

REHABILITATION AFTER PROXIMAL TIBIAL REPLACEMENT (KNEE MEGAPROSTHESIS)

Recovery after proximal tibial replacement for bone tumour: six weeks braced straight to protect the tendon repair, then staged bending.

PATIENT NAME

DATE OF SURGERY

WHAT IS INSIDE

- What was done, and what to expect week by week
- Weight bearing, walking aids and precautions
- Your exercises, with a diagram and a dosage for each
- Warning signs, and exactly who to call
- Getting back to driving, work and sport
- A progress chart to fill in and bring to appointments

25 minutes to read. Reviews: Wound review at about 2 weeks. Clinical review with an X-ray at 6 to 8 weeks. Then reviews and surveillance imaging on a schedule the sarcoma team sets, which continues for years.

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This is a general guide. Your operation record and the instructions you are given always take precedence over anything written here. Last reviewed 5 August 2026.

This guide covers recovery after a proximal tibial replacement: a megaprosthesis that replaces the upper part of the shin bone and the knee joint, using a rotating-hinge knee, after a bone or soft-tissue tumour is removed. It is written for patients of the RPA Bone & Soft Tissue Sarcoma Unit and for the physiotherapists, often on the Mid North Coast, a long way from Sydney, who will deliver most of the programme.

One rule sits above everything else in limb-salvage rehabilitation: the site of the reconstruction, not the diagnosis, determines the protocol. Nowhere does that matter more than here. A distal femoral replacement: the other "knee megaprosthesis", moves early; this operation is the opposite, because the patellar ligament (the tendon that lets you straighten the knee) has to be detached and reattached, usually reinforced with a muscle flap from the calf. Protecting that reattachment is the entire logic of this protocol, and Dr Broadhead's operation record always overrides the general figures in this guide.

The core message of this guide is non-negotiable: the knee is held straight in a splint or brace for about six weeks, and it is not bent, not by you, not by a helpful relative, not by a physiotherapist who is used to standard knee replacements, until your team starts staged bending. Early bending does not loosen a stiff knee; it compromises the patellar ligament reattachment, and a repair that stretches or fails cannot be fully rebuilt. The stiffness you accept for six weeks buys you a knee you can straighten and stand on for life. That is the trade, and it is worth it.

A megaprosthesis replaces a segment of bone and the adjacent joint. The metal is fixed and stable straight away; what dictates your programme is which muscles and tendons had to be detached and reattached. Recovery is measured in months, not weeks, and the functional ceiling is lower than after a standard knee replacement: most patients walk independently, with or without a stick, and return to daily activities, but not to running or impact sport. Early,

staged, active rehabilitation is safe, reviews of limb-salvage rehabilitation show early active mobilisation does not increase dislocation or infection and is associated with better quality of life, and this protocol is exactly that: active from day one (isometrics begin immediately, walking begins early), just not bending. Lifelong: avoid impact loading to limit wear; expect that revision surgery is likely at some point over a lifetime; and keep lifelong vigilance for infection, deep infection is the most significant risk in this surgery, considerably more common than after standard joint replacement, and this site carries the highest infection risk of the megaprosthesis family because the bone sits directly under thin skin. Surveillance imaging of both the tumour site and the prosthesis continues for years.

AT A GLANCE

WEIGHT BEARING

Partial weight bearing in the locked brace during the 6 weeks of immobilisation, then full weight bearing after. The operation record governs.

BRACE

The defining feature of this protocol: the knee is held in full extension in a splint or brace for about 6 weeks, not unlocked, not "just briefly".

DRIVING

Not while braced. Individually assessed after bending and control return. Your team will confirm.

PHYSICAL WORK

Assessed individually. Heavy physical work is often not a realistic goal: discuss your duties early.

REVIEWS

Wound review at about 2 weeks. Clinical review with an X-ray at 6 to 8 weeks. Then reviews and surveillance imaging on a schedule the sarcoma team sets, which continues for years

WALKING AIDS

Frame then crutches through the braced weeks; weaning to a stick happens later, over months, as bending and strength return.

PRECAUTIONS

No active or passive bending of the knee until your team starts it after about 6 weeks. Isometric exercises begin immediately.

DESK WORK

Possible during the braced weeks if the leg can be kept elevated and straight. Your team will confirm; commonly the 6–12 week window.

SPORT & ACTIVITY

Walking, swimming and cycling are the long-term goals. Running and impact sport are not part of life with a megaprosthesis.

WHAT WAS DONE IN YOUR OPERATION

The tumour was removed together with the segment of shin bone (tibia) it involved, including the knee end of the bone, with a margin of healthy tissue around it. The reconstruction is designed around what that removal required.

The missing bone and joint were replaced with a modular metal implant anchored in the remaining tibia, connected to a component in the thigh bone through a rotating-hinge knee. The hinge provides the stability the resected ligaments can no longer supply.

The step that defines your rehabilitation: the patellar ligament: the tendon connecting your kneecap to the shin, through which every ounce of knee-straightening force passes, attaches exactly where the tumour was removed. It was detached and reattached to the prosthesis, and the repair is usually reinforced and covered with a gastrocnemius flap: a muscle moved up from your calf, which also gives the implant healthy soft-tissue cover under the thin skin of the shin. That tendon-to-metal repair heals slowly, on a biological timetable, and it cannot be protected by the hinge or the stem. Only stillness protects it, which is why this protocol is the strictest in the library.

THE IDEAS THAT MAKE EVERYTHING ELSE MAKE SENSE

1. The site of reconstruction determines the protocol, and the operation record governs

Limb-salvage programmes are built around what was removed and reattached, not around the name of the tumour. This site demands the strictest protocol of the megaprosthesis family because the patellar ligament reattachment is unprotectable by anything except immobilisation. Your operation record is the final word, if anything here conflicts with your team's instructions, your team is right. Physiotherapists: this is not a standard knee replacement, and standard early-flexion protocols actively harm this repair.

2. Six weeks straight is the whole ballgame

The knee stays in full extension in its splint or brace for about six weeks. No bending, active or passive. This is not caution for its own sake: early mobilisation compromises the patellar ligament reattachment, and a stretched repair means a permanent lag: a knee that cannot actively straighten, ever. The stiffness you accept for six weeks buys you a knee you can straighten and stand on for life.

3. Immobilised is not inactive

Isometric (muscle-tightening) exercises begin immediately: quadriceps, gluteals, calf: inside the brace, from day one. You will also be up and walking early, taking partial weight through the braced, straight leg. The muscles are kept alive while the tendon heals; what is forbidden is movement at the knee, not effort.

4. Bending is earned, staged and supervised

After about six weeks, your team starts flexion deliberately: roughly 30-degree increments every two weeks, under physiotherapy supervision, with the brace advanced at each step. It feels slow because it is meant to be: each increment loads the repair a little more, and the repair sets the pace. Do not let anyone "push through" it.

5. Why the discipline matters: patella alta and the lag

If the repair stretches, the kneecap rides upward: patella alta, and the straightening mechanism loses its leverage. This develops in a majority of patients to some degree even with good care, and it matters: in endoprosthesis series, patients who develop patella alta average an extension lag of about 17 degrees, versus about 4 degrees in those who do not. That difference: a knee that hangs bent versus one that holds straight, is what the six braced weeks are protecting.

6. How results are measured: MSTS and TESS in plain language

Your team may mention two scores. The MSTS score is the clinician's rating of limb function from 0 to 100%. The TESS is your own rating of how difficult everyday tasks are. Good limb-salvage results typically land in the 70–85% range on these scales: good function, not normal function. A score in that range is a genuinely good outcome after this surgery.

