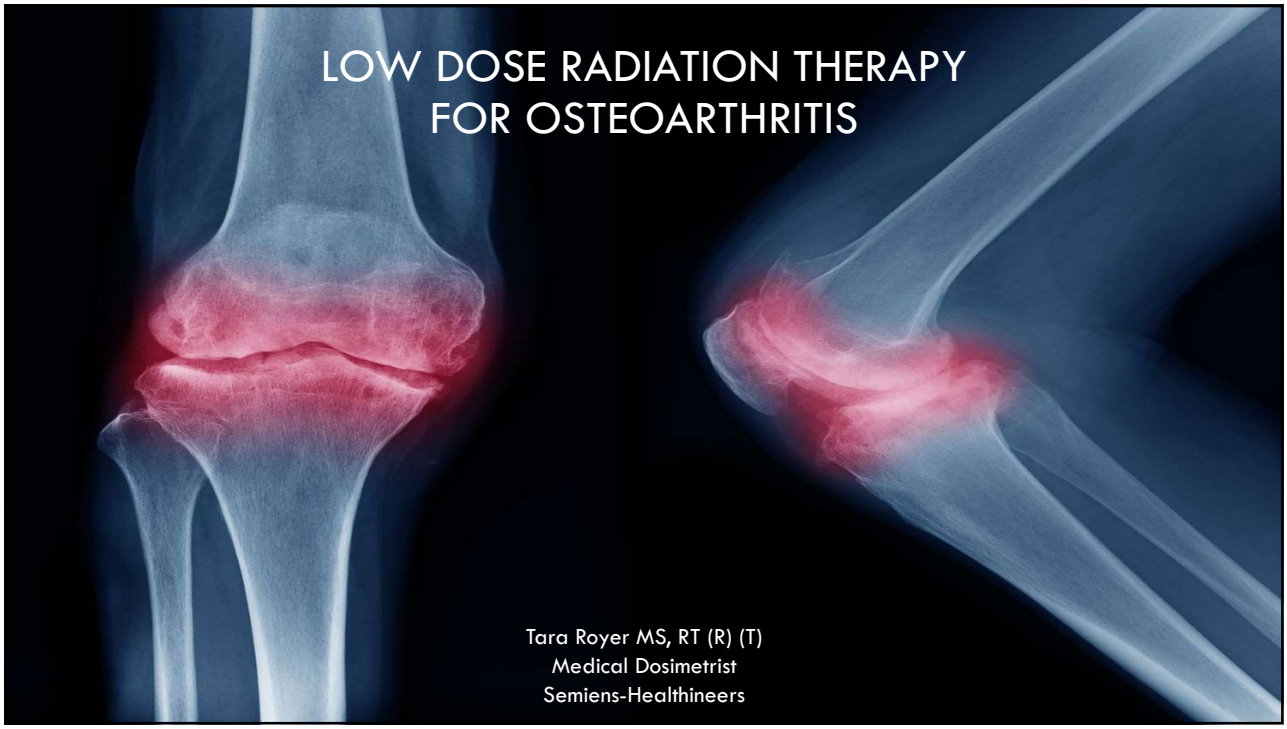
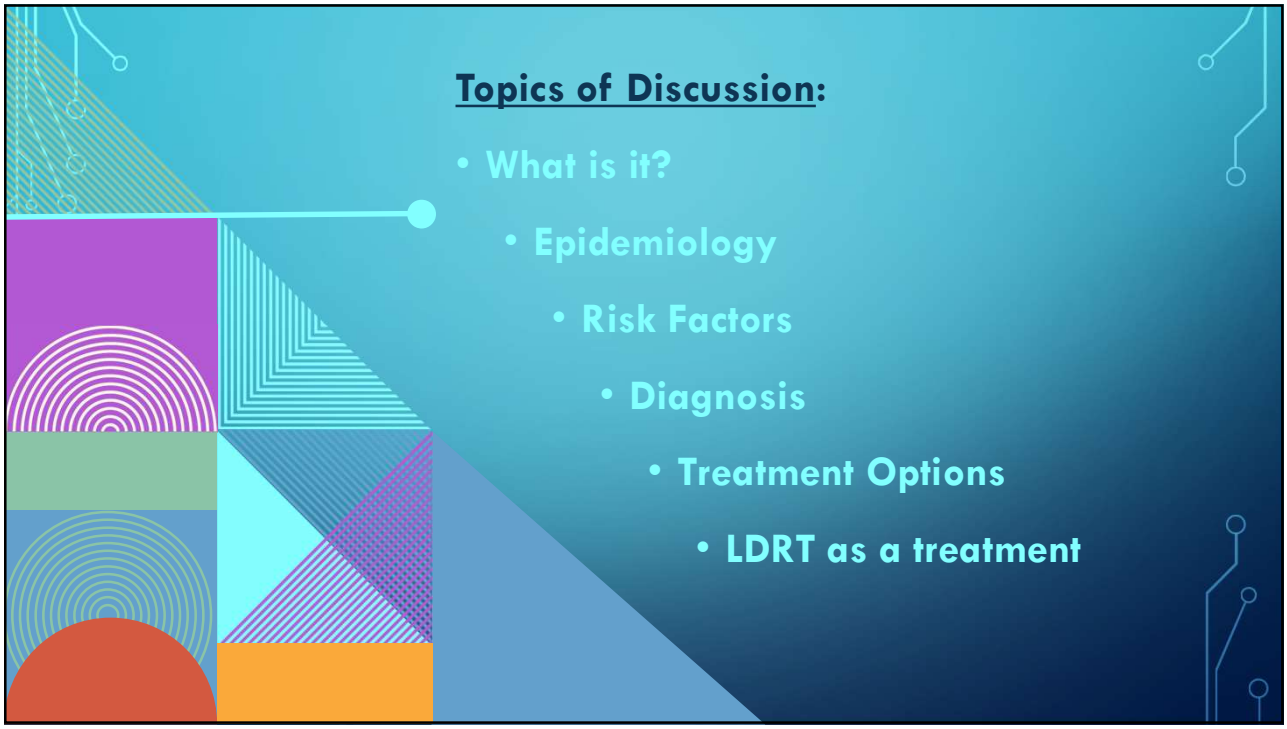

LOW DOSE RADIATION THERAPY
FOR OSTEOARTHRITIS
Tara Royer MS, RT (R) (T)
Medical Dosimetrist
Semiens-Healthineers


Topics of Discussion:
• What is it?
• Epidemiology
• Risk Factors
• Diagnosis
• Treatment Options
• LDRT as a treatment

## What is Osteoarthritis (OA)?

OA is a chronic joint disease caused by the breakdown of cartilage in a joint over a long period of time. As the disease progresses it leads to pain, stiffness, and reduced mobility. It can occur in any joint. The knees are the most affected joint, followed by the hips and hands.

OA effects the entire joint, including cartilage, bone, ligaments, tendons, and muscles. When the cartilage in the joint starts to break down, your body/joint works hard to try and repair itself. This causes deterioration of the joint.

There is no cure for OA, only pain management, and utilizing treatment methods to manage the progression of the disease

.

## EPIDEMIOLOGY

- Most common form of arthritis (others Psoriatic, RA)
- Leading cause of disability in the United States
- 1 in 5 will get diagnosed
- The incidence of developing OA is about 46%.
- Fastest increasing health condition in the US
- It is rising dramatically. It has affected millions of Americans
  - 1990-**21 million**
  - 2010-**27 million**
  - Currently over **32 million**
  - **78 million Americans expected to have arthritis by 2040**

## ECONOMIC IMPACT 2025

Direct medical costs: $65 billion annual costs. Primary costs. Hospitalizations, surgeries, medications, diagnostic tests, and rehabilitation.

