

Robotic-Assisted Shoulder Replacement

What is it

Robotic-assisted shoulder replacement is an **anatomic** or **reverse** shoulder replacement in which a robotic arm helps carry out the plan made before surgery. The operation itself does not change: it treats a worn joint (arthritis) and, with a reverse replacement, a shoulder with a badly damaged rotator cuff.

Before the operation, a CT scan of your shoulder is turned into a three-dimensional plan that sets the size, angle and depth of each part of the new joint. During the operation, the robotic arm positions the cutting guide for the top of the arm bone and holds the reamer that shapes the socket, at the angles and depth in that plan, then holds still while your surgeon makes the cut or shapes the socket. The robot does not operate on its own or make decisions; your surgeon performs every step.

What it's made of

The system has four parts: a robotic arm on a wheeled base beside the operating table; a camera that tracks small reflective markers; the tracking pins those markers sit on, placed in the arm bone and in the coracoid (a bony knob at the front of the shoulder blade) through the same incision as the operation; and the plan made from your CT scan. The pins come out at the end of the operation, and nothing robotic stays in your body. The implants are those of an anatomic or reverse shoulder replacement, described on those pages.

How your surgeon uses it

Dr Kieran Hirpara, an upper-limb surgeon at Mater Private Hospital Rockhampton, uses the ROSA robot (Zimmer Biomet) with the Zimmer Biomet Comprehensive shoulder replacement, planned with the Signature ONE planning software. We already plan every shoulder replacement on a CT scan, so a robotic operation needs no extra scan. We use robotic assistance routinely for both anatomic and reverse replacements. If the robot has a problem during the operation, we continue with patient-specific guides made from the same plan, and with standard instruments if needed. Other surgeons use other systems, such as Mako, or other aids such as navigation or patient-specific guides, and many use none.

What to expect

Your anaesthetic, hospital stay, sling and rehabilitation are the same as for any shoulder replacement, and the anatomic and reverse replacement pages describe them in detail. The robot adds no extra wounds or appointments. The operation may take a little longer at first while the theatre team becomes familiar with the system.

What the evidence says

The clearest finding so far is about accuracy. With robotic assistance, the position of the implant matches the plan more consistently, and the occasional large miss that can happen when parts are placed by hand is removed [1]. That is what the robot has been shown to do.

It has not yet been shown to change how the shoulder feels or how long the implant lasts. No study has shown better pain relief, better function or a longer-lasting implant in the shoulder with robotic help [2]. Related technologies point the same way. Navigation, which guides the surgeon's hand rather than holding the instrument, placed the socket more accurately [3], with results at two years at least as good as standard instruments and no extra complications [4]. Patient-specific guides showed no major differences in results over the long term [5].

The evidence is still building. Most published accuracy studies used a different robot, and outcome studies of the ROSA shoulder system are still to come [6]. Longer follow-up is needed before anyone can say whether greater accuracy changes how long a shoulder replacement lasts [7]. In robotic hip and knee replacement, where most of the experience lies, reported device problems have been uncommon, and the rate has fallen over time [8].

In short, the robot helps carry out the plan precisely and consistently. Whether that leads to a shoulder that works better or lasts longer is a question research has not yet answered.

In more depth

This section goes further than you need for your own treatment decisions. Robotic shoulder replacement is worth the extra reading because what it improves and what people expect it to improve are two different things. It reliably helps the surgeon carry out the plan; whether that changes how the shoulder feels and lasts is not yet known.

COLLABORATIVE, NOT AUTONOMOUS

Shoulder replacement robots are **collaborative**: the arm moves an instrument into the planned position and then locks still, and the surgeon makes the cut or shapes the socket [1]. The steps ROSA guides are described above; the rest of the operation is done by hand in the usual way [2]. The robot does not decide anything.

WHAT IT IMPROVES: THE MISSES, NOT THE AVERAGE

The clearest evidence is about **accuracy against the plan**. Almost all of it so far comes from the Mako robot (Stryker), which shapes the socket with a burr; ROSA holds a conventional reamer instead, and its own accuracy studies are still to come. In a laboratory study on 3D-printed shoulder blades, socket preparation with the Mako arm matched the plan more closely than both hand preparation and patient-specific guides: the angle of the socket was off by about **1°** on average with the robot, against **9°** by hand and **4°** with guides [3]. In patients, one surgeon's Mako series of **103** reverse replacements found the **average** accuracy was similar with and without the robot, but the spread was narrower: **no** robotic case was more than **10°** away from the plan, against **4 of 42 (10%)** done conventionally [4].

That is the real argument for the technology. Most hand-placed implants are already close to the plan; the robot's contribution is to remove the occasional large miss. Whether removing those outliers changes how long an implant lasts is the question no study has yet answered.

WHAT HAS NOT BEEN SHOWN YET

No study has yet shown that robotic shoulder replacement gives better pain relief, better movement or a longer-lasting implant than a well-performed conventional operation. The technologies that came before it tell a consistent story. Navigation made the socket angle about **6°** more accurate on average across pooled studies, but the authors questioned whether that difference matters clinically [5]. A meta-analysis of **537** patients found no difference in patient-reported results or complications with patient-specific guides [6], and a long-term comparison of reverse replacements found no major clinical differences with them either [7]. Across hip, knee and shoulder, reviews of trials and national registries have found robotic surgery reliably improves positioning but has not consistently improved outcomes, complication rates or implant survival [8].

That is not the same as “it makes no difference”. It means the benefit, if there is one, is in reducing uncommon problems, and that takes large numbers and long follow-up to prove.

THE LEARNING CURVE, THEATRE TIME AND THE MACHINE ITSELF

- **Learning curve.** In an Australian Mako series, the workload measured for the surgical team levelled off after **3 to 5** robotic cases [9].
- **Theatre time.** In a Mako series of **77** reverse replacements, robotic cases took about the same time on average as conventional ones but were more predictable [10].
- **Technology failure.** In a US national database of robotic hip and knee replacement, device problems were reported in **0.3 to 0.4%** of operations, with delays in **0.13 to 0.22%**, and the rate fell year on year [11].

EXPECTATIONS

In a survey of **615** American adults, **67%** believed robotic shoulder replacement gives better results and **54%** a faster recovery, neither of which has been shown. Asked to choose, **62%** would rather have a more experienced surgeon who does not use a robot than a less experienced one who does [12]. Experts writing on consent for robotic shoulder surgery make the same point: the robot is a tool that helps carry out a plan, it does not replace the surgeon's judgement, and its long-term benefits are not yet known [13].

WHAT THIS MEANS FOR YOU

- The robot changes how precisely the plan is carried out, not what the operation is.
- Its proven effect is consistency: fewer large departures from the plan.
- Better pain, function or implant life have not been shown, though they may follow.
- It is one of several ways to achieve an accurate plan; navigation and patient-specific guides do similar jobs, and many surgeons use none of them.

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