WEIGHT BEARING AND WALKING AIDS

WEIGHT BEARING

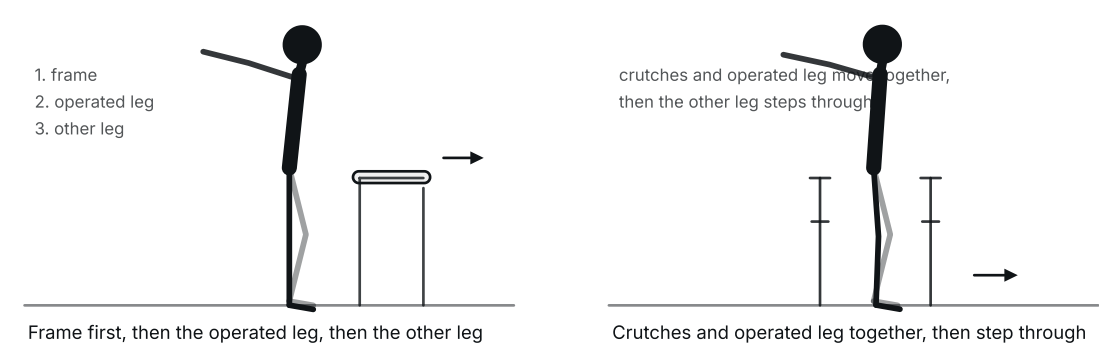
PARTIAL WEIGHT BEARING IN THE LOCKED BRACE DURING THE ~6 WEEKS OF IMMOBILISATION, THEN FULL WEIGHT BEARING ONCE THE IMMOBILISATION PERIOD ENDS. THE OPERATION RECORD GOVERNS.

The implant itself is stable immediately, and with the brace holding the knee straight, weight passes through the limb without pulling on the tendon repair, which is why walking is allowed while bending is not.

During the braced weeks you take partial weight through the operated leg with a frame or crutches, exactly as your team prescribes. After the immobilisation period ends, you progress to full weight bearing.

Walking aids stay longer than weight bearing rules do: even at full weight, the crutches and later the stick come off as bending, strength and gait control return over the following months: your physiotherapist paces this.

STAGE	TYPICAL TIMING	MOVE ON WHEN
Wheeled frame, brace locked straight	From day 1 through the early braced weeks	Safe transfers; partial weight bearing maintained; brace worn correctly
Two crutches, brace locked straight	During the braced weeks, as confidence allows	Steady, safe gait at the prescribed weight bearing
Two crutches, full weight bearing	After the ~6-week immobilisation ends	Team confirms the repair is ready; flexion programme starting
One crutch, then a stick	Over the following months, as bending and quadriceps control return	Knee trustworthy; no giving way; gait your physiotherapist is happy with



THE IMMOBILISATION RULES: PROTECTING THE PATELLAR LIGAMENT REATTACHMENT

ABOUT 6 WEEKS OF FULL-TIME IMMOBILISATION IN EXTENSION, THEN STAGED BENDING ONLY AS YOUR TEAM DIRECTS. THE OPERATION RECORD GOVERNS THE EXACT TIMING.

Every ounce of knee-straightening force passes through the reattached patellar ligament, and for the first weeks that repair is held by stitches and healing tissue, not by strength. Bending the knee tensions it directly. A repair that stretches produces patella alta and a permanent extension lag; a repair that fails cannot be fully rebuilt. Nothing about a stiff knee at six weeks is dangerous; everything about a bent one is.

RULE	WHY	HOW TO MANAGE
The knee stays in full extension in its splint or brace, about 6 weeks, full time	Only stillness protects the tendon-to-prosthesis repair. The hinge and the stem cannot.	Brace on for walking, resting and sleeping, and removed only as your team explicitly directs (for example, for supervised wound checks and washing with the leg held straight).
No bending of the knee: active or passive, until your team starts it	Early mobilisation compromises the reattachment. It does not matter whether you bend it or someone bends it for you; the repair feels only the tension.	Tell family, carers and any treating clinician who is new to your case. If a well-meaning professional proposes "gentle early range of movement", decline and have them call the rooms.
Partial weight bearing only, until the immobilisation period ends	The braced, straight leg can take partial load safely; full loading waits until the repair has had its six weeks.	Use the frame or crutches exactly as prescribed; your physiotherapist will teach you what your prescribed weight feels like.

RULE	WHY	HOW TO MANAGE
Isometric exercises are compulsory, not optional	Six still weeks would otherwise waste the quadriceps: the muscle the whole reconstruction exists to serve. Isometrics keep it alive without moving the knee.	Quadriceps, gluteal and calf isometrics from day one, on the schedule in the exercise section.
After 6 weeks: bending advances in roughly 30° increments every 2 weeks, under physiotherapy supervision	Each increment loads the repair a little more; the staging lets it adapt without stretching.	The brace dial is advanced by your team at each step. Never advance it yourself, and never let a session "push on" past the current limit.
EVERYDAY SITUATIONS Sitting with a leg that cannot bend. You will sit with the leg out straight, supported on a second chair, footstool or wheelchair leg-raiser. Plan the furniture at home before discharge. The occupational therapist will help. Getting in and out of a car. Front passenger seat pushed fully back and reclined; back in bottom-first and bring the straight leg in last, angled across the footwell. Long trips need a break every hour, and the leg elevated at the destination. Using the toilet. A raised toilet seat or over-toilet frame with rails makes lowering with a straight braced leg manageable. Arrange this before you come home. Washing. Follow the wound-care rules first. Strip washes or a shower chair with the braced leg kept straight and dry (a waterproof cover helps) until your team advises otherwise. Sleeping. Brace on in bed. On your back with the leg supported along its length is simplest; a pillow under the calf and heel, never under the knee, keeps it comfortable and straight.		

YOUR BRACE: KNEE SPLINT OR BRACE LOCKED IN FULL EXTENSION: THE DEFINING FEATURE OF THIS PROTOCOL, CONVERTING AFTER ABOUT 6