Indirect costs: $140 billion annual costs. Secondary costs. Lost wages, reduced work hours, disability benefits, and caregiver costs

As the populations ages, and obesity rates rise, OA prevalence and costs are projected to increase in North America, Europe, and other high driven income regions

## RISK FACTORS

**Age > 45 (almost 90% are over 45 when diagnosed)**

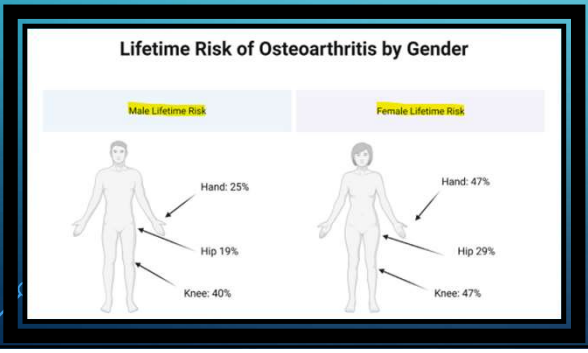
**Age > 65 (almost 50% are over 65 when diagnosed)**

**Sex – Female more common especially after menopause**

**BMI – Higher BMI's lead to a higher incident rate of OA**

**Family history-genetics**

**Previous joint injury or repeat stress on joints (sports, exercise, manual labor jobs)**




By the year 2050:

Hand osteoarthritis is expected to increase by almost 49%.

Hip osteoarthritis is projected to rise by nearly 79%.

Knee osteoarthritis cases are expected to increase by nearly 75%.

## DIAGNOSIS

- **ACR (American College of Rheumatology)** has certain guidelines they go by for classifying OA.
- Is the patient over the age of 45
- Do they have persistent joint stiffness & pain when moving and using the joints
- Does morning stiffness & pain usually last longer than 30 minutes

*If the above are met, X-Rays, which are the **GOLD** standard for diagnosing Osteoarthritis, will be ordered. The severity of the disease will then be graded using the **Kellgren - Lawrence Scale***

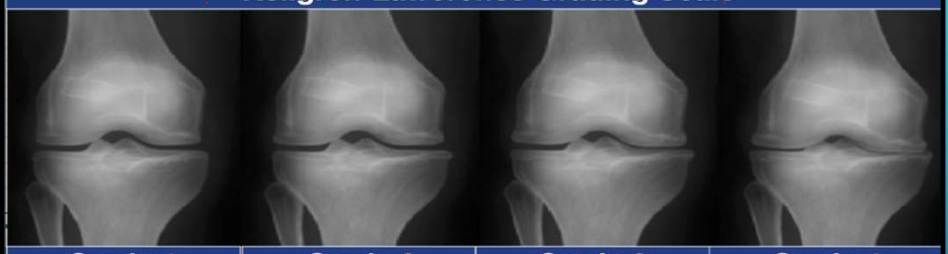
## Kellgren Lawrence Grading Scale

*Originated in **1957** when **British rheumatologist Dr. Jonas H. Kellgren** and **British epidemiologist Dr. John S. Lawrence** developed it as a standardized method to classify the severity of osteoarthritis based on plain X-ray findings.*

This system evaluates 4 key features on a radiograph and then grades/stages the severity between 1 & 4.

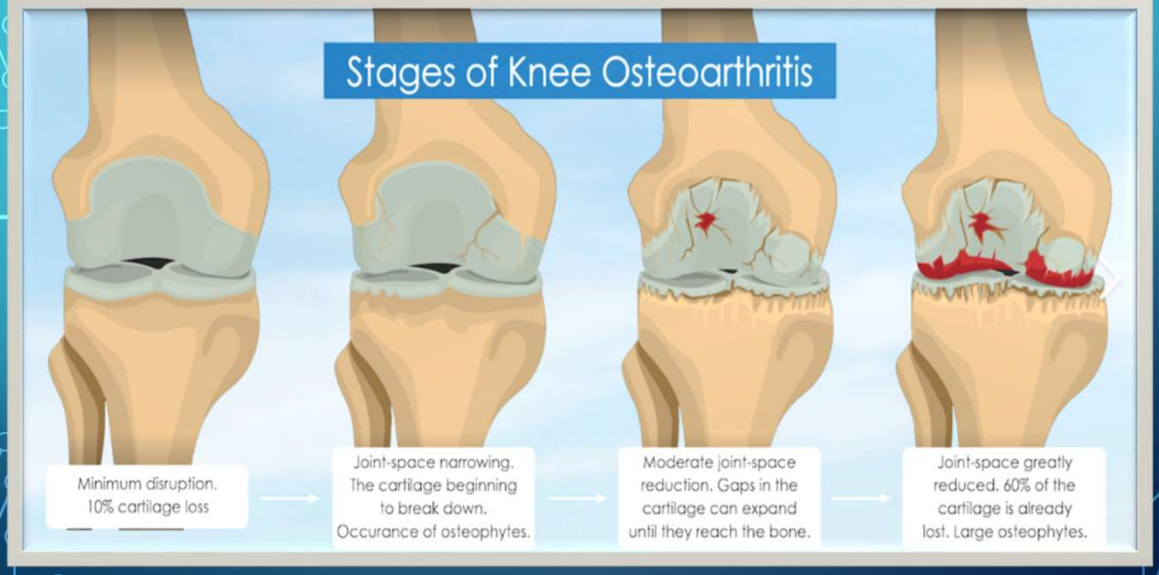
- Joint space narrowing – loss of cartilage in space between bones
- Osteophytes – formation of bone spurs or ridges along the margins of bones
- Subchondral Sclerosis – increased bone density under cartilage
- Bone Deformity – irregular bone contours or shapes in the joint

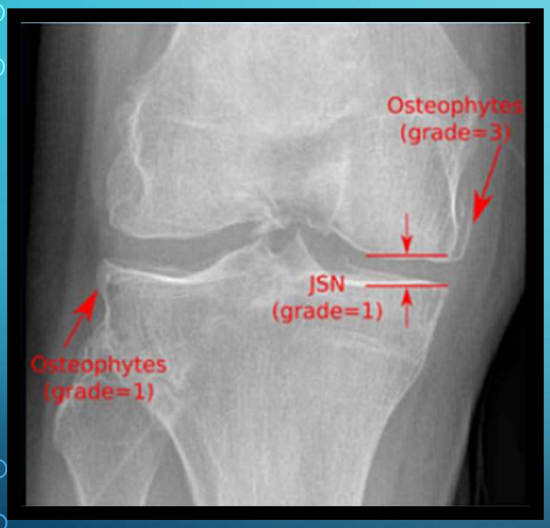
## Kellgren-Lawerence Grading Scale

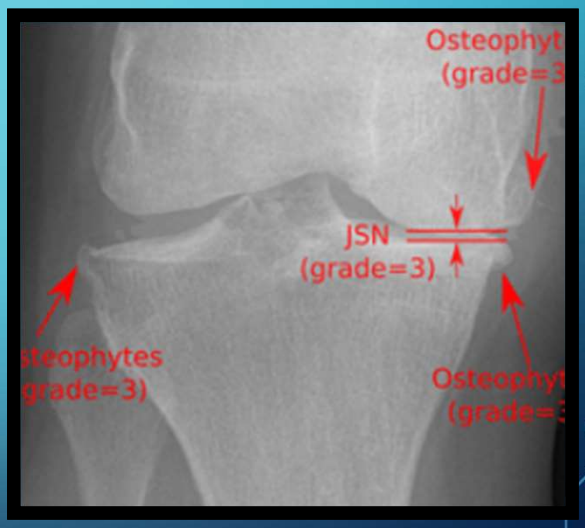


| | Grade 1 | Grade 2 | Grade 3 | Grade 4 |
|---|---|---|---|---|
| **Classifaction** | Normal | Doubtful | Mild | Moderate | Severe |
| **Description** | No Features of OA | Minute Osteophyte: doubtful significance | Definite Osteophyte: normal joint space | Moderate Joint Space Reduction | Joint Space Greatly Reduced: subchondral sclerosis |

- **grade 0 (none)**: definite absence of x-ray changes of osteoarthritis
- **grade 1 (doubtful)**: doubtful joint space narrowing and possible osteophytic lipping
- **grade 2 (minimal)**: definite osteophytes and possible joint space narrowing
- **grade 3 (moderate)**: moderate multiple osteophytes, definite narrowing of joint space, some sclerosis and possible deformity of bone ends
- **grade 4 (severe)**: large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone ends





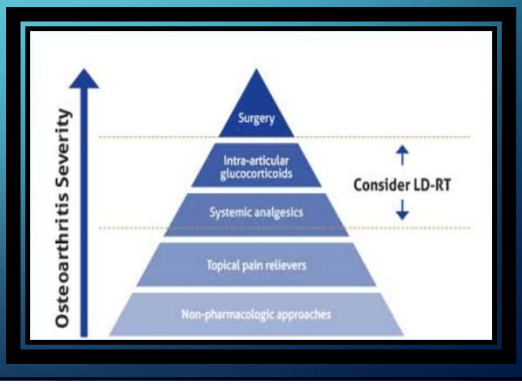




LDRT is a suitable OA management option for older patients. It is a recommended alternative treatment in patients with refractory symptoms of OA, and when other treatments are failing. Remember, OA is not curable or reversable. The delivery of LDRT at the right time is key for patients to benefit.

