

Radiotherapy for pain in the frail and forgotten: A new look on benign conditions

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OVERVIEW

1. Main causes of pain in frail/old patients?
2. A brief look into the history of LDRT
3. How does LDRT work?
4. Recent studies pro&con
5. Indication and Holistic Concept
6. Typical cases and treatments
7. Self empowerment: What patients can do for themselves
8. Work in progress....

MAIN CAUSES FOR PAIN IN FRAIL/OLD PATIENTS

- > Osteoarthrosis/-arthritis (50-80%)
- > Neurological disorders in up to 20% of cases (diabetic neuropathy, contractures after a stroke, neural compression syndromes e.g. lumbar prolaps, stenosis of spinal canal)
- > Osteoporosis, fractures
- > Bursitis/ Tendinitis
- > Circulatory disorders

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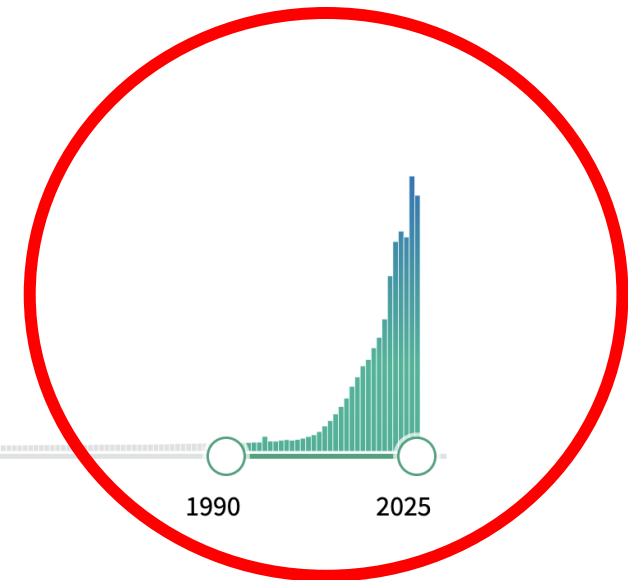
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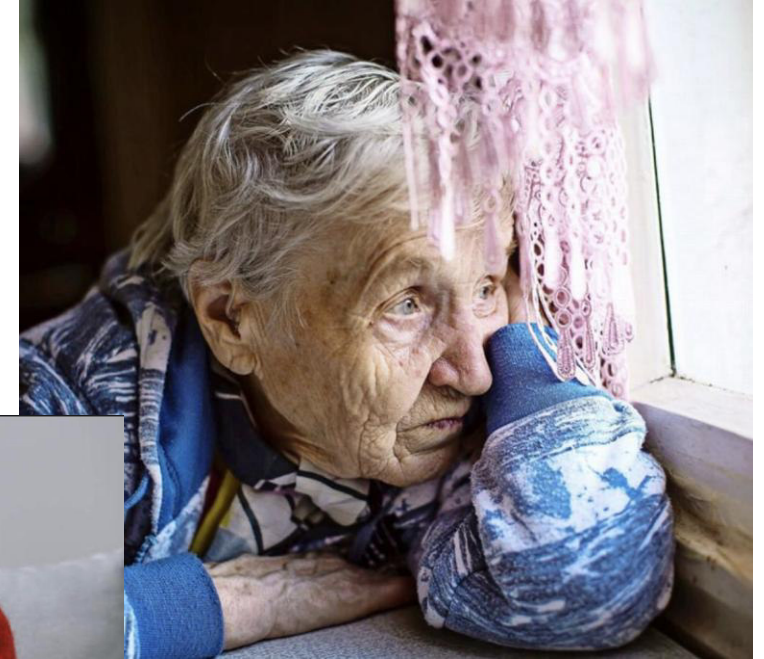
117,898 results