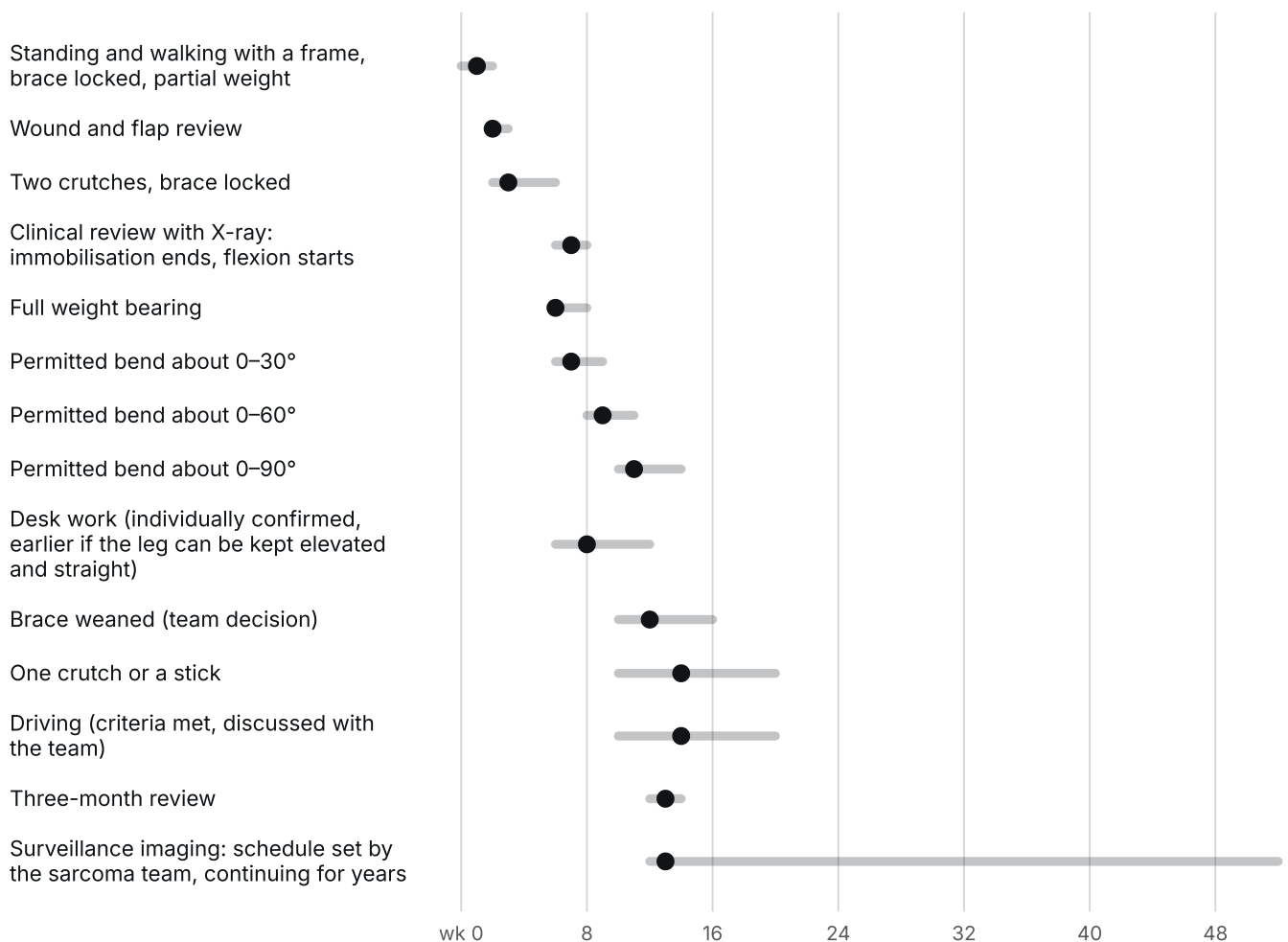
WEEKS TO A HINGED BRACE WHOSE PERMITTED BEND IS ADVANCED IN STAGES.

PERIOD	INSTRUCTION
Weeks 0–6 (approximately: the operation record governs)	Full time: walking, resting and sleeping. Removed only as your team explicitly directs, with the knee held straight throughout.
From about week 6	Converted to a hinged brace for the staged bending programme; worn as your team directs while the permitted range advances.
Weaning	Your team weans the brace once bending and quadriceps control are established: a review decision, not a calendar date.

PERIOD	PERMITTED RANGE
Weeks 0–6 (approx.)	Locked in full extension: 0 degrees. No bending, active or passive.
Weeks 6–8 (approx.)	About 0–30 degrees, started and supervised by your physiotherapist
Weeks 8–10 (approx.)	About 0–60 degrees, advanced by your team
Weeks 10–12 (approx.)	About 0–90 degrees, advanced by your team
Beyond 12 weeks	Advanced further as your team directs, guided by the repair, final bend is usually somewhat less than a native knee

- Only your team changes the lock or dial settings, never adjust them yourself.
- Check the skin under the straps and at the heel daily; the shin skin over this implant is precious: report rubbing or pressure marks the same day rather than padding them yourself.
- Bring the brace to every physiotherapy session and every review so fit and settings can be checked.

YOUR RECOVERY TIMELINE



Bars show the earliest-to-latest normal window; the dot is typical. Your own dates are set with us, not by this chart.

THE PHASES, ONE BY ONE

You move to the next phase by meeting its exit criteria, not by the calendar. The week numbers are typical, nothing more.

PHASE 1: LOCKED, PROTECTED AND WORKING

WEEKS 0-2

Brace locked in full extension, isometrics from day one, partial-weight walking with the frame, swelling controlled.

GOALS: TICK THEM OFF

- ☐ Brace routine established, on full time, worn correctly
- ☐ Isometric quadriceps, gluteal and calf work established as a daily routine
- ☐ Transferring and walking short distances with the frame at the prescribed partial weight
- ☐ Swelling controlled; wound and flap settling

DO THIS

- Static quadriceps sets inside the brace, plus gluteal squeezes and ankle pumps, isometrics begin immediately and are the backbone of these six weeks.
- Walk little and often with the frame at your prescribed weight bearing.
- Elevate properly (lying down, leg straight, foot above heart) several times a day, and ice as set out in the swelling section.
- Learn the sitting, car, toilet and sleeping set-ups in the precautions section before you leave hospital.

AVOID THIS

- Any bending of the knee, by anyone, for any reason.
- Unlocking or loosening the brace "just for a minute".
- Letting the leg hang down for long periods: the flap and the swelling both hate it.

READY FOR THE NEXT PHASE WHEN...

- Wound and flap reviewed and settled at about 2 weeks
- Isometrics done reliably without supervision
- Safe transfers and frame walking at the prescribed weight

PHASE 2: THE LONG PROTECTED STRETCH

WEEKS 2–6

Hold the line: brace locked, isometrics daily, walking tolerance building on crutches: patience as an active skill.

GOALS: TICK THEM OFF

- ☐ Isometric programme maintained daily without fail
- ☐ Progress from frame to two crutches, still at partial weight, as your team allows
- ☐ Straight leg raise improving inside the brace
- ☐ Skin, wound and flap healthy at every check

DO THIS

- Keep the isometrics honest: this is the phase where motivation dips and the muscle quietly switches off if you let it.
- Practise safe stairs with crutches once your physiotherapist teaches the pattern.
- Start scar massage once the wound is fully healed and your team confirms it is safe over the flap (from about 3 weeks).
- Use the elevation-and-ice routine after every walk.

AVOID THIS

- The six-week itch: the knee will feel fine and the brace will feel absurd. The repair cannot report its own healing: the timetable protects it, not the sensation.
- Any clinician new to your case starting “range of movement”, have them call the rooms first.

READY FOR THE NEXT PHASE WHEN...

- Team review at about 6 weeks confirms the repair is ready
- Brace converted to a hinged brace and the flexion programme scheduled
- Full weight bearing commenced on the team's instruction

PHASE 3: EARNING THE BEND

WEEKS 6–12 (TEAM-LED)

Staged flexion in roughly 30° increments every 2 weeks under physiotherapy supervision, full weight bearing, and the quadriceps put to work through range.

GOALS: TICK THEM OFF

- ☐ Flexion advancing on the team's schedule, about 0–30°, then 0–60°, then 0–90° in two-week stages
- ☐ Full weight bearing established; walking upgraded on crutches then towards a stick
- ☐ Active straightening preserved at every stage, no developing lag
- ☐ Sit-to-stand and calf work built into the daily routine

DO THIS

- Attend every supervised flexion session. The increments are advanced by your physiotherapist, at the reviews, on the plan.
- Between sessions, work within the current permitted range only.
- Keep the straight leg raises and quadriceps work going daily. The bend must never come at the cost of the straightening.
- Add sit-to-stands and heel raises as your physiotherapist prescribes.

AVOID THIS

- Pushing past the current increment because the knee feels ready: the repair sets the pace, not the knee's mood.
- Skipping the extension work now that bending is the novelty.

READY FOR THE NEXT PHASE WHEN...

- Permitted range reached about 0–90° with active straightening preserved
- Walking with full weight, gait controlled
- Team satisfied the repair has tolerated each increment

PHASE 4: FUNCTION FOR THE LONG TERM

MONTHS 3–12 AND BEYOND

Strength, endurance and confidence for real life; the brace weaned; honest expectations about the final bend; the lifelong routine of surveillance.

