

Robert Li, MD, attending orthopedic surgeon and Aditya M. Derasari, MD, orthopedic surgeon, Director of Total Joint Arthroplasty Service at NewYork-Presbyterian Queens and Assistant Professor of Clinical Orthopaedic Surgery at Weill Cornell Medicine



NEWYORK-PRESBYTERIAN QUEENS

Robotic-arm-assisted Arthroplasty Advances Surgical Precision

BY JOSH GARCIA

FROM PLANNING TO EXECUTION, ROBOTIC-ARM TECHNOLOGY HELPS ORTHOPEDIC SURGEONS INDIVIDUALIZE JOINT REPLACEMENT SURGERY ACCORDING TO EACH PATIENT'S SPECIFIC ANATOMY, RESULTING IN INCREASED ACCURACY AND PRECISION DURING ARTHROPLASTY PROCEDURES.

THE FIRST ROBOTIC-ARM-ASSISTED arthroplasty was performed at NewYork-Presbyterian Queens in August 2017 and was led by Aditya M. Derasari, MD, orthopedic surgeon, Director of Total Joint Arthroplasty Service at NewYork-Presbyterian Queens and Assistant Professor of Clinical Orthopaedic Surgery at Weill Cornell Medicine.

"Since then, we've performed somewhere between 50 and 100 robotic surgeries among all of the orthopedic surgeons," Dr. Derasari says. "I typically complete between two and four operations with the robotic arm in a given week."

According to Dr. Derasari, the robotic arm helps surgeons limit variability and improve the accuracy of bone removal during total hip and knee replacements or partial knee replacements, especially for patients with unique deformities, complications or components from previous arthroplasty surgeries.

"Surgeons can be extremely precise with the robot," Dr. Derasari says. "We're starting to use the robotic arm on more complex cases and are seeing good, reproducible outcomes."



Robert Li, MD

ROBERT LI, MD, attending orthopedic surgeon at NewYork-Presbyterian Queens and Assistant Professor of Clinical Orthopaedic Surgery at Weill Cornell Medicine, joined the hospital in September of last year.

"I was raised in Flushing, Queens," Dr. Li says. "I'm thankful to be able to improve care in the neighborhood where I grew up and give back to the community."

Dr. Li first gained an interest in orthopedics and surgery while working as a personal trainer during his undergraduate education at Boston University. While studying

biomedical engineering, he realized he could combine his fascination with physics and engineering with his passion for helping people improve their health.

Dr. Li graduated from New York Medical College and performed his orthopedic surgery residency at Albert Einstein College of Medicine and Yeshiva University, Montefiore Medical Center and Jacobi Medical Center before he completed an adult reconstruction fellowship program with New York University Hospital for Joint Diseases and the Insall Scott Kelly Institute.



Dr. Li led the first total knee replacement using the robot at NYP Queens.

PRECISION PLANNING

Much of the improved accuracy during arthroplasty is a result of the planning process and software that is used in conjunction with the robotic arm.

The process at NYP Queens requires a CT scan of a patient's hip or knee days or weeks before undergoing arthroplasty. Special software creates a virtual 3-D model of the affected area based on the CT scan. The 3-D model takes into account each patient's unique anatomy. A preoperative plan is then created, which highlights what areas of bone need to be removed and what areas need to be avoided to preserve healthy bone and ligaments. Surgeons can examine plans and make adjustments before entering the operating room.

"A representative from the company that makes both the robot and software is on-site to help us develop preoperative plans and parse out the details of the surgery," says Robert Li, MD, attending orthopedic surgeon at NYP Queens and Assistant Professor of Clinical Orthopaedic Surgery at Weill Cornell Medicine. "The plans help us determine the size of the components we need and how to appropriately place them. We know the depth, angles and positions for the bony cuts we will make before surgery begins. Personally, this increases my confidence because I know the patient's exact anatomy beforehand."

Prior to the advent of this technology, surgeons had no way of specifying the exact size of implants and components they would require until surgery began and the bone was exposed.

"For example, with total hip replacements, we would only have a rough estimate of what size cup we needed before preparing the hip socket," Dr. Li says. "We would have multiple

“The surgery itself is still the same when using the robot — whether it's total hip or knee replacement or partial knee replacement — but performed with more sophistication. We're making the same cuts with the same amount of exposure and the same implants, but the robot allows us to achieve our target angles every single time, especially in cases that may be more complex or patients who have deformities in their bone.”

— **ROBERT LI, MD, ATTENDING ORTHOPEDIC SURGEON AT NEWYORK-PRESBYTERIAN QUEENS AND ASSISTANT PROFESSOR OF CLINICAL ORTHOPEDIC SURGERY AT WEILL CORNELL MEDICINE**



Aditya M. Derasari, MD



"I typically complete between two and four operations with the robotic arm in a given week," Dr. Derasari says.

ADITYA M. DERASARI, MD, orthopedic surgeon, Director of Total Joint Arthroplasty Service at NewYork-Presbyterian Queens and Assistant Professor of Clinical Orthopaedic Surgery at Weill Cornell Medicine, is a board-certified orthopedic surgeon who has been with the hospital for almost four years.

