causes of re-surgery.

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