GOALS: TICK THEM OFF

- ☐ Brace weaned on the team's instruction
- ☐ Walking distance building; stick weaned or retained by choice
- ☐ Final bend developing, usually somewhat less than a native knee, and enough for daily life
- ☐ Surveillance appointments and imaging attended without fail

DO THIS

- Keep a permanent quadriceps and general strength habit. It protects the straightening you spent six braced weeks defending.
- Start the stationary bike once your permitted bend allows a revolution, and build low-impact endurance: walking, swimming once cleared, cycling.
- Add balance work as prescribed.
- Report anything new between reviews: new pain, a lump, a wound or skin concern over the implant: the same day you notice it.

AVOID THIS

- Running, jumping and impact sport: permanently.
- Kneeling or direct pressure over the front of the shin until your team specifically discusses it: the skin and flap over this implant remain precious for life.
- Skipping surveillance because you feel well.

READY FOR THE NEXT PHASE WHEN...

- Stable, confident walking with or without a stick
- Long-term surveillance schedule established and understood

YOUR EXERCISES

Little and often beats one heroic session. Each exercise lists what you should feel, sharp pain that lingers afterwards means ease off and, if it persists, call.



ANKLE PUMPS

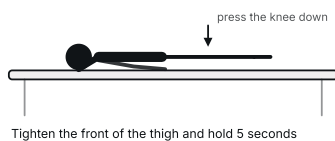
PHASE 1

Keep blood moving in the calf: your main clot-prevention exercise, and doubly important with the leg immobilised.

10 firm pumps, every waking hour, for the first 2 weeks and throughout the braced period

1. Lie or sit with the leg supported, brace on.
2. Pull your foot up towards you as far as it goes.
3. Point it away as far as it goes.
4. Repeat briskly.

Feel: You should feel the calf muscles working. The brace does not restrict the ankle, use the full range every time.



STATIC QUADRICEPS SETS (IN THE BRACE)

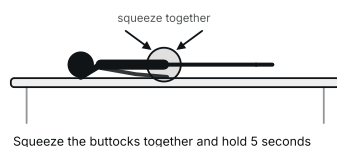
PHASE 1

The backbone of the braced weeks: keep the thigh muscle alive while the tendon heals. Isometric work tightens the muscle without moving the knee, which is exactly why it is safe from day one.

10 holds of 5 seconds, every waking hour in the first weeks, then at least 3–4 times daily throughout the braced period

1. Lie with the braced leg straight and supported.
2. Tighten the front of the thigh as if pressing the knee down, without any movement occurring.
3. Hold, then fully relax.

Feel: You should feel the thigh firm up under your hand, put a hand on it to check. No movement at the knee is the whole point: tension without motion.



STATIC GLUTEAL SQUEEZES

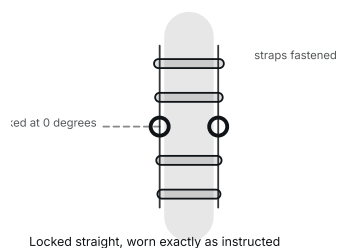
PHASE 1

Keep the hip and buttock muscles working while the leg is immobilised.

10 holds of 5 seconds, 3–4 times daily

1. Lie on your back, legs relaxed, brace on.
2. Squeeze the buttock muscles together firmly.
3. Hold, then fully relax.

Feel: You should feel the buttocks tighten and rise slightly. Keep breathing: do not hold your breath.



STRAIGHT LEG RAISE IN THE LOCKED BRACE

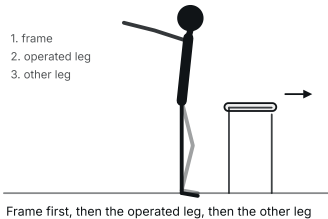
PHASE 1

Whole-leg strength with the knee held safely straight by the brace: the braced weeks' one "moving" leg exercise.

10 lifts, hold 3 seconds, 3 times daily, once your physiotherapist starts it

1. Lie on your back, other knee bent, braced leg straight.
2. Tighten the thigh first.
3. Lift the whole braced leg about 30 cm.
4. Lower slowly with control.

Feel: The locked brace keeps the repair safe while the hip and thigh do the work. If the leg is too heavy at first, keep working the static sets. The lift will come.



WALKING WITH THE FRAME (PARTIAL WEIGHT, BRACE LOCKED)

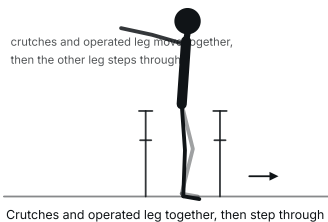
PHASE 1

Early, safe walking: the leg straight and braced, the load partial, the habit priceless.

Short walks, several times a day, at exactly the prescribed weight bearing

1. Frame forward first.
2. Step the braced leg into the frame, taking only your prescribed share of weight. Your physiotherapist will teach you what it feels like.
3. Step the other leg through.
4. Stand tall between steps.

Feel: The braced leg swings from the hip: let it. Rhythm beats distance in these weeks.



WALKING WITH TWO CRUTCHES

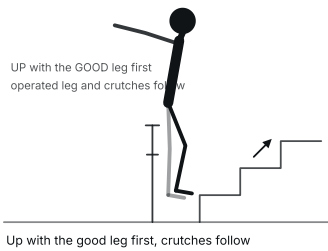
PHASE 2

A smoother, more upright walk as confidence builds, still partial weight and locked brace until the team says otherwise.

Replace frame walks once your team progresses you; build distance week on week

1. Move the crutches and the braced leg forward together.
2. Step through with the other leg.
3. Keep the pattern smooth and even.

Feel: Stand tall; look ahead, not at your feet. Same prescribed weight through the operated leg: crutches change the tool, not the rules.



STAIRS: GOING UP WITH CRUTCHES

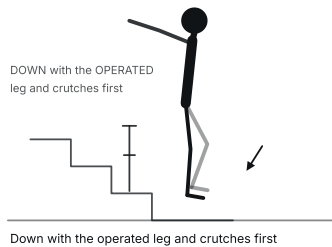
PHASE 2

Safe, repeatable stair climbing with a braced straight leg.

Practise with your physiotherapist first, then as needed

1. Stand close to the step, rail on one side if available.
2. Step up with the non-operated leg first.
3. Bring the braced leg and crutches up onto the same step.
4. Re-balance before the next step.

Feel: "Good leg up first." The braced leg comes up straight and trailing: give it room.



STAIRS: GOING DOWN WITH CRUTCHES

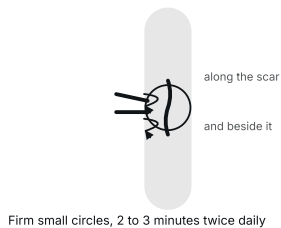
PHASE 2

The higher-risk direction: controlled descent protects the repair and your confidence.

Practise with your physiotherapist first, then as needed

1. Stand close to the edge, rail on one side if available.
2. Lower the crutches and the braced leg to the step below first.
3. Follow with the non-operated leg onto the same step.
4. Re-balance before the next step.

Feel: "Braced leg and crutches down first." If in doubt, go down sitting: dignity heals faster than a fall.



SCAR MASSAGE

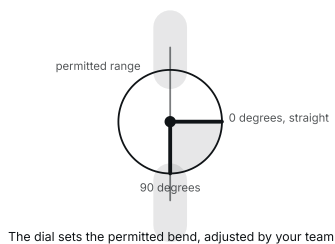
PHASE 2

Soften and desensitise the scar once fully healed, with your team's specific go-ahead over the flap.

2–3 minutes, twice daily, from about 3 weeks once healed, dry, and cleared by your team

1. Use a bland moisturiser.
2. Firm, small circles along and beside the scar, gentler over the flap until your team confirms it is robust.
3. Include the skin around it, which is often more sensitive than the scar itself.

Feel: Firm enough to blanch the skin slightly; it should not be painful. If you have had radiotherapy to the area, ask your team before starting.