RESULTS BY YEAR



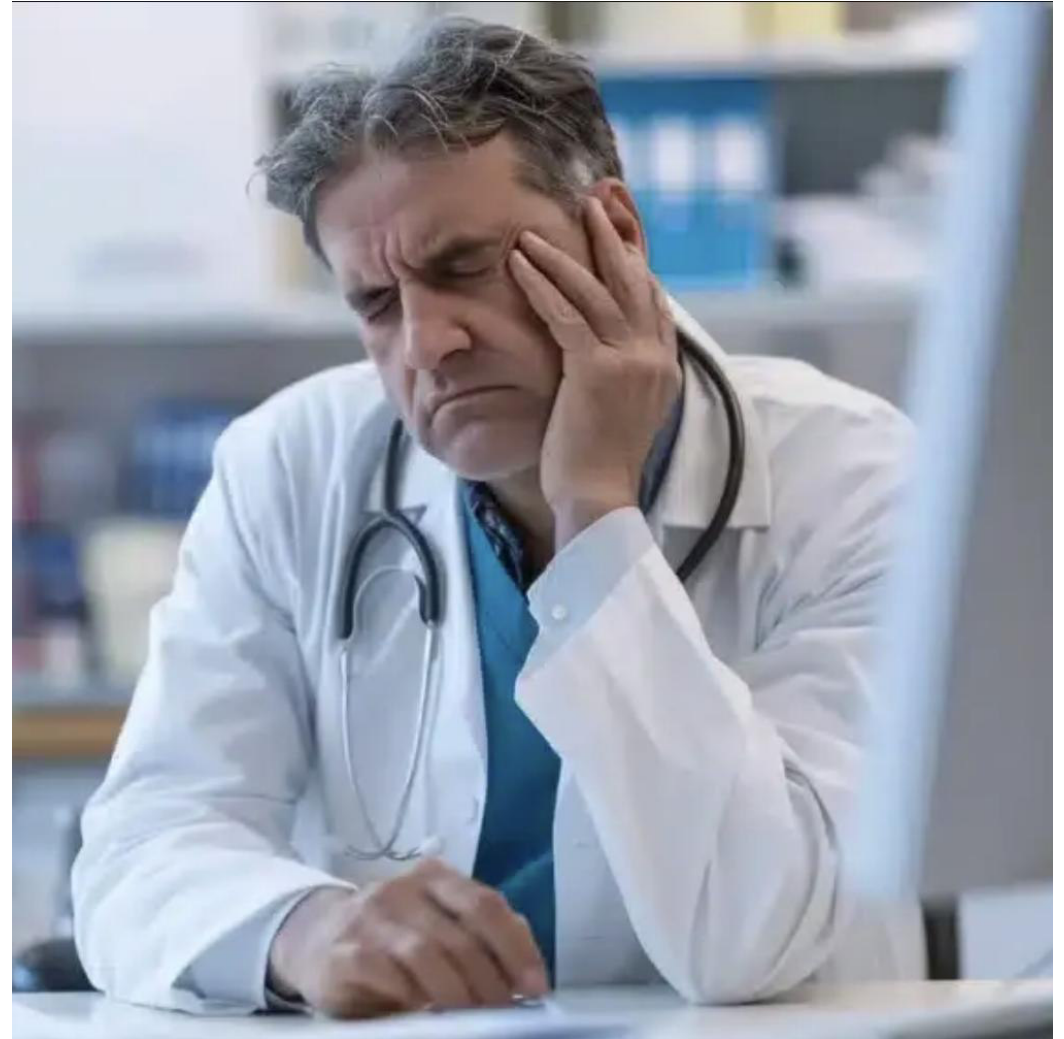
Patients present with:

- >Chronic pain
- >Stiffness
- >Reduced mobility
- >Weight gain
- >Depression
- >Vicious circle of decreasing quality of life!



What makes it even worse....

- > Chronic complaints „no doctor listens to me....no doctor has ever helped me...”
- > “Abuse” of diagnostic imaging
- > Still working population: Absence from work, necessity of retraining, risk of losing the job
- > Financial burden (public health system and private) not to be underestimated !





**Who in the audience has already experienced
symptoms of osteoarthritis?**

What can we offer these patients?

- > Pain medication
- > Physiotherapy & orthoses
- > Surgery
- > and also low dose radiotherapy.
- > But only in the right context and with a solid indication!

A brief look into history

Wilhelm Konrad Röntgen discovered the x-rays in November 1895 and renounced a patent!

As a result of which his x-ray apparatus spread more quickly.



> „ My inventions and discoveries belong to the general public and should not be preserved by patents, license agreements and similar individual companies“

He was awarded with the Nobel Prize in 1901 and donated the prize money of 50.000 crowns (ca. 350.000 Euro) to the University of Würzburg.