We want to deliver LDRT when OA is in **Stage 2 or 3** when over-the-counter pain and anti-inflammatory meds are not working, and steroid injections, PT, or OT are no longer effective.

**Stage 1**, symptoms are usually managed with OTC pain relief medications.

**Stage 4**, the progression of the disease is severe. LDRT is not a beneficial treatment at this stage. Surgery is one of the only options left



## MOST COMMON STANDARD OF CARE IN THE US FOR OA

**Oral Medication**

- Acetaminophen - Tylenol
- NSAIDs (nonsteroidal anti-inflammatory drugs)- Aleve, ibuprofen, Advil
- Duloxetine (Cymbalta)-antidepressant that has off label relief for OA.

**Non-Invasive Treatment**

- **Physical Therapy**
- Occupational Therapy
- TENS units (Transcutaneous electrical nerve stimulator)
- **Low Dose Radiation**

**Surgical or Invasive Treatments**

- Cortisone Injections
- Lubrication Injections
- Bone Realigning – surgery to reshape the bones & align to relieve pressure
- Joint Replacement-Surgery

## RADIATION THERAPY FOR BENIGN CONDITIONS

- Graves
- Trigeminal Neuralgia
- Plantar Fasciitis
- Tendonitis
- Acoustic schwannomas
- Keloids.
- *Osteoarthritis*

## RADIOBIOLOGICAL EFFECTS

The role LDRT plays is still being studied, but they know it has anti-inflammatory effects at cellular levels. The most prominent are the disruption of Macrophages & Osteophytes.

*Macrophages* are inflammatory cells that are produced and keep multiplying in injured joints.

*Osteophytes* are bone formations in joints that keep producing over time, leading to the development of bone spurs & ridges on the margins of the bones in the affected joints.

**LDRT significantly alters and suspends the production of both Macrophages and Osteophytes.**

## EUROPEAN STUDY

**GCB-BD** (German Cooperative Group on Radiotherapy for Benign Diseases) have the largest study to date between 2008-2020. Providing evidence based results that LDRT helped 60%-90% of patients.

Around 1800 sites on about 1000 Patients >65 years

Small and large joints

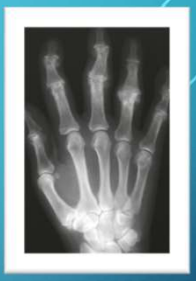
**Giving a Daily dose of 0.5Gy to 1Gy (50cGy-100cGy) every other day for a TD of 3GY to 6GY**

At the conclusion of treatment, 70% reported pain and stiffness had significantly decreased during or by the end of treatment. At the 8 week follow-up, 384 of the1000 were given a second course or LDRT because first course was not as beneficial.

***Fact-Germany – Has no restrictions on using Radiation, unlike the US which is for Cancer primarily. 1/3 of all RT treatments are benign disease. This includes 15,000 patients treated yearly for Osteoarthritis***

## HAND STUDY

- Another study was done involving 100 patients treated for Hand OA, who reported their pain was 8/10 prior to treatment. At the end of treatment, and follow up 6 months post treatment, 94% of the patient's showed significant pain improvement with an average pain level of 3/10. 63% of the patients did require a second course at 12 weeks due to an inadequate initial response.



Informative tables that indicates the study size for specific joints treated and trial size group. Includes the dose, energy & fractionation. Also, the pain relief noted and if second course was given.

## RECOMMENDATIONS FOR LDRT

**0.5-1.0Gy (50-100cgy) per fraction every other day for TD3Gy-6Gy (300-600cGy) 2-3 times a week. 6mv for small joints, and 10mv for larger joint, Dose Rate 600**

- CT simulation, with immobilization
- AP/PA or Opposed Lateral fields
  - open fields
  - Blocked fields - *contoured volume must include the entire joint, cartilage & bone*
- Planned to midline
- 5mm of bolus can be added for a more homogenous dose distribution
- If pain relief is not achieved with 1st cycle, can repeat for a 2nd cycle after 6-8 weeks

## Presentation of Cases

All presented with pain related to osteoarthritis

All had CT simulation with immobilization

Treated on TrueBeam

Photons 6x or 10x

Received a dose of 0.5 - 1.0Gy (50cGy – 100cGy)Every other day over a course of 2 weeks.

Follow up within 6-8 weeks post treatment.

## PATIENT A

Patient presented with bilateral hand pain in mid November 2025.. On a scale from 1-10,
the patient reported pain level of about 8/10. Patient received steroid injects but had to
stop due to increased blood glucose levels. Patient returned in late November for CT simulation of her left and right hands. Patient started treatment 12/1/25 and ended treatment 12/15/25.

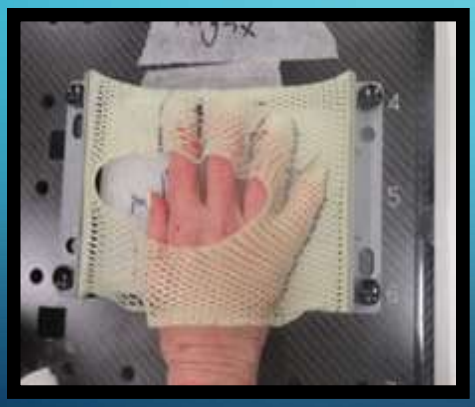
Patient was prescribed a TD of 300cGy to bilateral hands.
Was given 50cGy each treatment, every other day for 6 fractions.

Course: C1

| Treatment Site | Dose/Fx (cGy) | #Fx | Total Dose (cGy) | Start Date | End Date | Elapsed Days |
|---|---|---|---|---|---|---|
| L Hand OA | 50 | 6/6 | 300 | 12/1/2025 | 12/15/2025 | 14 |
| R Hand OA | 50 | 6/6 | 300 | 12/1/2025 | 12/15/2025 | 14 |

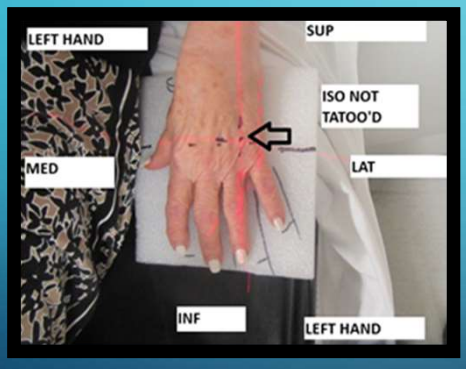
## RIGHT HAND SIM SETUP

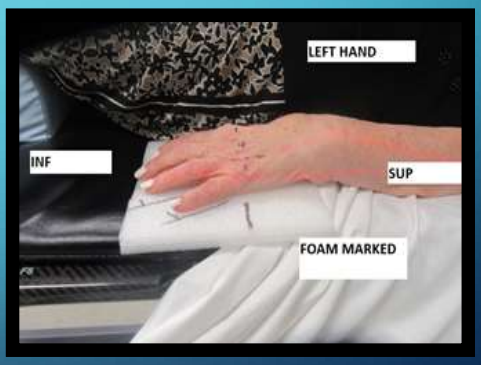
Patient was simulated for both the Right and Left hand. For the RIGHT hand the patient was in a prone position and the use aquaplast for immobilizing the patient.