STAGED BENDING IN THE HINGED BRACE (FROM ~6 WEEKS, SUPERVISED)

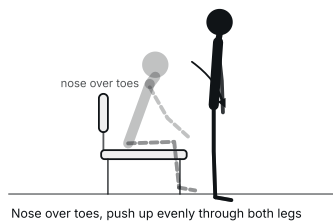
PHASE 3

Earn the bend back in stages, roughly 30° more every two weeks, without stretching the repair that six braced weeks just protected.

Supervised sessions as scheduled by your physiotherapist; between sessions, 10 slow bends to the current permitted limit, 3 times daily

1. Brace converted to hinged mode by your team; the dial set to the current stage.
2. Bend the knee slowly to the set limit, no bouncing, no pushing past.
3. Hold briefly, feeling a firm stretch.
4. Return slowly to fully straight, every repetition.

Feel: The dial belongs to your team: the increments advance at reviews, on the plan, roughly every two weeks. Finish every session with the knee actively held straight: the bend must never cost the straightening.



SIT-TO-STAND

PHASE 3

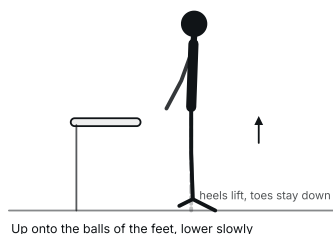
Loaded straightening in the most useful movement you own: introduced once bending and full weight bearing allow.

2–3 sets of 8–10, once or twice daily, once your physiotherapist starts it

1. Sit on a firm, raised chair with arms. The seat must suit your current permitted bend.
2. Feet back as far as the permitted range allows, lean forward, push up through both legs.
3. Lower back down slowly, making the operated thigh work all the way.

Feel: The slow lowering is where the quadriceps learns the most. Raise the seat if the knee has to bend past its permitted range to sit.

Harder: Less arm assistance, then a lower seat: as your permitted range and your physiotherapist allow.



HEEL RAISES

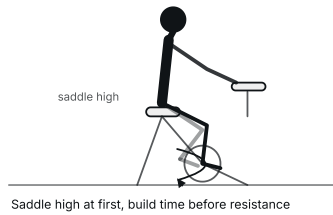
PHASE 3

Rebuild the calf, which matters double here, because the gastrocnemius flap borrowed part of it.

2–3 sets of 10, once or twice daily, once your team clears calf loading

1. Stand tall holding the bench or rail.
2. Rise up onto the balls of both feet.
3. Lower slowly.

Feel: Expect the operated side to feel weaker. The flap changed the calf's anatomy, and some difference may persist. Even, unhurried repetitions.



STATIONARY CYCLING

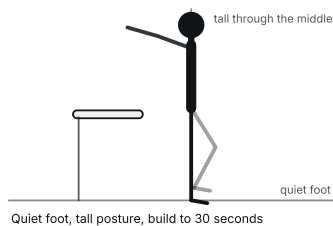
PHASE 4

Range, circulation and endurance with almost no load on the repair, once the bend allows it.

10–20 minutes, most days, once your permitted bend allows a full revolution and your team agrees

1. Saddle high at first: a higher seat needs less bend.
2. Start with gentle half-revolutions back and forth if a full turn is not there yet.
3. Progress time before resistance.

Feel: Stay inside the permitted range: the saddle height is how you control it.



SINGLE-LEG BALANCE

PHASE 4

Steadiness and confidence: protects you from trips and falls.

Build to 3 holds of 30 seconds each leg, daily, once your team clears single-leg loading

1. Stand near the bench, fingertips hovering.
2. Lift the other foot and balance on the operated leg.
3. Keep the knee softly straight: held by muscle, not locked back.

Feel: Quiet foot, tall posture. This is where six weeks of isometrics pay their dividend.

SWELLING, ICE AND ELEVATION

WHAT IS NORMAL

- Swelling is the single biggest brake on progress. It peaks about 6–8 days after surgery, then settles gradually.
- Most of the swelling resolves over the first two to three months, but it is normal for the limb to puff up after a long day or a burst of activity for some months after that, measurable swelling is still present at 7 weeks in most knee replacement patients.
- A limb that is bigger the morning after activity means you did too much the day before, not that something is wrong.

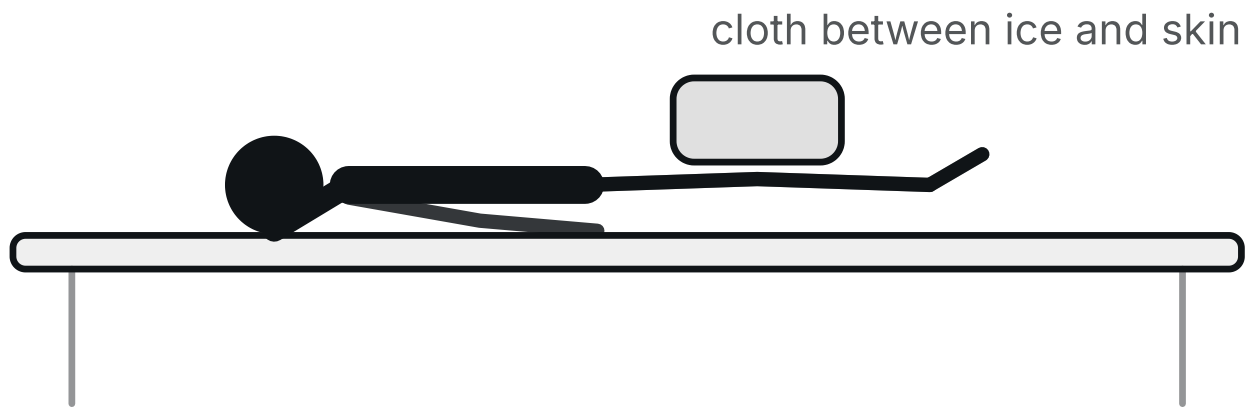
- Warmth and mild redness around the wound settle over weeks.
- After tumour surgery the swelling can be slower to settle than these general figures suggest: the operation removes more soft tissue than a standard knee replacement, and radiotherapy or chemotherapy slow things further. Persistent swelling that is stable is common; swelling that is increasing is a phone call.

ICE

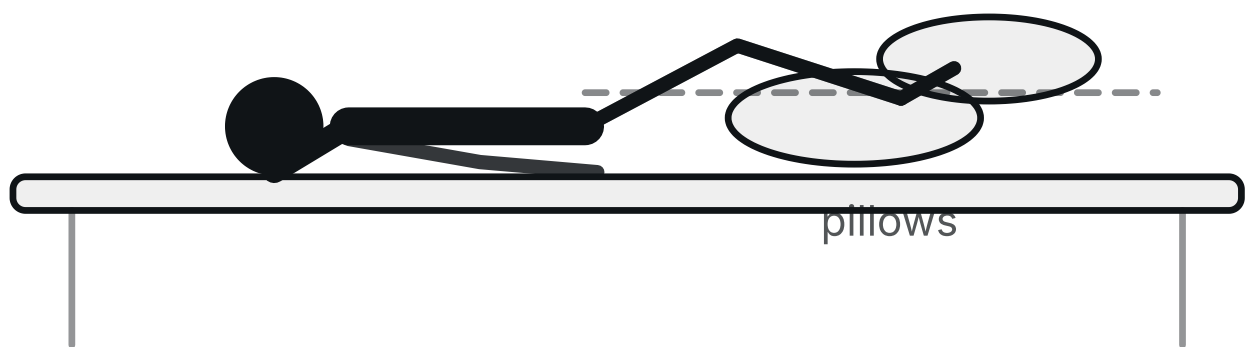
- Ice is safe, cheap and comfortable, and probably gives a small benefit for pain and swelling in the first few days.
- Use it for 15–20 minutes at a time, 4–6 times a day for the first 2 weeks, then as needed after activity and physiotherapy. It is particularly useful in the hour after exercise.
- Always place a thin cloth between the ice and your skin. Never sleep with ice on. Never ice over numb skin or a fresh wound dressing without checking with the rooms first.
- Stop and call the rooms if the skin becomes white, mottled or numb.
- One extra rule for this operation: take care icing over the gastrocnemius flap and the thin skin at the front of the shin: always with a cloth barrier, never directly, and ask your team before icing near the flap in the early weeks.
- An honest note about the evidence: the 2025 Cochrane review of icing after knee replacement (22 trials, 1,839 patients) found small improvements: pain at 48 hours better by 1.6 points out of 10, about 8 degrees more bend at discharge, and less blood loss: all on low-certainty evidence. The reviewers concluded the benefits may be too small to justify routine use. Use ice because it is harmless and makes you more comfortable, not because it changes the final result.
- There is no good evidence that expensive cold-compression machines work better than a bag of ice or a gel pack. The trials have never been analysed in a way that answers that question. Please do not spend money on one on our recommendation.