"I enjoy working at a large hospital where I'm able to teach residents," Dr. Derasari says. "There's a nice mix of academic opportunities, and our orthopedic department represents various subspecialties."

Dr. Derasari received his medical degree from the University of South Florida College of Medicine before spending time at Jackson Memorial Hospital for his residency in orthopedic surgery. He went on to complete a fellowship in adult reconstructive surgery at Houston Methodist.

He appreciates being able to work in orthopedic surgery — a well-defined field that provides proven solutions to patients.

“The guide on the robot keeps us from cutting any healthy bone. Once the surgical site is locked in, there's no variability. When the information is put into the machine appropriately, we can't miss.”

— **ADITYA M. DERASARI, MD**,
ORTHOPEDIC SURGEON,
DIRECTOR OF TOTAL JOINT
ARTHROPLASTY SERVICE AT
NEWYORK-PRESBYTERIAN
QUEENS AND ASSISTANT
PROFESSOR OF CLINICAL
ORTHOPAEDIC SURGERY AT
WEILL CORNELL MEDICINE

sizes on hand and find the correct one during the procedure. Now, since we know the exact dimensions ahead of time, we can prepare the patient's acetabular bed to accept the cup implant at the same time.”

SURGICAL MAPPING

The robot software's 3-D planning model not only provides surgeons a view of the patient's anatomy before surgery, but it is also used during procedures to improve accuracy and guide surgeons as they perform necessary cuts and reams.

Before surgeons perform any cuts to bone, the patient's exposed bone is marked at several points with a probe. These marks are used to ensure that the preoperative 3-D model matches the patient's anatomy as the surgery is performed. The points are overlaid with the 3-D model, allowing the robotic arm to position itself appropriately so the surgeon can safely perform the replacement procedure.

While the robotic arm and cutting device are controlled by the surgeon through a handle and trigger mechanism, the robotic arm has an additional

safeguard to ensure surgeons do not unnecessarily remove bone or tissue that should remain in place. Based on the 3-D model and the marked bone, the robot limits the surgical area a surgeon can work on. Should the surgeon attempt to move the robot arm past these pre-defined boundaries, the arm will stop and keep the surgeon from moving outside of the operating area.

Surgeons can, however, make adjustments and input new measurements into the robot's software program in cases where there are discrepancies between the 3-D model and the actual marked bone area.

During more traditional manual surgery, jigs are pinned to the bone based on the position of anatomical landmarks and allow for the proper placement of cuts and bone removal. This process is laborious and can take a substantial amount of time.

"In the past, if we needed to take more bone or rotate the jig after our initial cuts, we would have to pin the jig again, recheck its placement, and make sure everything still lined up," Dr. Derasari says. "Now, if an implant is too tight, we can go into the program and remove

extra bone in half-millimeter increments. The instrument glides into the proper plane at the correct angle, and we begin removing the appropriate amount of bone.”

Though extremely rare, if a situation arises where the 3-D model is drastically misaligned with the patient’s anatomy, surgeons can easily revert to a manual surgery.

“The more robotic surgeries we perform, the more we’ve noticed that we were doing a great job using the manual surgery technique as well,” Dr. Li says.

PARTIAL KNEE REPLACEMENTS

Partial knee replacements can offer many benefits to patients but provide less bone exposure for surgeons, making it more difficult to avoid ligaments and healthy segments of the knee and complicating the placement of components.

“The great thing about partial knee replacement is that patients can retain all four of their ligaments in the knee, which keeps their knee feeling natural after surgery,” Dr. Derasari says. “For total replacements, one or two of those ligaments are typically cut and the results can feel a little less natural for the patient.”

The robotic arm allows surgeons to use a small round burr that precisely removes bone for the placement of components during partial knee replacement while providing surgeons with more information regarding the balance of the knee and its ligaments.

“I would say that partial knee replacement is the best application of the robot,” Dr. Li says. “Historically, it’s very difficult to position a partial knee implant appropriately even if a surgeon is looking directly at it.”

PRECISION PLACEMENT

Rather than inserting instruments into the canal of the femur, which may cause blood clots, surgeons can perform procedures without affecting the femur’s canal or applying jigs. The robot also reduces the amount of blood loss and allows surgeons to place cups in more appropriate positions during hip replacements, which may lower the risk of dislocation for patients after surgery.

“The robot software also provides detailed information on how long a patient’s leg will be after surgery,” Dr. Derasari says. “This helps us avoid making a patient’s leg too long, which can be a complication after hip replacement.”



Dr. Derasari consults with a patient.

Rapid Rehabilitation

TO IMPROVE CARE and recovery times for patients who need arthroplasty, specialists at NewYork-Presbyterian Queens prepare patients for rehabilitation long before they reach the operating room.

“Patients are evaluated by a physical therapist before they come in for a surgical procedure,” says Aditya M. Derasari, MD, orthopedic surgeon, Director of Total Joint Arthroplasty Service at NYP Queens and Assistant Professor of Clinical Orthopaedic Surgery at Weill Cornell Medicine. “That way, both the patient and the therapist know what to expect before surgery takes place.”

