# Circular Frame Treatment for Knee Contractures

## Gradual Correction of Knee Flexion and Extension Contractures

*Limb Deformity and Reconstruction Service · A Guide for Patients and Families*

## How a Circular Frame Corrects a Knee Contracture

A **knee contracture** means your knee is stuck in one position and cannot move through its full range. Over time, the muscles, tendons, joint capsule, skin, nerves, and blood vessels around the knee have shortened or tightened, holding the knee in place.

A circular frame (also called a ring fixator or external fixator) can correct a contracture slowly and safely. The frame has two rings: one around your **thigh**, attached to the thigh bone (femur), and one around your **shin**, attached to the shin bone (tibia). The rings are connected across the knee by **hinges** lined up with your knee's natural pivot point, along with an adjustable rod or set of struts.

**No bone cut is needed.** Instead of cutting bone, the frame gently stretches the soft tissues a small amount each day. When tissues are stretched very gradually, they respond by lengthening and adapting rather than tearing. This is safer than forcing the knee straight all at once, which can injure the nerves and blood vessels behind the knee.

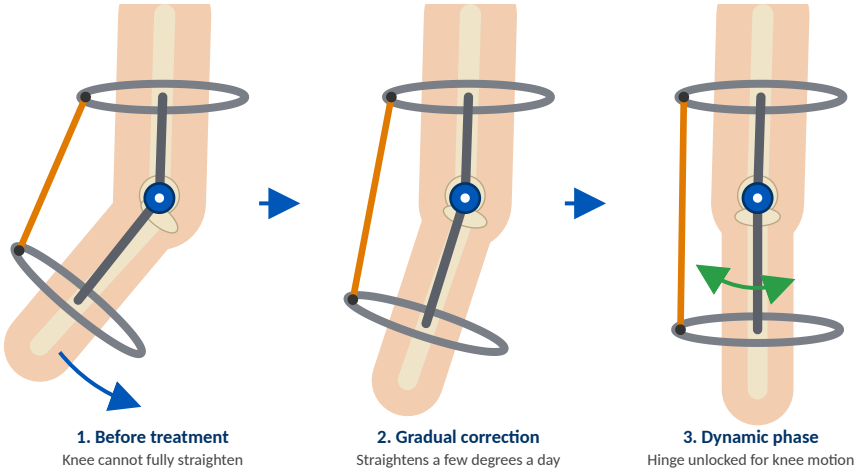



*Illustration of a two-ring hinged knee frame gradually straightening a knee flexion contracture, then allowing motion through the hinge.*

## Who Is This Treatment For?

Your care team may recommend a circular frame if you have a knee contracture that has not improved with physical therapy, stretching, bracing, or serial casting, or if surgery to release the tight tissues alone would not safely correct it.

**Flexion contracture**
*The knee cannot fully straighten.*

This is the most common type. A bent knee makes walking tiring, can cause limping, and puts extra strain on the hip, other leg, and back. The frame gradually **straightens (extends)** the knee, stretching the tight hamstring muscles, the back of the joint capsule, and the skin, nerves, and blood vessels behind the knee.

**Extension contracture**
*The knee cannot bend well.*

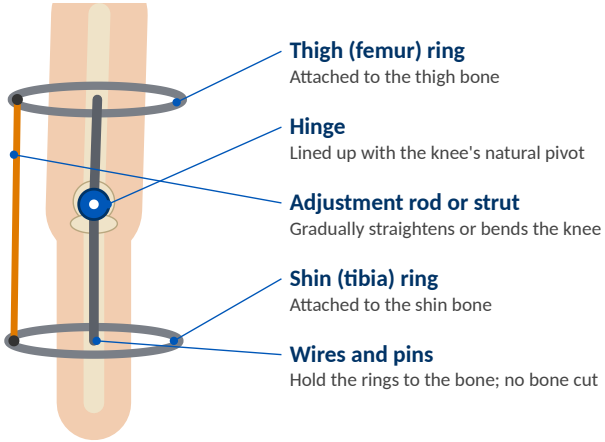
A stiff, straight knee makes sitting, climbing stairs, getting in and out of a car, and normal walking difficult. The frame gradually **bends (flexes)** the knee, stretching the tight quadriceps muscle, tendon, and scar tissue at the front of the knee.