ELEVATION & COMPRESSION

- Elevate the limb above heart level for 20–30 minutes several times a day: foot higher than the knee, knee higher than the hip, hip higher than the heart.
- Lie down to do this: a recliner does not raise the leg above your heart.
- Avoid sitting with the leg hanging down for long periods.
- Elevation matters more after this operation than almost any other in this library: the flap and the shin skin drain poorly when the leg hangs down. Lying down with the straight, braced leg raised is a treatment, not a rest.
- A graduated compression stocking or sleeve helps control swelling, wear it as advised.



15 to 20 minutes, 4 to 6 times daily



Foot above knee, knee above hip, lying flat

WOUND AND SCAR CARE

- Keep the dressing dry and intact until it is reviewed. Most modern waterproof dressings allow showering, but do not soak, scrub, or put soap directly on the wound.
- No baths, spas, pools or ocean swimming until the wound is fully healed and has been reviewed, usually 2–3 weeks at a minimum.
- Do not apply creams, powders or antiseptics unless you have been told to.
- Clips or stitches are removed or checked at your first appointment.
- Tell the rooms about any dressing that becomes soaked, loose or soiled.
- This operation usually includes a gastrocnemius flap, muscle moved from the calf to cover the implant, so there are two areas to care for: the main wound at the front and the donor area on the calf. Both follow the same rules, and the flap is checked closely at every review.
- The skin over the front of the shin is the thinnest soft-tissue cover of any megaprosthesis site, and it is precious for life: report any blister, pressure mark, graze or colour change over the implant the same day, do not dress it yourself and wait.
- If you have had radiotherapy or chemotherapy, wounds heal more slowly. Attend every wound review, and report any change between them the same day.
- From about 3 weeks, once the wound is fully healed and dry: massage the scar with a bland moisturiser for 2–3 minutes, twice a day, using firm circular pressure. This softens the scar and desensitises the skin around it.
- Silicone gel or sheeting can improve the appearance of prominent scars.
- Protect the scar from the sun for 12 months. It burns easily and can darken permanently.
- Scars take a full 12–18 months to fade and flatten.
- Numbness in the skin around and below the scar is normal and often permanent, small skin nerves are unavoidably divided during surgery.

SLEEP AND POSITIONING

The brace stays on in bed throughout the immobilisation period, sleep is a third of the six weeks, and an unbraced bend in your sleep is exactly what the brace exists to prevent.

Sleep on your back with the braced leg supported along its whole length. A pillow under the calf and heel keeps it comfortable, never a pillow under the knee.

If you are more comfortable slightly turned, keep the braced leg straight and supported and put the pillow between the legs.

Disturbed sleep is common for some weeks. The brace is a poor bedfellow, and that is normal. Timing pain relief for the night, and icing before bed, both help. It gets easier when the hinged phase begins.

PAIN, MEDICATION AND WHAT TO EXPECT

Expect to need regular pain relief for the first few weeks, weaning gradually. Take medication ahead of exercise and walking sessions rather than chasing pain afterwards, and wean the strongest medications first.

You will usually be on a blood thinner, take it exactly as directed; it matters even more with the leg immobilised.

The calf donor site for the flap has its own ache in the early weeks, expected, and it settles.

If you are having chemotherapy, the rehabilitation and oncology timetables are coordinated by your team, energy levels, blood counts and treatment cycles all shape what each week looks like, and a slower fortnight during treatment is expected, not a setback.

When staged bending starts after week six, expect a firm stretching discomfort with each new increment. That is normal. Sharp pain at the front of the knee that lingers after a session is not: stop at the current stage and call.

Pain that is increasing week on week, or new pain at rest or at night, is never "just stiffness", call the rooms.

PREVENTING BLOOD CLOTS

- Get up and move at least hourly while you are awake.
- Do ankle pumps: 10 firm up-and-down pumps of the ankles: every waking hour for the first 2 weeks.
- Stay well hydrated.
- Take any prescribed blood thinner exactly as directed, and wear stockings as advised.
- Avoid long-haul flights for 6 weeks after joint replacement: discuss any earlier travel with the rooms.

DRIVING: THE CRITERIA THAT ACTUALLY MATTER

You may drive when **all** of the following are true:

- You are off opioid painkillers and any other sedating medication.
- You can sit comfortably in the driver's seat.
- You can perform an emergency stop at full force, without hesitation and without pain.
- You are not using a walking aid in the car, and not wearing a brace that limits the movement needed to work the pedals.
- You have practised the movements in a stationary car first.

What the driving research does and doesn't show

What the research actually measures is braking reaction time on a simulator. Those studies show braking performance returns to its pre-operative level at about 2 weeks after a right hip replacement and about 4 weeks after a right knee replacement, with movement time back to normal by 6 weeks. After knee arthroscopy the simulator evidence is more conservative than common practice: in the one study that measured it directly, braking was still slower one week after surgery than before it, and had recovered by four weeks, and a 2021 review of eight studies put the average return at about six weeks. Most people having a simple arthroscopy are driving well before that, which is why the criteria above matter more than the date. But these are averages, in one study, about one in three right-hip patients still could not meet an emergency-stop

benchmark at six weeks. Treat the timeframes in this guide as targets for discussion with us, not as permissions.

No published study has compared automatic and manual cars. The logical point is simply that a manual needs the left leg for the clutch, so left-sided surgery is the relevant caution in a manual. Advice about driving earlier with a left-leg operation in an automatic is clinical judgement, not trial evidence.

In Australia, your treating doctor's advice governs: under the Austroads "Assessing Fitness to Drive" standards, temporary post-operative impairment is a matter of clinical judgement, and commercial drivers are held to a higher standard. Driving while impaired may invalidate your insurance, check your insurer's position. Do not drive for at least 24 hours after any general anaesthetic or sedation.