Application of x-rays with a therapeutic approach

- > Alexej Petrovic Sokolow (1854-1928): Therapy against painful inflammatory disorders of the joints
- > Günther von Pannewitz (1900-1966)
„Röntgenreizbestrahlung“ for degenerative disorders (pain score named after him!)

Dangerous use of x-rays in shoe-shops until the 1960ies



HOW DOES LDRT WORK?

- > Anti-inflammatory effects through immune modulation
- > Reduced proinflammatory cytokine expression
- > Promotion of tissue repair
- > Effects where found in animal models and clinical studies

> (Front Immunol Th. Weissmann et al: **Low-Dose Radiotherapy Leads to a Systemic Anti-Inflammatory Shift in the Pre-Clinical K/BxN Serum Transfer Model and Reduces Osteoarthritic Pain in Patients** 2022 Jan 3:12:777792.)

> (Int Immunopharmacol Guorong Ma et al: **Modulating systemic anti-inflammatory response mitigates osteoarthritis progression and associated pain after low-dose radiotherapy** 2025 Jun 17:158:114815.)

MOST RECENT CLINICAL STUDIES WITH POSITIVE EFFECTS

- > LDRT provides **pain relief in 60-90% of treated cases**, with the most favorable results achieved using fraction doses between 0.3 and 0.7 Gy. (Clin Transl Oncol. 2025 Apr 27. B Alvarez et al: **Implementing a low-dose radiation therapy program for musculoskeletal pain disorders: tips, tricks, and essentials for clinical researchers**)
- > Retrospective single institution study in the US: Eighty percent of joints **showed significant pain improvement (von Pannewitz score 0-2) at end of treatment**, n= 69 patients, 168 joints (Int J Radiat Oncol Biol Phys 2025 May 9. B Koneru et al: **Low-Dose Radiation Therapy for Osteoarthritis: A Retrospective Single-Institution Analysis of 69 Patients and 168 Joints**)

CLINICAL STUDIES WITH NO SIGNIFICANT EFFECT

- > Osteoarthritis Cartilage 2018 Oct M J M Minden et al: **Lack of beneficial effects** of low-dose radiation therapy on hand osteoarthritis symptoms and inflammation: A randomised, blinded, sham-controlled trial
- > Osteoarthritis 2019 Jan Vol 78, Eilen A M Mahler: Effectiveness of low-dose radiation therapy on symptoms in patients with knee osteoarthritis: A randomised, double blinded, sham controlled trial (55 patients, split in two groups of 27 and 28 patients each)
- > Potential pitfalls: Low number of patients, probably incorrect definition of target volumes in the latter study, no CT based planning!

WHEN SHOULD WE THINK ABOUT LDRT FOR A PATIENT WITH CHRONIC PAIN DUE TO A MUSCULOSCELETAL DISORDER SUCH AS OSTEOARTHRITIS, BURSITIS, TENDINITIS?

- > Previous therapy without any significant positive effect
- > Long history of suffering („I have tried everything for the last years!“)
- > **Functional inoperability**
- > **Frail and old**
- > **The indication should be made carefully – and LDRT should be used as part of a holistic therapeutic concept!**

THE HOLISTIC APPROACH



FIRST VISIT: TAKE TIME!

- >How long have the symptoms been present?
- >When do they occur?
- >What treatment has already been given?
- >Are there similar cases in the family?
- >Occupation
- >Lifestyle & Leisure activities
- >Weight & Diet
- >How strongly is the quality of life impaired?

OCCURANCE AND DURATION OF SYMPTOMS

- > People with generally **heavy physical strain** due to their occupation (e.g. construction workers, freight forwarders....)
- > Occupational overloading of the legs due to **standing profession** (e.g. surgeons, hairdressers, factory workers, salespeople)
- > **Occupational overloading** of individual joints due to repetitive movements of the arms and hands (excavator and crane operators, roofers, factory workers)
- > Osteoarthritis after **accidents/fractures involving joints**
- > Osteoarthritis due to **congenital malformation or diseases in childhood** (e.g. aseptic femoral head necrosis, congenital hip dysplasia)
- > Pain due to **incorrect loading** (e.g. heel spur on the left side leading to painful arthritis of the right knee or hip)