Contractures may be caused by:

- Conditions present from birth, such as arthrogryposis or pterygium syndromes
- Neuromuscular conditions, such as cerebral palsy or spina bifida
- Injuries, fractures, or surgery around the knee, and long periods of immobilization or bed rest
- Scarring from burns, infection, or prior surgery
- Arthritis or bleeding disorders that affect the joint

A frame may not be the best option if you are unable to perform daily pin care and frame care (or have no one to help), have poor skin or soft tissue where the wires and pins would go, have an active infection, or have a medical condition that makes surgery unsafe right now. If your knee joint itself is severely damaged by arthritis, a joint replacement may be a better option. Your surgical team will review your x-rays, health, and goals with you.

## Parts of Your Frame




- **Rings:** one around the thigh and one around the shin
- **Wires:** thin, tensioned wires that pass through the bone and attach to the rings
- **Half pins:** thicker screws that go into, but not through, the bone
- **Hinges:** on each side of the knee, allowing it to pivot like a normal knee
- **Adjustment rod or struts:** control how quickly the knee is straightened or bent. Some frames use a hexapod with six numbered, color-coded struts.

Your frame is built specifically for your leg and your correction. Do not loosen, tighten, or remove any part of the frame, or unlock the hinges, unless your care team has shown you how.

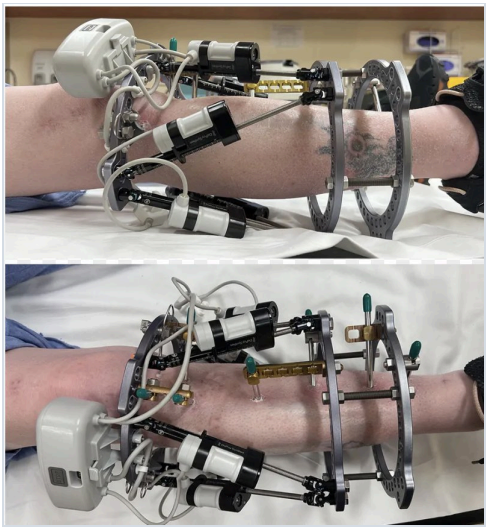
## Manual and Automatic Adjustment

Your frame is adjusted a small amount each day, either by hand or automatically. Your surgeon will discuss which system is right for you.

| | Manual adjustment | Automatic hexapod (MAXFRAME AutoStrut™) |
|---|---|---|
| **Who adjusts the frame** | You or a family member, by hand, following a printed schedule | Small motors inside the struts adjust them automatically |
| **How often** | Usually 1 to 4 times per day, as listed on your prescription | Many small adjustments throughout the day (up to about 20) |
| **Your job** | Turn each rod or strut to the correct setting, check your work, and record it | Keep the control unit on, connected, and charged; watch for alerts |
| **Main benefits** | Simple, reliable, no electronics or charging | No hand adjustments, lower risk of adjustment errors, and smaller steps that may be gentler on soft tissue |
| **Both systems** | Require daily pin site care, regular clinic visits and x-rays, and physical therapy. Your team may update your prescription at any visit. | |



*Example of a manual hexapod frame*



*Example of an automatic hexapod (MAXFRAME AutoStrut™) with its control unit*

## Using a Manual Frame

Before you go home, your care team will teach you (and a family member or caregiver) how to adjust your frame, and you will practice with them. You will receive an **adjustment prescription**: a chart that lists the exact setting for each rod or strut, day by day.

### Daily adjustment steps

1. **Check your prescription** and find today's date and time. Adjust at the same times each day.