GETTING BACK TO WHAT YOU DO

ACTIVITY	TYPICAL	WHEN IT'S RIGHT	NOTES
Walking for exercise	From the outset: braced, partial weight, with the frame or crutches	Prescribed weight bearing and brace rules followed	Distance builds properly once immobilisation ends
Swimming and hydrotherapy	After the immobilisation period, once the wound and flap are fully healed and your team agrees	Wound and flap reviewed and closed; bending sufficient for safe pool entry	Excellent low-load exercise once cleared
Stationary cycling	Once the permitted bend allows a revolution, usually	Team-set range sufficient; saddle high	Progress time before resistance

ACTIVITY	TYPICAL	WHEN IT'S RIGHT	NOTES
	some weeks into the flexion programme		
Driving	Not while braced; individually assessed after bending and control return	All the driving criteria below, discussed with the team, including being out of any brace that limits the movements needed for the pedals	For a right leg this is usually well after the 6-week point; plan on being a passenger for a while
Desk work	Commonly in the 6–12 week window, earlier is possible if the leg can be kept elevated and straight	Comfortable positioning; transport sorted	The straight-leg sitting set-up from the precautions section applies at the desk too
Physical work	Individually assessed	Duties reviewed with the team	Heavy physical work is often not a realistic goal after proximal tibial replacement, raise your actual duties early so modified duties or retraining can be planned honestly
Golf, bowls, doubles tennis and similar low-impact sport	Team-cleared, usually well after 3 months	Strength, balance and a trustworthy knee	Discuss the specific sport: rotation, uneven ground, and anything that risks a blow to the shin are the considerations
Kneeling	Only after specific discussion with your team	Skin and flap robust; team agreement	Direct pressure over the thin skin at the front of this implant is a lifelong caution, not just an early one
Running, jumping and impact or contact sport	Not part of life with a megaprosthesis	—	This is a permanent trade: impact accelerates wear, endangers the repair, and risks fracture through bone weakened by resection, radiotherapy and chemotherapy

ACTIVITY	TYPICAL	WHEN IT'S RIGHT	NOTES
Air travel	Discuss with the team: see the travel notes in this guide	Clot prevention planned; a braced straight leg needs a bulkhead or aisle plan	Especially relevant for Mid North Coast patients travelling to Sydney for reviews. The same planning applies to long drives: break them up, move hourly

Flying after joint replacement: an honest note

You will often hear "no flying for six weeks" after joint replacement. Be aware that this is a convention, not a proven rule: a 2025 review found limited data and no demonstrated difference in clot risk between people who did and did not fly after hip or knee replacement: mostly within the first week.

The six-week convention reflects practical realities rather than trial evidence: managing airports and cramped seating, being past the highest-risk clot window while still on prevention, the higher baseline clot risk of long-haul flights over four hours, and individual airline and travel-insurance rules, check both, as some airlines impose their own restrictions.

If you need to travel long-haul in the first six weeks, talk to the rooms first so clot prevention, an aisle seat, stockings and on-board movement can be planned.

WARNING SIGNS: ACT, DON'T WATCH

None of these should be watched overnight to see how they go. Early treatment of a problem is simple; late treatment is not.

EMERGENCY: 000 Emergency department / call 000

- Sudden shortness of breath
- Chest pain
- Coughing blood, or feeling faint
- Sudden pain, new deformity, or inability to take weight through the limb, even after minor loading. Bone weakened by resection, radiotherapy and chemotherapy can fracture around a prosthesis

GP TODAY See your GP today

- New, one-sided calf pain, tenderness or firmness
- Calf or whole-leg swelling out of proportion to the rest of your recovery

CALL THE ROOMS Call the rooms: same day

- Pain that is increasing rather than decreasing after the first week
- New redness spreading out from the wound
- Wound discharge, particularly cloudy, thick or offensive fluid, or wound edges opening
- Fever of 38°C or higher, or shaking chills, or feeling generally unwell
- Any wound, flap or skin concern over the shin, fever, or feeling unwell, after a megaprosthesis the threshold to call is deliberately lower than after standard joint replacement, and this site carries the highest infection risk of all. Same-day contact, never wait-and-see
- A sudden giving-way at the front of the knee, a pop, or a new inability to hold the knee straight or lift the braced leg. The repair must be assessed urgently
- A new lump near the operation site, or new persistent pain at any new site, do not wait for the next surveillance scan to mention it

For joint replacement patients, a wound problem is never something to "wait and see". Early treatment of an infected joint replacement is vastly more successful than late treatment, call

the rooms the same day.

ARRANGING PHYSIOTHERAPY IN AUSTRALIA

- Most privately insured patients self-fund private physiotherapy or use extras cover. A GP Chronic Disease Management plan subsidises only five allied-health visits per calendar year, not enough for a major reconstruction, so plan for this.
- Compensable patients (workers compensation, CTP) follow an insurer-approved plan.
- Tele-rehabilitation and app-supported home programmes are reasonable additions, but a sports knee reconstruction still needs periodic in-person objective strength testing.

COMMON QUESTIONS

When will I walk again after limb salvage surgery?

Sooner than most people expect: you will usually be up walking with a frame within a day or two of surgery: the brace holds the knee straight, and weight passes through the limb without pulling on the tendon repair. You walk with partial weight through the braced weeks, progress to full weight after the immobilisation ends at about six weeks, and then wean from crutches to a stick over the following months. Recovery is measured in months, not weeks, and many people keep a stick for distance long term, which is a sensible adaptation, not a setback.

Why can't I bend my knee, when other knee replacement patients bend theirs on day one?

Because this is not that operation: the site of the reconstruction, not the diagnosis, determines the protocol. In a standard knee replacement the tendon that straightens your knee is left attached. Here it had to be detached and reattached to the prosthesis, and for about six weeks that repair is held by stitches and healing tissue, not strength. Bending the knee: actively or passively: tensions it directly, and early mobilisation compromises the reattachment. A stretched repair means a kneecap that rides high and a knee that can

never again fully straighten on its own. The stiffness you accept for six weeks buys you a knee you can straighten and stand on for life.

How long do I wear the brace, and when does the bending start?

The knee is held in full extension in its splint or brace for about six weeks, full time: walking, resting and sleeping. After that, your team converts it to a hinged brace and starts flexion deliberately: roughly 30 degrees more every two weeks, under physiotherapy supervision, about 0–30°, then 0–60°, then 0–90°, with the dial advanced at each review, never by you. The brace is weaned once bending and muscle control are established, as a review decision rather than a date.

Won't six weeks of no bending leave me permanently stiff?

This is the fear behind most protocol violations, so here is the honest answer: temporary stiffness after immobilisation recovers with the staged programme. That is what phases 3 and 4 are for, and final bend usually ends up somewhat less than a native knee, mostly because of the surgery itself rather than the bracing. What does not recover is a stretched or failed tendon repair. Between a knee that is temporarily stiff and a knee that permanently cannot hold itself straight, the six braced weeks choose the right problem.

What are patella alta and extension lag. The things the brace is protecting me from?

If the reattached tendon stretches, the kneecap rides upward: patella alta, and the straightening mechanism loses its leverage. Some upward drift develops in a majority of patients even with good care, which is exactly why the protocol is so strict about not adding to it. It matters because of the lag: in endoprosthetic series, patients who develop patella alta average an extension lag of about 17 degrees: the knee hangs bent when they try to hold it straight, versus about 4 degrees in those who do not. Those six braced weeks are the price of being in the second group.

Will I be able to run?

No, and it is better to hear that clearly at the start. Running, jumping and impact sport are not part of life with a megaprosthesis: impact accelerates wear, endangers the tendon

repair, and risks fracture through bone weakened by the resection and by any radiotherapy or chemotherapy. The realistic and genuinely good outcome is independent walking, with or without a stick, a full daily life, and low-impact exercise such as walking, swimming and cycling.

Why is there a wound on my calf as well?

The repair is usually reinforced and covered with a gastrocnemius flap: part of your calf muscle, moved up to wrap the reattachment and give the implant healthy soft-tissue cover under the thin skin of the shin. The donor area on the calf has its own ache and its own scar, both of which settle, though the calf may stay a little weaker. The flap is one more reason the early weeks are handled so carefully, and why the skin over the front of your shin deserves lifelong respect: report any blister, graze or colour change over the implant the same day.

What about infection: what am I actually watching for?