CLINICAL EXAMPLES

- > **Frail:** Painful ankle joint/knees/hips: 80 year old man with severe arthrosis due to a lifetime of heavy work (e.g. farm work in rural regions), cardiovascular risks
- > **Forgotten:** Heelspur: Obese female patient recently started intense workout program „from zero to hundred“ including walking/jogging for many reasons (beginning of the year, new partner...). She has „forgotten herself“, no self care for many years
- > „ I have to look after 100 dairy cattle and five grandchildren – I don't have time to care of myself“

MORE CLINICAL EXAMPLES (NOT FRAIL AND FORGOTTEN BUT ALSO IN PAIN)

> Painful elbow:

- > Ambitious golfers , tennis players or weight lifters of any age and sex who typically intensify their training during the season (spring, summer)
- > Elderly men who clean the sidewalk in front of the house every day during heavy snowfall (winter)

> Painful wrist:

- > Trendsport Paddle! All ages!

> ALWAYS ASK FOR: Lifestyle, change of Lifestyle, new hobby, aggressive weight loss regimen, weight gain, sudden unusual loading/work !!!

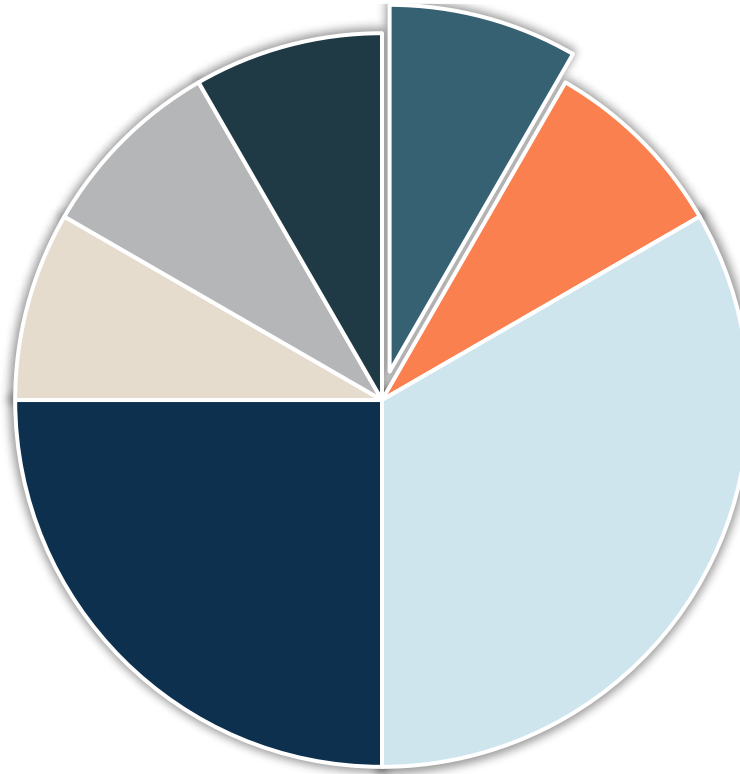
SELF EMPOWERMENT: WHAT PATIENTS CAN DO THEMSELVES?

- > Stop (or significantly reduce) doing what causes you pain!
- > But don't stop moving! Is there an alternative to your favoured sport or activity?
- > Start moving: Regular endurance sport without joint stress has an anti-inflammatory effect (and is also beneficial for other diseases of the elderly like high blood pressure, Typ II diabetes, high blood lipids...and cancer!)
- > Start muscle training, preferably with a coach/physiotherapist: Strong muscles and tendons protect the joints!

SELF EMPOWERMENT: WHAT PATIENTS CAN DO THEMSELVES?

- > Occupational overloading: Can working conditions be improved?
- > Orthopedic aids: Bandages, orthoses, insoles
- > Short-term relief of symptoms: Painkillers and muscle relaxants
- > Obesity: How to reduce weight? Change nutritional habits? How to (re)gain control:
Calory counting App, weight watchers, bariatric surgery
- > Further medical examinations: Check hormonal status, osteoporosis, rheumatic disease

THE HOLISTIC APPROACH TO PAINFUL MUSCULOSKELETAL DISORDERS



- Radiotherapy: LDRT
- Physiotherapy
- Self Healing: Life Style Change & Improving working conditions
- Orthopedics: Orthopedic aids, arthroscopy, joint surgery
- Psychotherapy