2. **Find each strut or rod** by its number and color. Always work in order, starting with number 1.
3. **Unlock the strut** if your strut has a lock, as you were shown.
4. **Adjust the strut** by turning the adjustment knob until the indicator matches the number on your prescription. Most struts click as they turn; your team will show you how much each click moves the strut.
5. **Re-lock the strut** and double-check the setting.
6. **Check off the adjustment** on your prescription chart.

| Day | Date / time | 🔴 1 | 🟠 2 | 🟡 3 | 🟢 4 | 🔵 5 | 🟣 6 | Done ✓ |
|---|---|---|---|---|---|---|---|---|
| 1 | 11/16 8 AM | 142 | 155 | 139 | 160 | 148 | 151 | |
| 1 | 11/16 8 PM | 143 | 155 | 140 | 159 | 148 | 152 | |
| 2 | 11/17 8 AM | 144 | 156 | 141 | 158 | 149 | 152 | |

*Example only. Your own prescription will have different numbers and timing. Always follow the prescription your care team gives you.*

**Important tips for manual adjustments**

- Never skip an adjustment, and never "catch up" by doing two at once. If you miss one, call your care team.
- Some struts will move forward, some backward, and some not at all on a given day. This is normal.
- If a strut will not turn, reaches the end of its range, or the numbers do not match your chart, **stop and call your care team**. Do not force it.
- Your team may need to swap a strut for a longer or shorter one during treatment. This is done in clinic.
- Bring your prescription chart to every clinic visit.

## Using an Automatic Hexapod (MAXFRAME AutoStrut™)

With an automatic hexapod, each strut contains a small motor connected to a **control unit** that is programmed by your care team with your prescription. The control unit makes small adjustments many times a day, so **you do not need to turn the struts yourself**.

### Your responsibilities

- **Keep the system on and connected** at all times unless your care team tells you otherwise. Do not unplug cables or remove the control unit.
- **Keep the control unit charged** as instructed, and follow the charging routine your team teaches you.
- **Check the control unit daily** for status lights or messages, and learn what a normal display looks like.
- **Call your care team right away** for any alert, error message, low battery that will not charge, damaged cable, or if you think the frame has stopped adjusting.
- **Protect the electronics from water.** Follow your team's instructions for covering or protecting the control unit and struts when showering.
- **Never try to manually turn** a motorized strut or change the program.

Your care team will still check your knee and x-rays regularly and may reprogram the control unit to fine-tune your correction.

## What Happens During Surgery

Surgery is performed under anesthesia. Your surgeon places one ring around your thigh and one around your shin and attaches them to the bones with wires and half pins through small skin punctures. **The bone is not cut.** The hinges are carefully lined up with your knee's natural pivot point so that the knee moves smoothly and stays in the correct position as it is straightened or bent. In some cases, your surgeon may also lengthen or release tight tendons or scar tissue during the same surgery. Many patients stay in the hospital for one to a few nights for pain control, pin care teaching, and physical therapy.

## The Treatment Process (Timeline)

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Distraction | Gradual correction | Rest | Dynamic (hinge motion) | Frame removal |

- **Distraction phase:** Over the first several days after surgery, the frame gently separates the thigh bone and shin bone by a few millimeters. Opening the joint slightly protects the cartilage from pressure and allows the knee to pivot smoothly during correction.
- **Gradual correction phase:** The frame then slowly **straightens** the knee (for a flexion contracture) or **bends** it (for an extension contracture), usually a few degrees a day, following your prescription. This phase commonly takes a few weeks, depending on how much correction is needed. Some stretching discomfort is normal; your team may slow the schedule if you have significant pain, numbness, or tingling.
- **Rest (holding) phase:** Once the knee reaches its goal position, the frame is locked and held still for a period of time, often a few weeks. This allows the stretched muscles, tendons, joint capsule, nerves, and skin to adapt to their new length.
- **Dynamic phase:** The hinges are then unlocked so that you can begin **moving the knee through the hinge**. Your physical therapist will guide range-of-motion exercises while the frame keeps the knee aligned and protected. The frame may be locked in the corrected position at night or between exercise sessions to help hold your correction.
- **Frame removal:** When your knee has kept its correction and is moving well, the frame is removed, usually in a short outpatient procedure under anesthesia. After removal, you will typically wear a knee brace or night splint for a period of time and continue physical therapy to maintain your motion and prevent the contracture from returning.