A joint education class taught by a former surgeon also helps answer patients’ questions before surgery.

Typically, patients begin physical therapy on the same day as their surgery, which helps shorten the length of their hospital stay and overall recovery time while bettering outcomes.

“We’re able to get patients home after just a few days and improve their joint function later on,” says Robert Li, MD, attending orthopedic surgeon at NYP Queens and Assistant Professor of Clinical Orthopaedic Surgery at Weill Cornell Medicine. “We’re able to get patients back into society and living their lives according to their normal routines in a quicker manner.”

NYP Queens also partners with an in-home therapy service, which allows patients to undergo physical therapy in their own home for the first two weeks after surgery. After that, patients return to the hospital multiple times a week to continue therapy and are often able to walk using only a cane — as opposed to using a walker or not walking at all — within a few weeks.

“Much of the success we’ve seen in our arthroplasty program can be attributed to physical therapy and patient education,” Dr. Derasari says.





"We're able to get patients back into society and living their lives according to their normal routines quickly," Dr. Li says.

Pain Management



NEWYORK-PRESBYTERIAN QUEENS TAKES a new approach to pain management during and after arthroplasty to better prepare patients for physical therapy and rehabilitation.

"Almost all patients receive regional anesthesia — a spinal block or epidural along with a local block — which we can reapply if the patient experiences any pain after surgery," says Aditya M. Derasari, MD, orthopedic surgeon, Director of Total Joint Arthroplasty Service at NYP Queens and Assistant Professor of Clinical Orthopaedic Surgery at Weill Cornell Medicine. "We can reapply these methods in the recovery room instead of limiting them to the operating room."

Anti-inflammatories and other medicines that control nerve pain give physicians multiple options for addressing pain. By blocking pain through several different pathways, the orthopedic team at NYP Queens can keep patients comfortable while limiting the use of opioid-based painkillers.

Though long-term data is still being collected regarding patients who have undergone robotic-arm-assisted arthroplasty, surgeons hope that the increased accuracy of implant placement will increase the longevity of hip and knee replacements moving forward.

"As orthopedic surgeons, we have shown that total hip replacements should have 40 degrees of inclination and 20 degrees of anteversion to achieve the appropriate stability," Dr. Li says. "That's the gold standard, and the robot allows us to achieve that target every single time we perform the procedure."

To further ensure successful patient outcomes, NYP Queens has also revamped its rehabilitation and pain management protocols (see "Rapid Rehabilitation" and "Pain Management") and utilizes TXA medication to lower the rate of blood transfusions.

TRAINING PROGRAM

NYP Queens has five orthopedic surgeons who are trained and certified to use the robotic arm for arthroplasty, with availability for other surgeons to learn how to use the machine if they are

interested. Surgeons receive training directly from the company that produces the robot, which also keeps a representative at NYP Queens to help with the robot and answer any questions surgeons may have.

“The company provides a training course for our surgeons, and NYP Queens mandates that we attend the course and receive certification before using the machine,” Dr. Li says.

The training course encompasses two day-long sessions that culminate with the surgeons practicing with the robot in a cadaver lab. Once surgeons are certified, they are required to perform their first few surgeries alongside staff members who already have strong backgrounds with the machine. After these initial procedures, surgeons can begin leading hip and knee replacements with the robot on their own.

THE RIGHT CHOICE

Before acquiring the robot, Dr. Derasari and other members of NYP Queens staff visited the headquarters of the company that produces the robot to learn more about the machine, which was designed with input from expert surgeons. Once the hospital decided the robot would be a beneficial addition to the orthopedics program, NYP Queens recruited new talent



Drs. Li and Derasari review a patient's X-ray.

to help make sure the robot's implementation was successful.

“My fellowship at New York University Hospital for Joint Diseases was for total and partial hip and knee replacements, with the robot being an integral part of my fellowship,” Dr. Li says. “Robotic surgeons at New York University helped trial the robot, and I was specifically trained on using it.”

While other procedures had already been performed with the robot before

Dr. Li arrived, he led the first total knee replacement using the robot at NYP Queens. The operation was successful and helped relieve a patient's pain that was caused by joint degeneration as a result of osteoarthritis.

FURTHER APPLICATIONS

New applications are still being found for the robot, and new software is released periodically which allows the machine to be used for additional types of surgeries. For example, the robot was initially used for total hip replacements and eventually expanded its capabilities to include partial and total knee replacements.

“When new software is released, NYP Queens actively obtains it,” Dr. Li says. “We want to adopt new technology and applications as they come.”

Even with the robot already serving as a proven valuable tool for orthopedic surgeons, Dr. Derasari looks forward to finding new ways of using the robot and has begun performing revision surgeries on patients with previous replacements who are unhappy with their results or are experiencing adverse complications.

“We still haven't tapped into the full potential of the robot,” Dr. Derasari says. “We're finding out that it can do more than we thought.” ■



To further ensure successful patient outcomes, NYP Queens has also revamped its rehabilitation and pain management protocols.