Deep infection is the most significant risk of this surgery, considerably more common than after standard joint replacement, and the proximal tibia is the highest-risk site of all because the implant sits directly under thin skin. Watch for increasing pain, spreading redness, wound discharge, fever, feeling unwell, or any skin problem over the shin, and call the rooms the same day, every time, for the rest of your life with the implant. Early treatment of an infected prosthesis is vastly more successful than late treatment. Tell every future dentist and doctor you have a megaprosthesis before procedures.

What are the MSTS and TESS scores my team mentions?

Two ways of measuring how the limb is doing. The MSTS score is the clinician's rating of limb function on a 0–100% scale; the TESS is your own rating of how difficult everyday tasks are. Good limb-salvage results typically land in the 70–85% range. That means good function, not normal function, and a score in that range after a proximal tibial replacement is a genuinely good outcome.

My physiotherapist is on the Mid North Coast, how do they work with the Sydney team?

This is normal and it works well, with one crucial caveat for this particular operation: the protocol is unusual, and a physiotherapist meeting it for the first time should know that standard knee replacement rehabilitation actively harms this repair. Most of the hands-on work happens locally, guided by the operation record and the written protocol from your Sydney team; the staged flexion increments are set at your reviews and communicated in writing, and your physiotherapist is welcome, encouraged, to call the rooms directly before changing anything. Bring this guide and your operation record to your first local appointment.

Can I fly, or drive to Sydney for my reviews?

The general convention after joint replacement is no long-haul flying for 6 weeks, though the evidence behind a fixed rule is limited, and a leg braced straight adds a practical seating problem, so talk to the team before booking anything early. For the drive from the Mid North Coast: travel as a passenger with the seat back and the braced leg supported, break the trip every hour to move and do your ankle pumps, and elevate the leg at the destination. Driving yourself waits until the brace is off for driving movements and the criteria in this guide are met.

Will I need more surgery in the future?

Plan on it, calmly: over a lifetime, revision surgery of some kind is likely, components wear, and the implant is serviced rather than permanent. This is one reason for the permanent no-impact rule and for the surveillance imaging of both the tumour site and the prosthesis, which continues for years: problems found early are far easier to fix. Between scans, report anything new: a lump, new pain anywhere, a skin concern over the shin: the same day you notice it.

THE EVIDENCE BEHIND THIS GUIDE 11 sourced statements

CLAIM

SOURCE

The site of reconstruction, not the diagnosis, determines the

Standardisation of rehabilitation after limb salvage surgery for sarcomas, Hematol Oncol Stem Cell Ther

CLAIM	SOURCE
rehabilitation protocol; proximal tibial replacement follows the most restrictive protocol of the lower-limb megaprotheses	2013 (PMID 24161605); functional outcomes of endoprosthetic reconstruction by site, Clin Orthop Relat Res 2015 (PMID 24777730)
Early, staged, active rehabilitation after limb-salvage surgery is safe, no increase in dislocation or infection, associated with better quality of life	Standardisation of rehabilitation after limb salvage surgery for sarcomas improves outcome, Hematol Oncol Stem Cell Ther 2013 (PMID 24161605); occupational therapy rehabilitation after limb salvage surgery, a scoping review, Disabil Rehabil 2021 (PMID 31180732)
Immobilisation of the knee in extension for about 6 weeks after patellar ligament reattachment, with isometric exercise from the outset and staged flexion thereafter, is the standard protective protocol; early mobilisation compromises the reattachment	Muscle function after endoprosthetic replacement of the proximal tibia, comparing techniques for extensor reconstruction, Acta Orthop Scand 1995 (PMID 7604712); extensor function after medial gastrocnemius flap reconstruction, Clin Orthop Relat Res 2013 (PMID 23423620)
Flexion after proximal tibial replacement is reintroduced in staged increments (of the order of 30° every 2 weeks) under supervision	Muscle function after endoprosthetic replacement of the proximal tibia, comparing extensor reconstruction techniques, Acta Orthop Scand 1995 (PMID 7604712). The staged increments themselves are unit protocol rather than a trial finding
Patella alta develops in a majority of patients after proximal tibial replacement with extensor mechanism reattachment; patients who develop it average an extension lag of about 17° versus about 4° in those who do not	Extensor function after medial gastrocnemius flap reconstruction of the proximal tibia, Clin Orthop Relat Res 2013 (PMID 23423620). Patella alta developed over the first 2 postoperative years and then stabilised; it carried a larger extensor lag (mean 17° against 4°) but more flexion (94° against 77°)
Medial gastrocnemius flap coverage of the proximal tibial implant and extensor mechanism repair improves soft-tissue cover and reduces wound complications	Extensor function after medial gastrocnemius flap reconstruction of the proximal tibia, Clin Orthop Relat Res 2013 (PMID 23423620); medial gastrocnemius flap in limb-sparing surgery for proximal tibial tumours, Ann Plast Surg 2003 (PMID 12966238)

CLAIM	SOURCE
Deep infection is the most significant complication of megaprosthetic reconstruction, considerably more common than after conventional arthroplasty, and the proximal tibia is the highest-risk anatomical site	Henderson et al., failure mode classification for tumour endoprostheses, J Bone Joint Surg Am 2011 (PMID 21368074); the fate of periprosthetic joint infection following megaprosthesis reconstruction, JB JS Open Access 2021 (PMID 34841189); complications after proximal tibial reconstruction, PLoS One 2015 (PMID 26270336), where 56% of patients had at least one complication
Revision surgery is likely at some point over a lifetime with a megaprosthesis; impact loading accelerates wear and is advised against	Survival of megaprostheses in lower limb reconstruction after tumour resection, Clin Orthop Relat Res 2015 (PMID 24964884); complications after proximal tibial reconstruction, PLoS One 2015 (PMID 26270336)
MSTS is a clinician-rated 0–100% limb-function score; TESS is a patient-reported measure of everyday task difficulty; good limb-salvage outcomes typically fall in the 70–85% range	Enneking et al., MSTS functional evaluation system, Clin Orthop Relat Res 1993 (PMID 8425352); Davis et al., development of the Toronto Extremity Salvage Score, Qual Life Res 1996 (PMID 8973131); functional outcomes of endoprosthetic reconstruction after tumour resection, Clin Orthop Relat Res 2015 (PMID 24777730)
Bone weakened by resection, radiotherapy and chemotherapy carries an elevated periprosthetic fracture risk, including after minor loading	Henderson et al., failure mode classification for tumour endoprostheses, J Bone Joint Surg Am 2011 (PMID 21368074), in which periprosthetic fracture is a recognised failure mode; late complications and survival of endoprosthetic reconstruction, Clin Orthop Relat Res 2010 (PMID 20625951). The added contribution of radiotherapy and chemotherapy to that risk is a clinical concern rather than a quantified finding
Long-term surveillance imaging of the tumour site and prosthesis is standard of care for years after sarcoma resection and endoprosthetic reconstruction	Soft tissue and visceral sarcomas: ESMO-EURACAN-GENTURIS clinical practice guidelines, Ann Oncol 2021 (PMID 34303806)

This guide is general information for patients of Dr Matthew Broadhead (Harbour Orthopaedics & Sports Medicine) and is not a substitute for the specific advice given to you by Dr Broadhead, your physiotherapist or your hospital team.

Surgical findings vary, and your protocol may differ from what is written here: your operation record and your surgeon's instructions always take precedence.

If in doubt, call the rooms on (02) 9052 1883. In an emergency, call 000.

Last reviewed: 2026-08-05 by Dr Matthew Broadhead, FRACS (Orth).

YOUR PROGRESS TRACKER

Fill this in once a week: it shows your trend at a glance and makes reviews far more useful.
Bring it to every appointment.

Week	1	2	3	4	5	6	7	8	9	10	11	12
Exercises done (sessions)												
Walking distance / time												
Pain score (0–10)												
Knee bend (degrees)												
Swelling (less / same / more)												

QUESTIONS FOR DR BROADHEAD