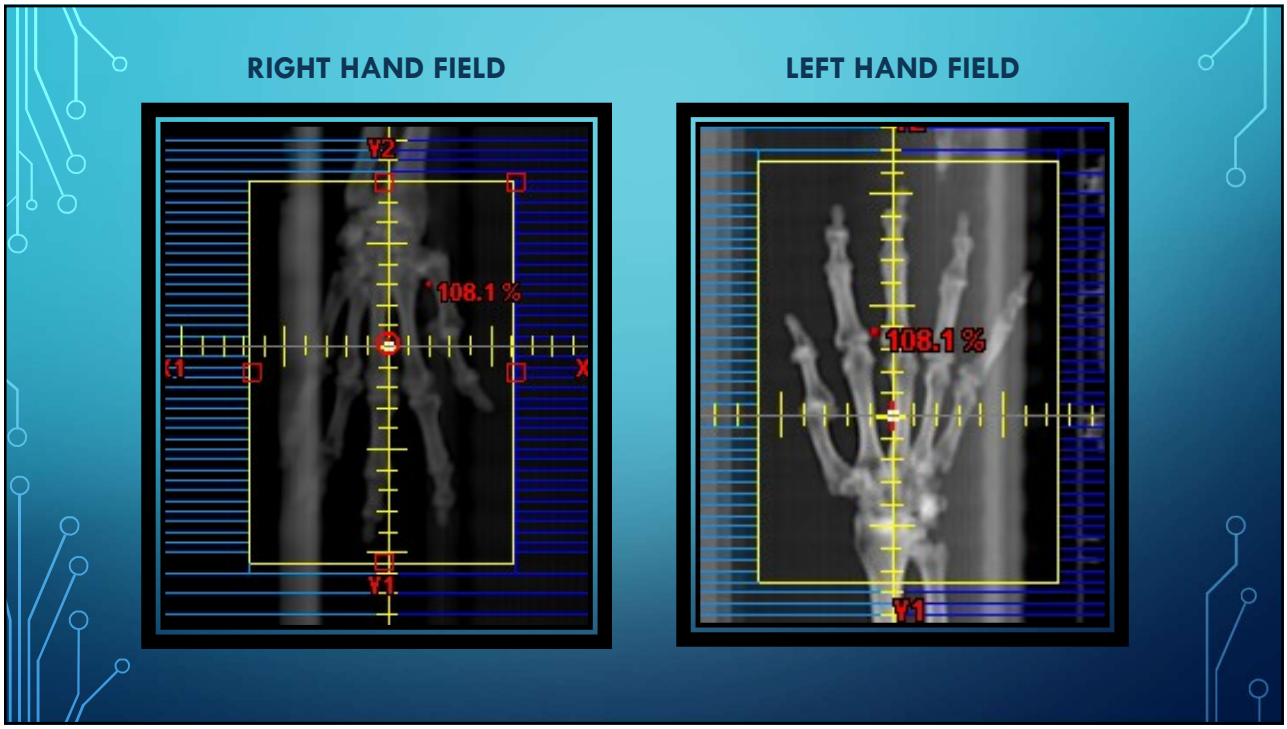


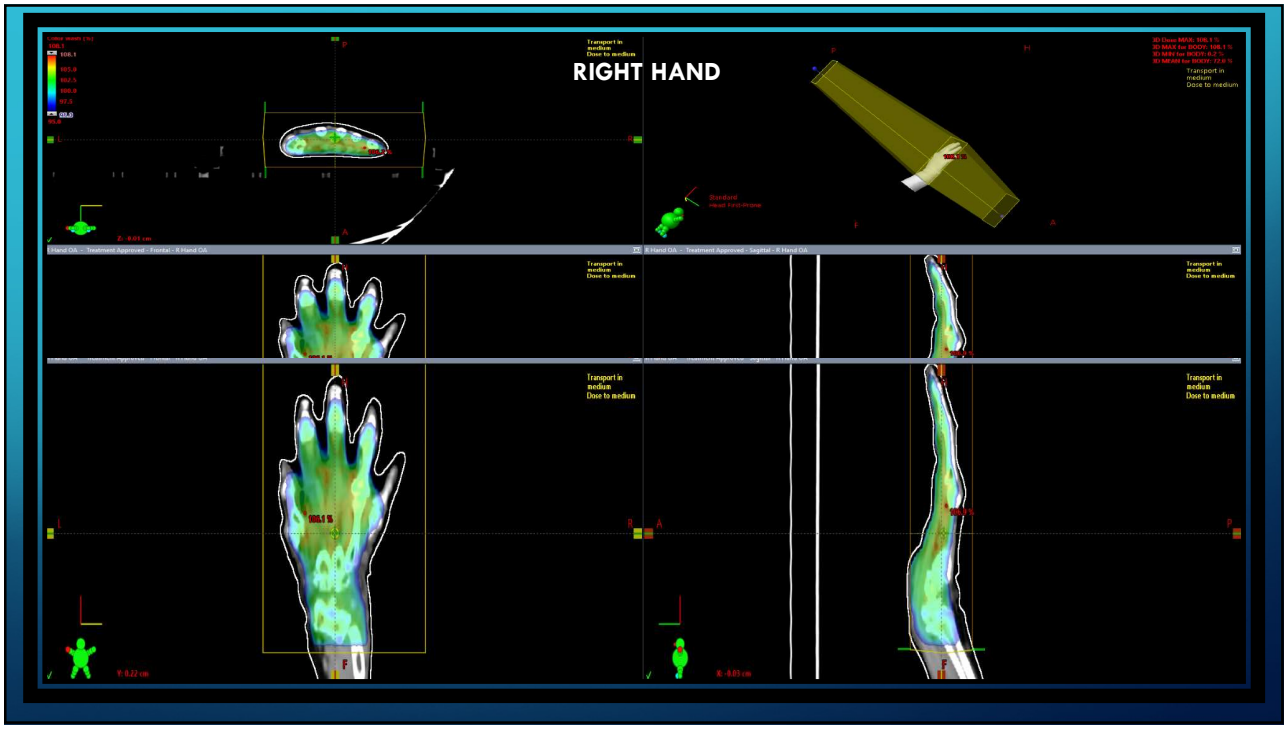
## LEFT HAND SIM SETUP

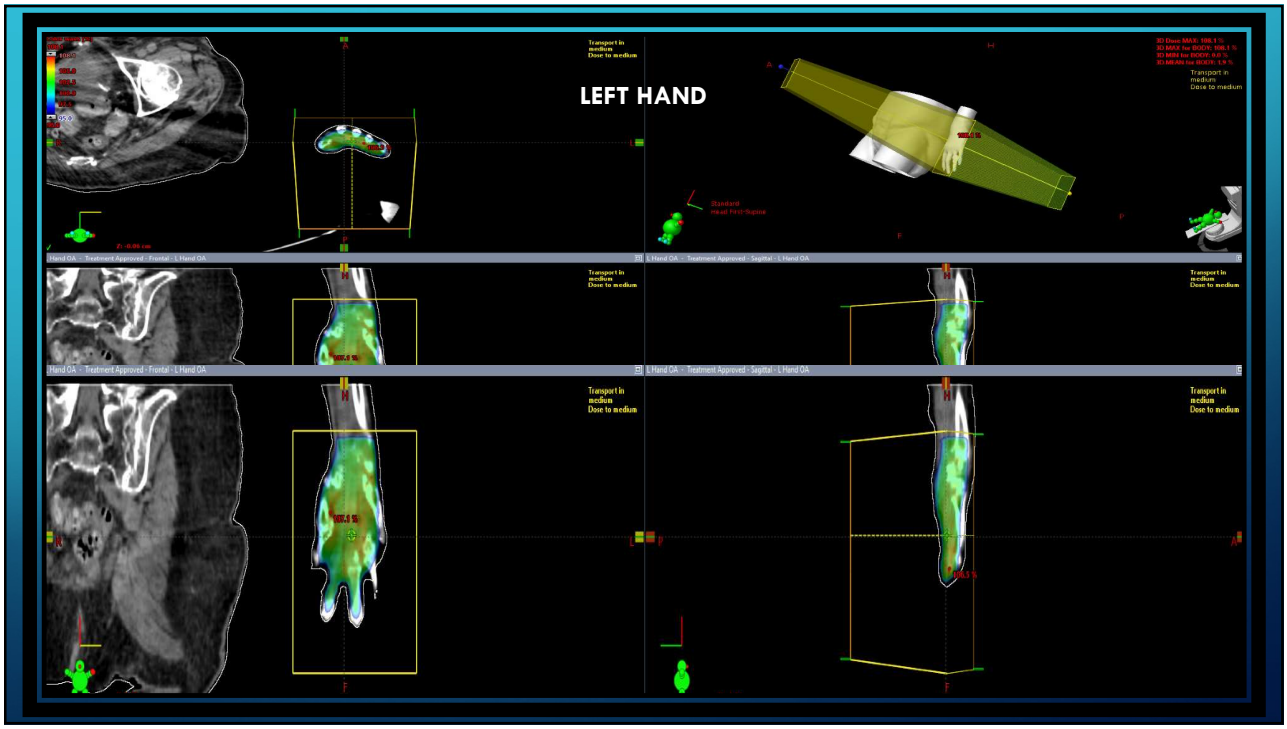
The LEFT hand was simulated in the supine position with he Left hand marked and traced on a foam plate.