BEFORE THERAPY STARTS: INFORMATION, SIDE EFFECTS & CONSENT

- > One course = CT planning followed by 2 weeks of therapy, no interruption, 0,5 Gy/day every second day to a total dose of 3,0 Gy
- > Most important:
 - >1) Temporarily intensification of pain is possible (30 % of patients)
 - >2) Usually no pain relief at the end of the treatment
 - >3) Pain relief can be expected in 6-12 weeks after end of treatment, follow up exam after 6-8 weeks
 - >4) A second or third course may be necessary if pain relief is not sufficient

EPICONDYLITIS RADIALIS



EPICONDYLITIS ULNARIS



HEELSPUR, OSTEOARTHRHOSIS OF THE ANKLE



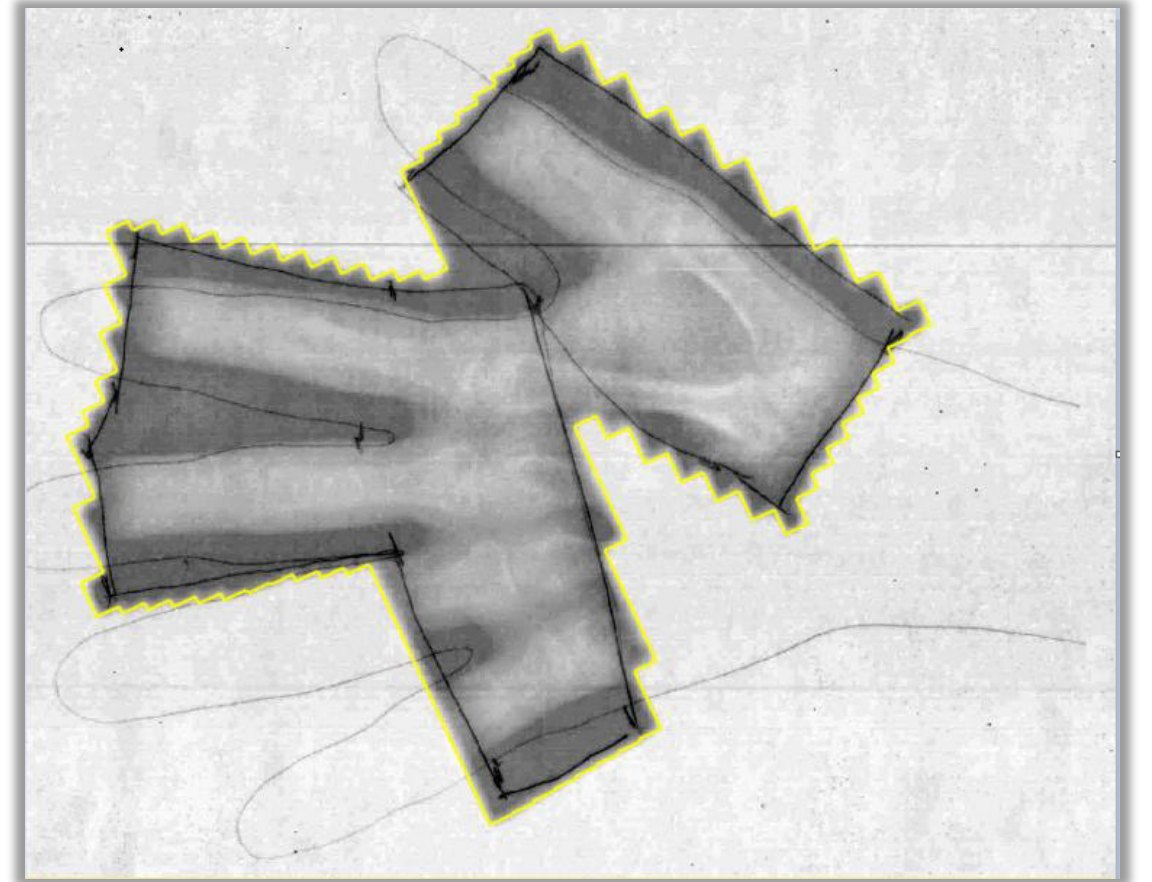
HEELSPUR



SMALL JOINTS OF THE HAND



SMALL JOINTS OF THE HAND



GROWING INTERNATIONAL INTEREST IN LDRT FOR BENIGN DISORDERS!