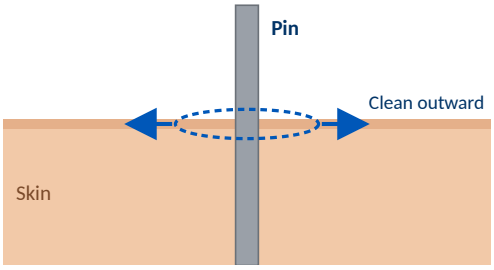
Total time in the frame is commonly about 2 to 4 months, depending on the size of your contracture, your condition, and how your tissues respond. Your surgical team will give you a more specific estimate. You will have regular clinic visits, often every 1 to 2 weeks, to check your knee position, nerves, skin, and pin sites.

## Pin Site Care

The places where wires and pins pass through your skin are called **pin sites**. Good pin site care is the most important thing you can do to prevent infection, which is the most common problem with a frame. You will be taught pin care in the hospital before you go home.

## Supplies

- A cleaning solution recommended by your team: **2% chlorhexidine (CHG)** or **70% isopropyl alcohol**
- Sterile cotton-tipped swabs or gauze
- Clean, dry pin site dressings or sponges, if instructed
- A clean towel and a clean area to work




*Clean from the pin outward in a circular motion, using a new swab for each pin.*

## Daily pin care steps (once a day)

1. **Wash your hands** with soap and water for at least 20 seconds.
2. **Remove old dressings** and look at each pin site for redness, swelling, or drainage.
3. **Clean each pin site** with a **new** swab or gauze soaked in chlorhexidine or isopropyl alcohol. Start where the pin enters the skin and wipe in a circular motion moving outward, away from the pin. Then wipe the pin itself.
4. **Gently remove crusting** that comes off easily. Do not pick or scrape the skin.
5. **Let the sites air dry** completely.
6. **Apply clean dressings** if your team has instructed you to. Dressings should be snug enough to limit skin movement around the pin.

**Pin care do's and don'ts**

- **Do** use a separate clean swab for every pin, so you do not spread germs from one site to another.
- **Do** pay extra attention to pins near the knee, where skin moves the most during the dynamic phase.
- **Do** keep the frame and pin sites clean and dry, and wear clean, loose clothing over the frame.
- **Don't** use lotions, ointments, creams, or powders on pin sites unless your team tells you to.
- **Don't** swim or soak in a bath, hot tub, pool, lake, or the ocean until your care team says it is safe.

## Showering

Once your incisions have healed and your surgeon says it is okay (often about 10 to 14 days after surgery), you may shower with the frame on. Use mild soap and clean, running water, let it rinse over the frame and pin sites, then pat dry with a clean towel and do your pin care. Shower before your daily pin care, not after. If you have an automatic hexapod, protect the control unit and electronics as instructed.

## What is normal, and what is not

| Usually normal | Possible infection: call your care team |
|---|---|
| • A small amount of clear or light yellow drainage<br>• Mild pink skin right around the pin<br>• Light crusting<br>• Mild soreness, especially after activity or therapy | • Redness spreading away from the pin, or warm, swollen skin<br>• Thick, cloudy, yellow-green, or foul-smelling drainage<br>• New or increasing pain at one pin site<br>• A pin that feels loose or clicks<br>• Fever or chills |

Pin site infections are usually minor and respond well when treated early, often with more frequent pin care and oral antibiotics. Call early rather than waiting.