RIGHT HAND FIELD
LEFT HAND FIELD
V2
108.1 %
-1
X
Y1
108.1 %
Y1


RIGHT HAND




**Patent A** came in for follow up on 1/12/26.

Patient Reports
-Left Hand Pain 0/10
-Right Hand Pain 0/10

Bilateral hand pain has fully resolved and she's regained use of her hands w/out pain, feels very satisfied with the treatment.

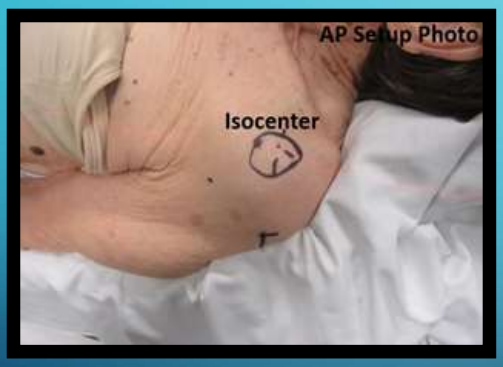
Patient noted Left shoulder pain, 5/6 out of 10. Difficulty with random of motion. At the end of treatment, patient noticed only slight improvement with pain. Will return for follow up in mid June 2026.

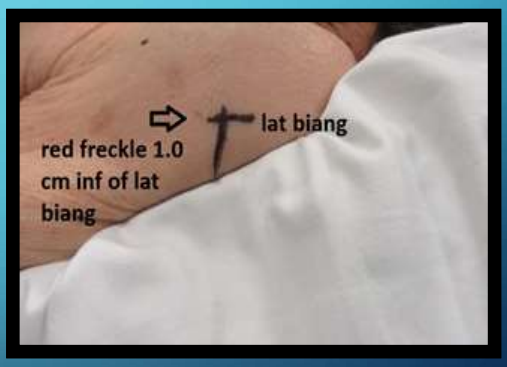
Course: C2

| Treatment Site | Dose/Fx (cGy) | #Fx | Total Dose (cGy) | Start Date | End Date | Elapsed Days |
|---|---|---|---|---|---|---|
| L Shoulder OA | 50 | 6/6 | 300 | 4/30/2026 | 5/18/2026 | 18 |

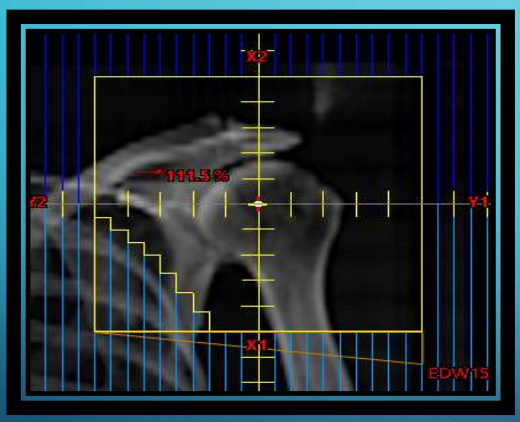
## LEFT SHOULDER SETUP

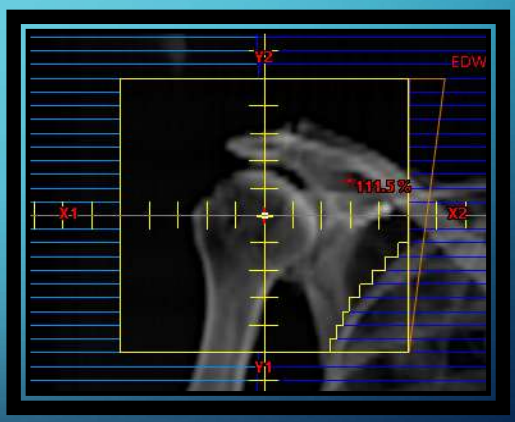
Patient was simulated in prone position, utilizing a Vak Lok Bag

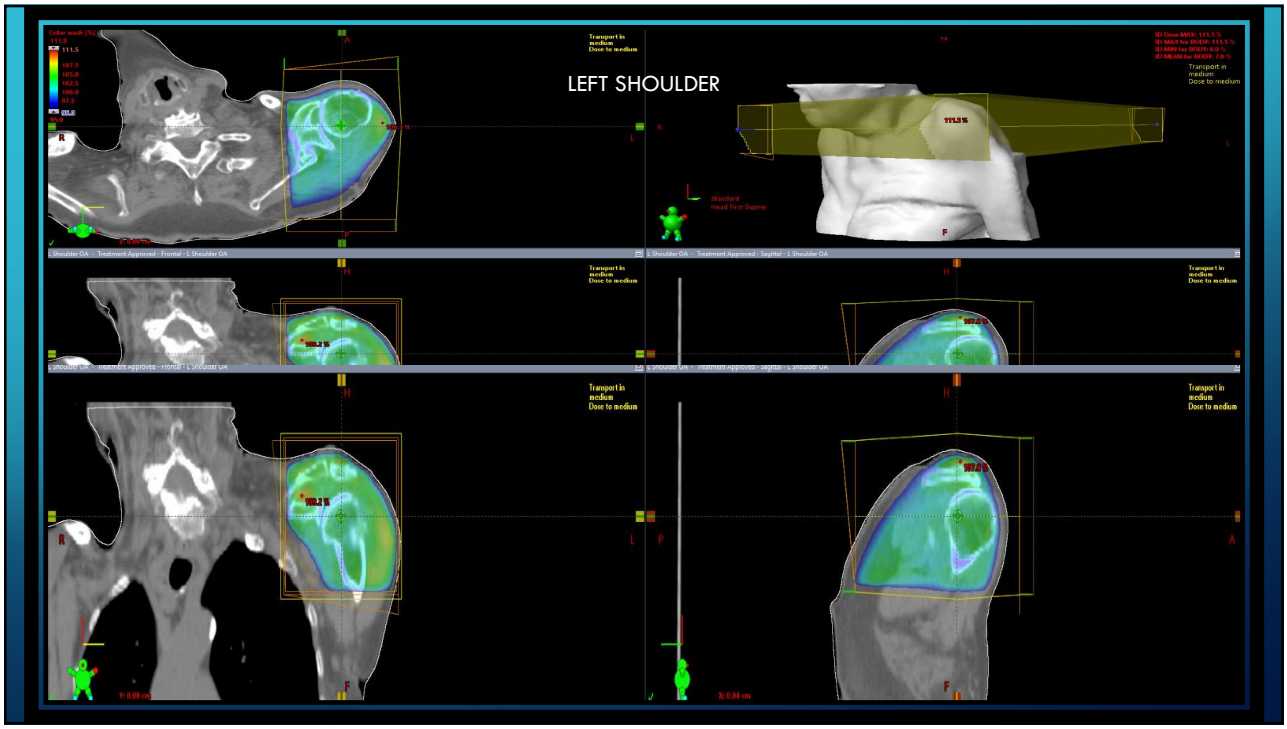



## LEFT SHOULDER FIELDS






**Patient B**

Presented in June 2025 with moderate to severe bilateral ankle and knee pain. Had tried prednisone and steroid injections which worked at first but no longer relieve symptoms. Patient was simulated in late June 2025 for both bilateral knees and hands. Started treatment beginning of July 2025 and completed treatment mid July 2025.

Patient was prescribed a TD of 300cGy to bilateral ankles and knees. Was given 50cGy each treatment, every other day for 6 fractions.