ASTRO'S 67TH ANNUAL MEETING
SEPTEMBER 27 - OCTOBER 1, 2025
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☒ **Nonmalignant Disease (7)**
☐ Palliative Care (1)
☐ Radiation and Cancer Biology (1)
☐ Special Session (1)

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Sunday, September 28

SEP 28
SH 10 - Nonmalignant Disease Science Highlights
8:00 AM - 8:30 AM PT
Nonmalignant Disease

Monday, September 29

SEP 29
EDU 18 - Radiotherapy for the Management of Non-Oncologic Diseases: How to Treat and Why It Works
10:45 AM - 12:00 PM PT
Nonmalignant Disease Radiation and Cancer Biology

WORK IN PROGRESS....

- > Standardized treatment protocols, including CT based 3D planning!
- > International benign target volume peer group (IBTVG) is currently working on standard definitions of target volumes for osteoarthritis:
 - > „Each participating institute of the IBTVG delineated their joint-specific target volumes using a standardized CT data “**homunculus**” of a male body. The individual institutional target volumes were then subsequently compared and harmonized within the IBTVG framework following the defined procedures of the **Delphi consensus process**.“



THREE-DIMENSIONAL TREATMENT PLANNING AND TARGET VOLUME DEFINITION OF OSTEOARTHRITIS – RECOMMENDATIONS OF THE INTERNATIONAL BENIGN TARGET VOLUME PEER GROUP (IBTVG)

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INTRODUCTION

Low dose radiotherapy (LDRT) is a well established and noninvasive method to treat osteoarthritis (OA).¹⁻³ However, no standardized approach currently exists for defining the appropriate 3D target volumes. A precise 3D delineation of the irradiated areas should be guided by accurate ICD diagnoses, appropriate joint- and site-specific imaging, and clearly defined target volume planning parameters. Within the framework of the International Benign Target Volume Group (IBTVG), we conducted a structured Delphi consensus process to systematically develop the recommendations for 3D target volume planning of each OA-affected joint site.

METHOD

Planning was based on the definition of the anatomical isocenter and CT-planning volumes along the spatial axes (x, y, z). The appropriate target volumes were defined as illustrated in the figures: (1) GTV (region of joint arthrosis), shown in orange; (2) CTV (pathological structures including the joint capsule and pain-relevant areas), shown in pink; and (3) PTV (CTV plus a 3–8 mm margin), shown in red. Each participating institute of the IBTVG delineated their joint-specific target volumes using a standardized CT data "homunculus" of a male body. The individual institutional target volumes were then subsequently compared and harmonized within the IBTVG framework following the defined procedures of the Delphi consensus process.

DISCUSSION & CONCLUSION

3D planning of OA target volumes is essential for the optimal LDRT application. It should be anatomically precise, pathology-oriented, and well established like in radiation oncology. Although initial efforts to define target volumes already exist²⁻⁴, some have extended the proposed PTVs, thereby encompassing uninvolved normal tissues.² Others such as the Spanish proposal by Alvarez & Montero et al.⁴ have relied solely on bony landmarks. However, OA affects not only the bone but also multiple joint-associated structures, making the joint capsule a more appropriate anatomical reference for target volume definition. The IBTVG 3D planning proposal improves anatomical accuracy and enables precise PTV delineation, which is relevant for LDRT to uphold the ALARA principle. It also serves as a basis for randomized clinical trials, clinical education, and the development of AI-based planning tools.