## Caring for Yourself at Home

- **Physical therapy:** Daily exercises are essential. Keep your hip and ankle moving, do thigh-muscle (quadriceps) tightening exercises, and keep stretching your ankle and toes upward. During the dynamic phase, your therapist will add knee range-of-motion exercises through the hinge.
- **Weight bearing:** Many patients may put weight on the leg with a walker or crutches while the frame is locked. Follow your surgeon's specific instructions.
- **Swelling and pain:** Elevate your leg when resting, and take pain medicine as prescribed. Some stretching discomfort during correction is normal. Taking pain medicine before therapy can help.
- **Skin behind and in front of the knee:** Check daily for redness, blisters, or pressure areas, especially where the skin is being stretched.
- **Nutrition:** Eat a balanced diet with enough protein, vitamin C, and vitamin D to support healing, and stay well hydrated.
- **Smoking and nicotine:** Avoid smoking, vaping, and all nicotine products, which slow healing and increase infection risk.
- **Blood sugar:** If you have diabetes, tight blood sugar control supports healing and lowers infection risk.
- **Blood clot prevention:** Take any blood thinner prescribed, and move around regularly.
- **Daily life:** Wide-leg or tear-away pants, a pillow under the frame at night, and a frame cover can make life easier. Do not drive unless your surgeon clears you.

## Possible Risks and Complications

As with any surgery, circular frame treatment carries some risks. Your surgical team will discuss how these apply to you. Possible complications include:

- Pin site infection (the most common complication, usually minor and treatable with local care and/or oral antibiotics)
- Stretching of the nerve behind the knee, which can cause numbness or weakness in the foot (often improves when the correction is slowed or paused)
- Irritation of blood vessels, or skin problems where the skin is being stretched
- Shifting of the shin bone out of its normal position at the knee (subluxation), which your team watches for on x-rays
- Pain or stiffness, including stiffness when the knee is moved in the opposite direction
- Return of some of the contracture after the frame is removed, especially without bracing and therapy
- Loose or broken wires or pins, or rarely a fracture near a pin site
- Blood clots, and risks related to anesthesia and surgery in general
- The need for additional procedures, such as a frame adjustment, manipulation, or a second surgery

### Call Your Care Team Right Away If You Notice:

- Increasing redness, warmth, swelling, or drainage at a pin site or incision
- A pin or wire that feels loose, or a frame or hinge that feels unstable, bent, or broken
- Fever over 101°F (38.3°C) or feeling generally unwell
- Severe or worsening pain not relieved by your prescribed medication
- New numbness or tingling in the foot or toes, difficulty lifting your foot or toes, or a cold or pale foot
- A strut that will not adjust, a missed adjustment, or an alert or error on an automatic hexapod control unit
- Calf pain or swelling, chest pain, or shortness of breath (call 911 for chest pain or trouble breathing)

## Frequently Asked Questions

### Will the adjustments hurt?

Most patients feel a stretching or pulling sensation, especially behind or in front of the knee. This is usually manageable with pain medicine. Tell your team if pain is getting worse, as the schedule can be slowed.

### Will I be able to walk with the frame?

Many patients can walk with a walker or crutches while the frame is locked. Your surgeon will tell you your specific weight-bearing instructions.

### Why is my bone not cut?

A contracture is caused by tight soft tissues, not a bent bone. The frame works by slowly stretching those tissues across the knee joint, so a bone cut is not needed. If you also have a bone deformity, your surgeon will discuss whether it needs separate treatment.

### Will my contracture come back?

Some loss of correction can happen, especially in children who are still growing and in people with neuromuscular conditions. Wearing your brace or night splint and continuing your exercises after the frame is removed are the best ways to keep your correction.

### How do I know if I should have a manual or automatic frame?

Both work well. Your surgeon will consider your correction, how often adjustments are needed, your home support, and insurance coverage. Ask your team which is recommended for you and why.

### Can I go to work or school?

Many patients return to school or desk work within a few weeks once pain is controlled. Jobs that require heavy labor or long periods of standing may need to wait until after frame removal.

### Will I have scars?

You will have small round scars where the pins and wires were. These usually fade over time.

## Questions or Concerns?

Contact your Mayo Clinic Limb Deformity and Reconstruction care team with any questions about your surgery, recovery, frame adjustments, or pin care. If you are unable to reach your care team and believe you have an urgent problem, go to the nearest emergency department.

**Care team / clinic phone:** 904-953-2496
**After-hours or urgent line:** 904-953-2000