**R knee : R2**

| Prescribed Dose/Frac | Number Of Fractions | Total Prescribed Dose | Frequency | Energy | Technique | Linked Plans |
|---|---|---|---|---|---|---|
| 50.0 cGy | 6 | 300.0 cGy | Every Other Day | 10 MV | AP/PA | R knee |

**L knee : R2**

| Prescribed Dose/Frac | Number Of Fractions | Total Prescribed Dose | Frequency | Energy | Technique | Linked Plans |
|---|---|---|---|---|---|---|
| 50.0 cGy | 6 | 300.0 cGy | Every Other Day | 10 MV | AP/PA | L knee |

**R ankle : R2**

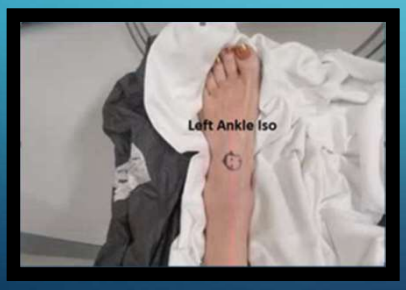
| Prescribed Dose/Frac | Number Of Fractions | Total Prescribed Dose | Frequency | Energy | Technique | Linked Plans |
|---|---|---|---|---|---|---|
| 50.0 cGy | 6 | 300.0 cGy | Every Other Day | 10 MV | AP/PA | R ankle |

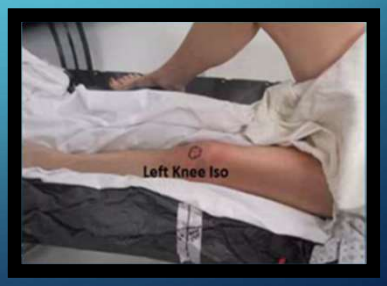
**L ankle : R2**

| Prescribed Dose/Frac | Number Of Fractions | Total Prescribed Dose | Frequency | Energy | Technique | Linked Plans |
|---|---|---|---|---|---|---|
| 50.0 cGy | 6 | 300.0 cGy | Every Other Day | 10 MV | AP/PA | L_ankle |

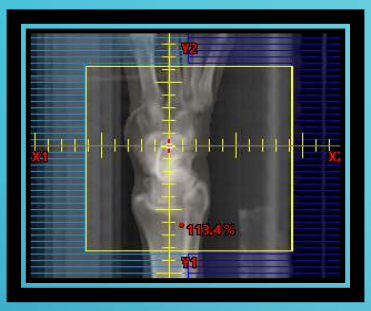
Patient B was simulated inverted on couch, Vak Lok bag for each side the Left and Right