RESULTS

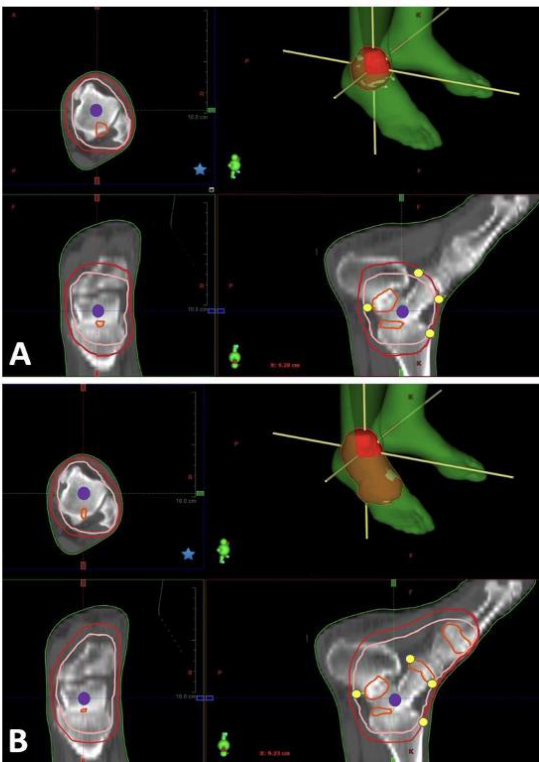


Figure 2: PTV Definition for the Ankle and Forefoot Osteoarthritis (combination)
A: the gross target volumes (orange) addresses the fibulo-talar and talo-calcaneal joints. B: the GTV also encompasses the calcaneo-tarsal and the tarso-metatarsal joints. The clinical target volume (CTV, pink) outlines affected bone and joint pathologies surrounded by the physical oriented planning target volume (PTV, red); the four yellow dots are positioned to indicate the joint capsule for orientation in sagittal planes; the isocenter is marked in purple.

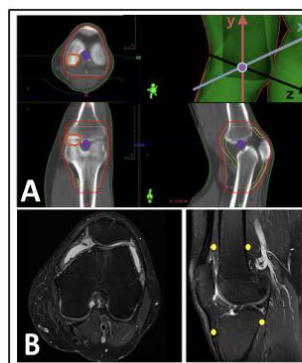


Figure 1: Illustration of the Cartesian coordinate system as a basis for planning and ICD coding of osteoarthritis
Left: Panels A & B display CT & MRI images of knee joint with the isocenter and corresponding radiation volumes delineated. Center: Illustration of the Cartesian coordinate system for spatial orientation in the human body, shown in frontal & lateral views. Right Below: Systematic mapping of OA localizations (e.g., shoulder, hip, knee) with their corresponding ICD-10 codes.

The isocenter is defined as biomechanical center of rotation across the relevant joint axes. The GTV is defined by bony and joint abnormalities, while the CTV encompasses all affected bony structures and pain-relevant inflammatory joint pathologies (e.g. any joint effusions, synovial inflammation, and osteo-chondral changes). The PTV finally defines the physical parameters. The joint capsule gives important anatomical orientation in all planes for the design of the target volumes. As part of the structured Delphi consensus process, the standardized target volumes were established for eleven common joint osteoarthroses sites on a unique CT body "homunculus". Clinical examination, added by advanced imaging modalities (e.g. MRI), provides essential information for accurately characterizing the joint pathology.

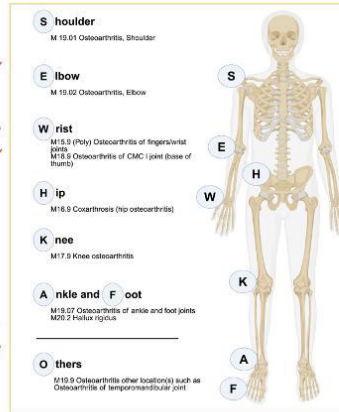


Figure 3: PTV Definition for two types of Shoulder Joint Osteoarthritis
A: Acromio-clavicular osteoarthritis with the isocenter (purple) centrally positioned in the articular region. B: Gleno-humeral osteoarthritis with yellow markings indicating the joint capsule. The expanded PTV in panel B reflects a symptom-oriented adaptation to the clinical presentation and extent of arthritic involvement (including a possible joint effusion).

REFERENCES

- 1 Dove A et al., The Use of Low Dose Radiation Therapy in Osteoarthritis: A Review. IJROBP 2022, 2 Yu JB et al., Radiation Therapy for the Treatment of Osteoarthritis, Practical Radiation Oncology 2025
- 2 Muecke R, Micke O, Seegenschmied MH, et al. S2 guideline of the German Society for Radiation Oncology (Version 3.0 DEGRO) 2024. 4 Alvarez B & Montero A, et al. British Journal Radiology 2024.

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Prof. Dr. med. Michael Heinrich Seegenschmied, MD, PhD prof.seegenschmied@gmail.com

WORK IN PROGRESS....

- > More prospective (randomized, sham controlled) clinical studies with larger patient groups
- > Clarifying the potential cancer induction risk
- > Interdisciplinary and holistic approach (like for cancer therapy)
- > Training courses for interested colleagues, e.g. RT-ABC by Richard Shaffer, UK <https://online.rt-abc.com/course/online-course>



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enabling
healthcare
potential

Thank you !