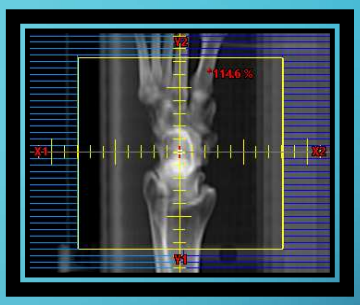


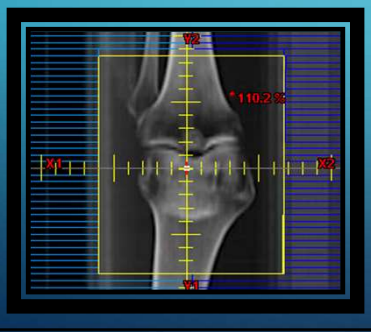

LEFT ANKLE



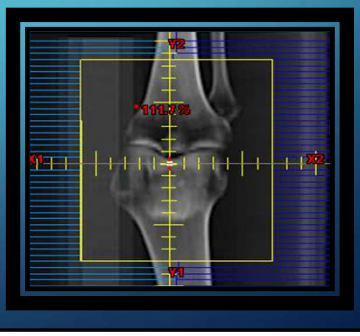
RIGHT ANKLE

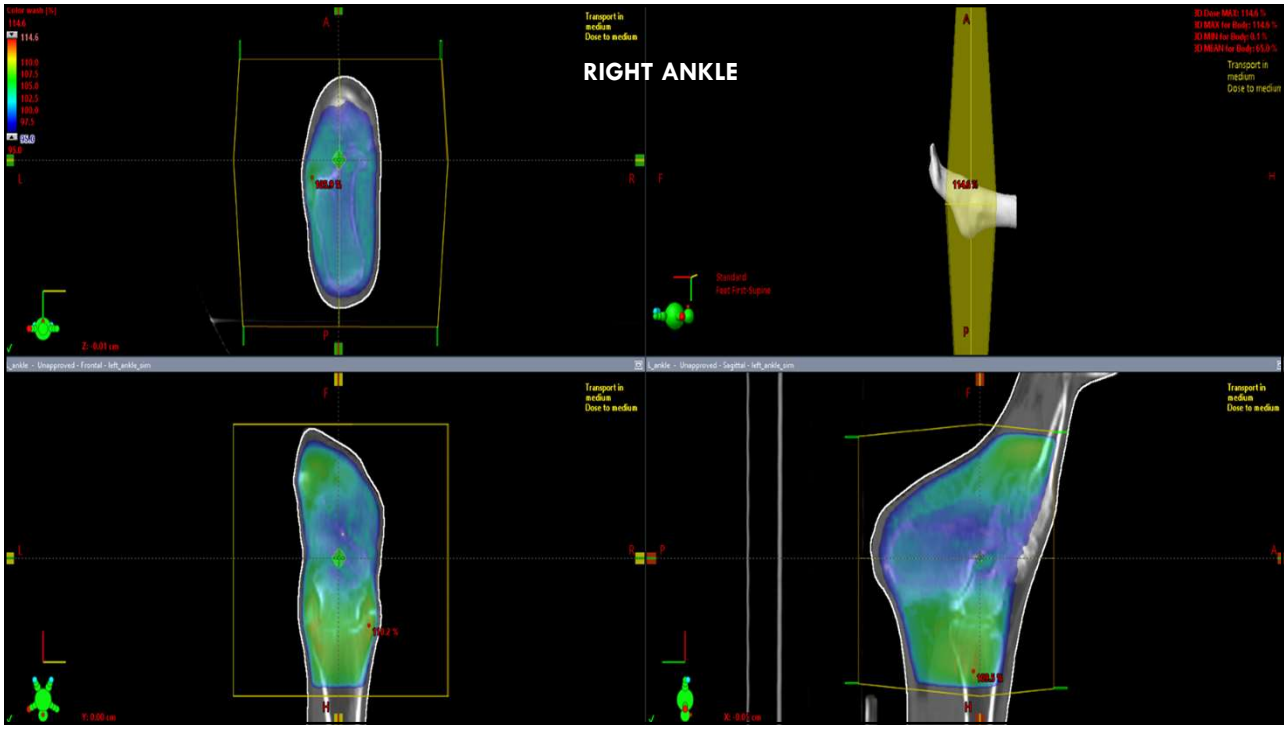


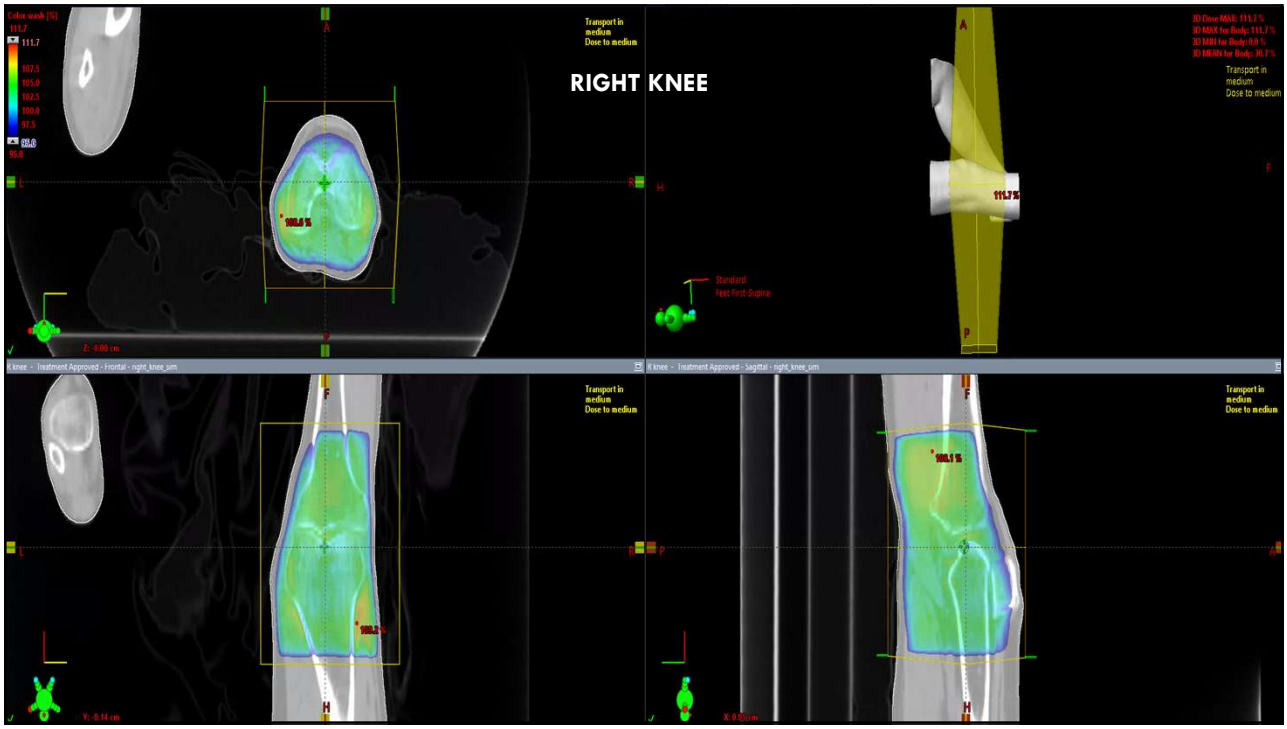
LEFT KNEE



RIGHT KNEE




RIGHT ANKLE


RIGHT KNEE

Patent B Came in for follow up for follow up on 08/2025.

REPORTS
-Ankle pain has gotten much better.
-Knee pain is only slightly better.

Patient was offered a second course of Radiation for her knee OA, she opted for no further treatment. Patient was now on daily morphine for other unrelated conditions.

## PATIENT C

Patient came in for yearly follow up in August of 2025. She complained about arthritis in bilateral knees. LDRT was discussed and patient wanted to move forward with treatment.

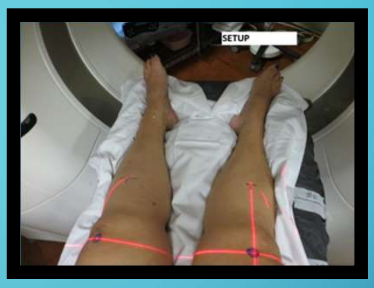
She returned the end of August for simulation. She began treatment in the beginning of September 2025 and completed mid September 2025.

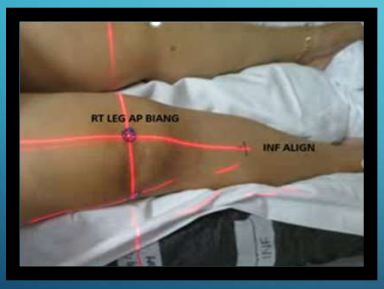
At the time of completion, the patient noted significant improvement of symptoms. She was prescribed 100cGy x 6 fractions for a TD of 600cGy

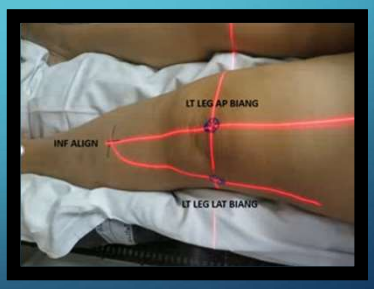
Course: C2

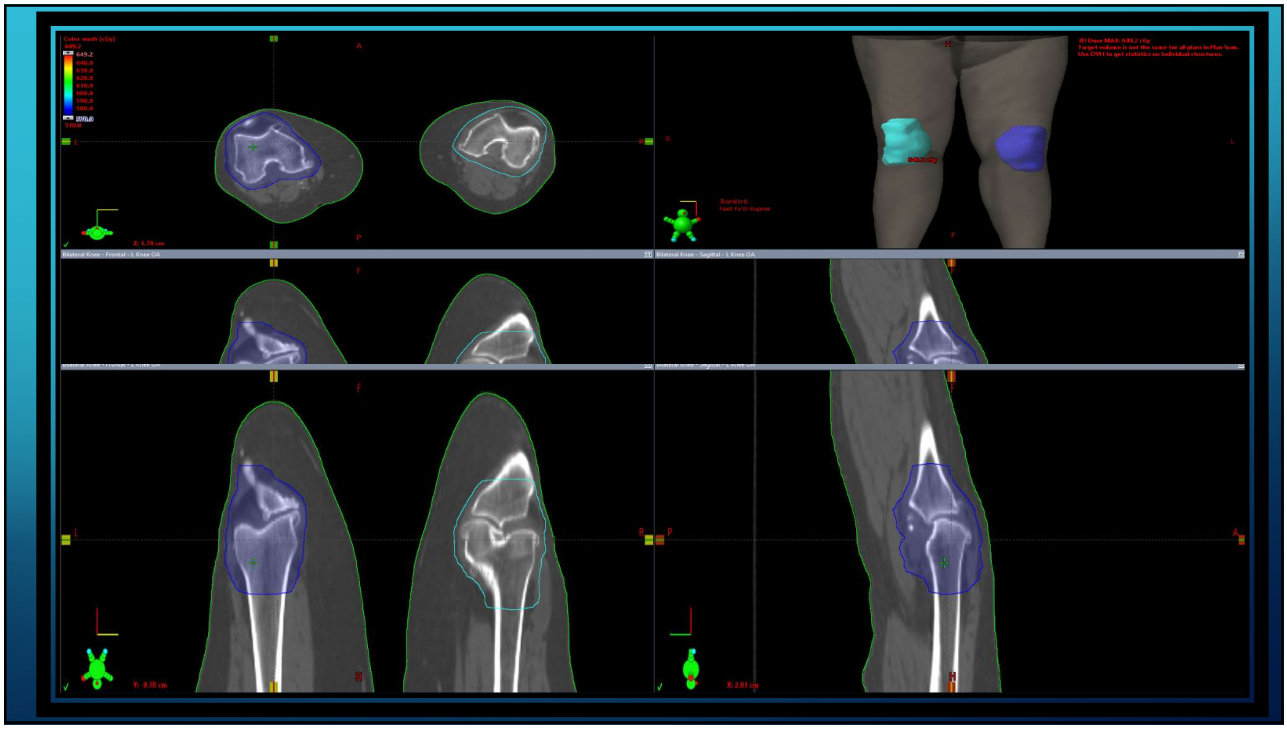
| Treatment Site | Dose/Fx (cGy) | #Fx | Total Dose (cGy) | Start Date | End Date | Elapsed Days |
|---|---|---|---|---|---|---|
| L Knee OA | 100 | 6/6 | 600 | 9/11/2025 | 9/30/2025 | 19 |
| R Knee OA | 100 | 6/6 | 600 | 9/11/2025 | 9/30/2025 | 19 |

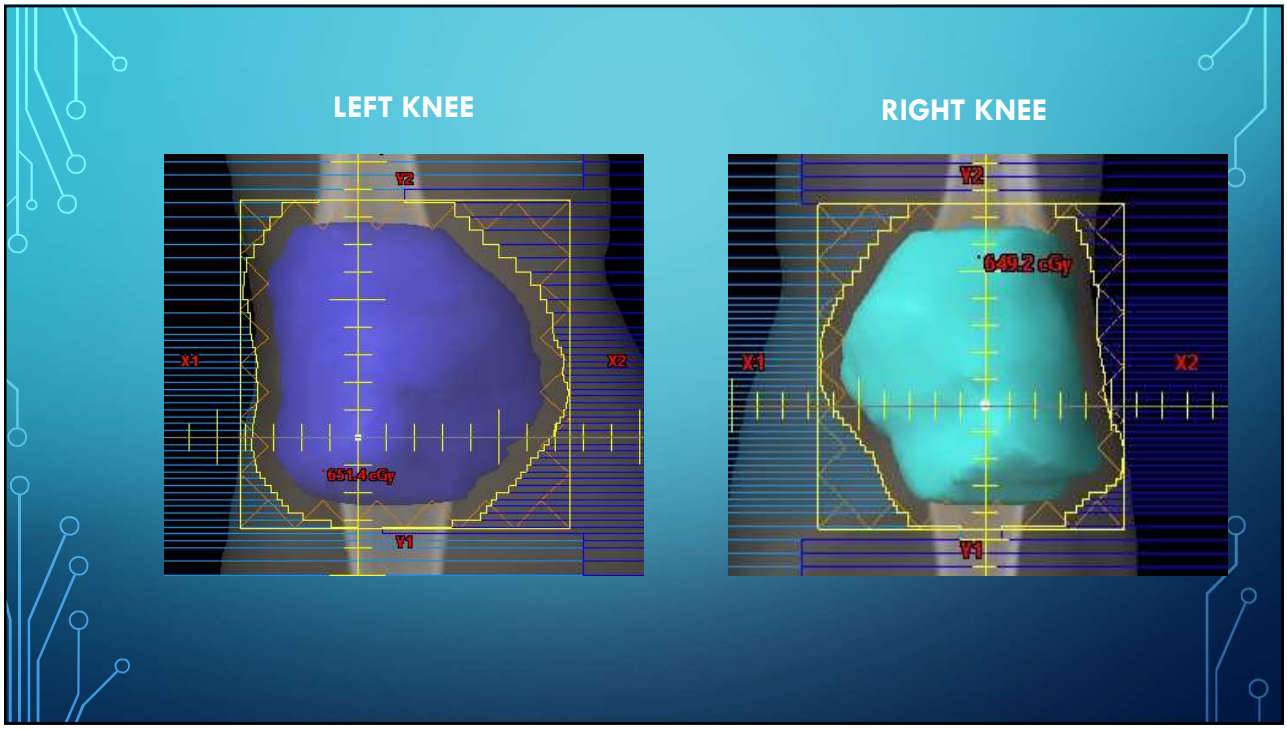
Patient was simulated inverted on table. One Vac Lok bag for both knees.

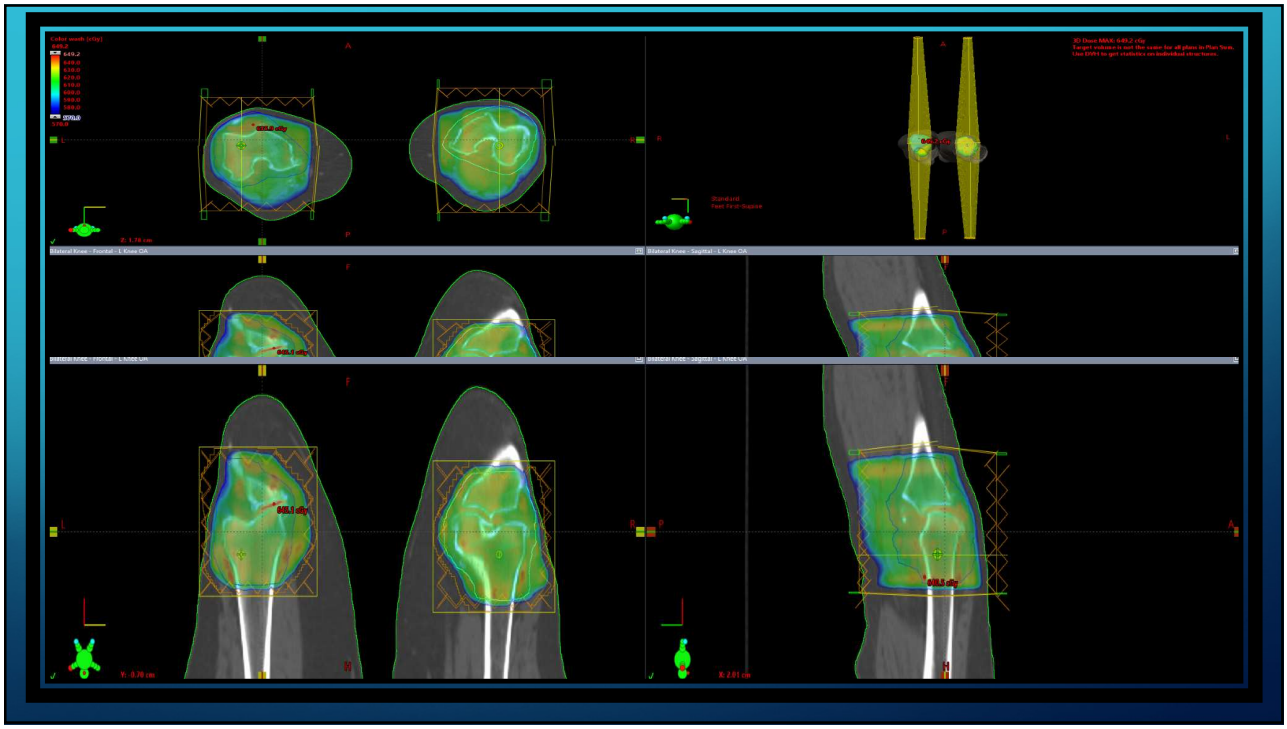


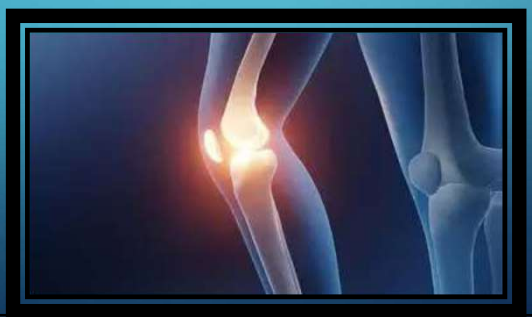

LEFT KNEE
RIGHT KNEE
Y2
X-1
X2
651.4 cGy
Y1
Y2
649.2 cGy
X-1
X2
Y1



**Patient C** was seen in mid November 2025. The patient reports symptoms are still improving in both knees.

The patient states there are still bad days but feels it is related to the weather.

Patient returned for 6 month follow up. Stated knee pain has improved since receiving RT. She noted that sitting for extended periods of time causes some pain.





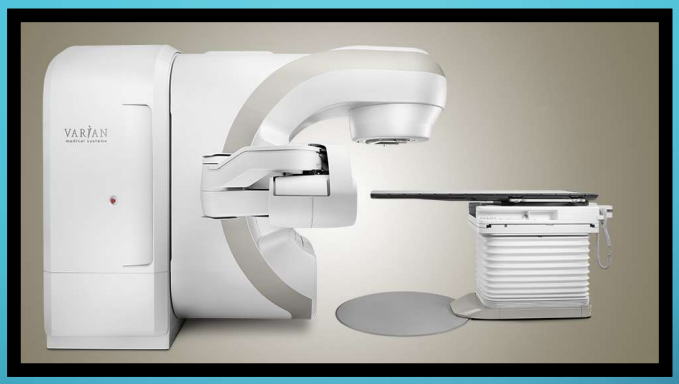



## Advantages of treating OA with LDRT

- Proven to reduce pain in joints at the same time increasing mobility
- Non-invasive
- Viable alternative for Non-Surgical candidates
- Very minimal side effects.
  - *(GCG study; only 1 patient reported mild skin redness)*
- Very low risk of any secondary malignancy, especially in extremities.
- Short treatment course that can be given again if symptoms persist
- Cost effective

## Disadvantages

- Not enough data/studies yet to prove the efficacy and duration of management (pain & mobility)
- Insurance approvals
- Referrals- who will refer the patient? Primary Care, Rheumatoid, or Orthopedic Doctors
- If not diagnosed and treated before Stage 4 of the progression of the disease, the only option usually left is surgery




In March of this year, 2026. TrueBeam was given FDA 510k clearance for LDRT in the treatment of Osteoarthritis in refractory patients.
This is the first time precision radiotherapy platforms have been authorized for non-cancer, chronic musculoskeletal conditions.

## What is 510(k) Clearance

Process that gives permission for an item/device to be marketed in the U.S. It has been demonstrating the item/device are substantially equivalent to another legally marketed item/device.

Many patients find relief with medications, injections, or physical therapy, but a significant number continue to suffer persistent pain and reduced mobility. This is a non invasion option for individuals who are not getting significant relief from other treatment options.

This is a big step for our field. It will give a more defined role in the treatment for OA with LDRT. Hopefully this will educate staff and patients, and increase referrals and insurance reimbursements.