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Medical Exposure in Radiotherapy

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INTRODUCTION

DEFINITION

<u>Medical exposure</u> is an exposure

- Incurred by patients as part of their own medical or dental diagnosis and treatment
- Incurred by persons, other than occupationally exposed, knowingly while voluntarily helping in support and comfort of patients
- Incurred by volunteers in a program of biomedical research involving their exposure. (1.)

In radiotherapy supporting persons and volunteers are typically not exposed to radiation as they are not in the treatment room during the irradiation.

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MEDICAL EXPOSURE IN RADIOTHERAPY

In radiation therapy, patients are exposed to radiation

- Diagnostic exposures (such as diagnostic X-Rays and CT scans)
- Planning exposures at planning CT
- Therapeutic exposures in radiotherapy
- Verification exposures (such as portal imaging) (1.)

AIM OF MEDICAL EXPOSURE IN BREAST CANCER TREATMENT

With the breast cancer there can be different treatment methods. Usually, surgery is first. The two types of surgery used to treat breast cancer are mastectomy (removal of the entire breast) and lumpectomy (breast conserving surgery). Lymphadenectomy can also be done. Radiation therapy is often given after surgery to destroy any cancer cells that may remain after surgery. (2-4.)

In the mamma saving therapy the primary tumour volume is usually first surgically disposed. Then there usually is an adjuvant combination treatment of radiotherapy with chemo or hormonal therapy. This adjuvant treatment is applied to *prevent from local recurring*. In this radiation therapy the whole mamma is irradiated. (2-4.)

In the ablatio mamma therapy the patient's thorax wall will be irradiated. Aim is to *reduce the change of a local regional recurrence*. The treatment depends on the survival probabilities and the side effects in short and long terms, the chance of recurrence and the cosmetic outcome. (2-4.)

JUSTIFICATION

Medical exposures in radiotherapy should be justified by **weighing the diagnostic or therapeutic benefits they produce against the radiation detriment** they might cause, taking into account the **benefits and risks** of available alternative techniques that do not involve medical exposure.

The exposure must be **prescribed by a medical practitioner** who has the ultimate responsibility for the patient.

Patient must be fully informed of the risks of medical exposure. (1.)

OPTIMIZATION

The aim of medical exposure in radiation therapy is to **deliver enough radiation in the tumour to damage it without irradiating normal tissue to a dose that will lead to morbidity**. The protection against radiation is important because of the harm of the radiation in patients. **The tumour control should be greater than the damage in the healthy tissue.** This optimization is a major task in radiotherapy and it must be considered in every phase of the planning and treatment process. (1.)

EXAMPLES OF OPTIMIZING OF MEDICAL EXPOSURE

IRRADIATION TECHNIQUES

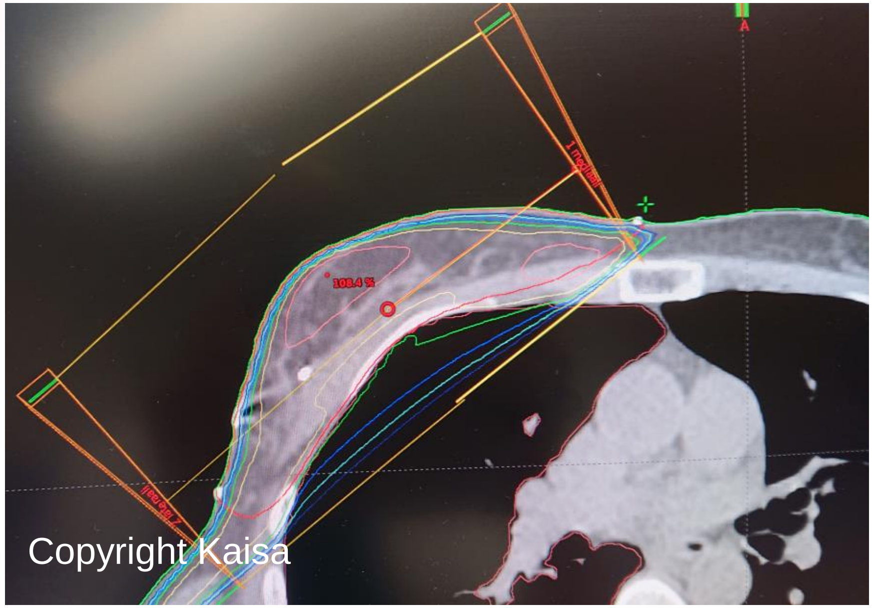

Figure 1: Tangential fields in breast radiotherapy

For radiation therapy on the breast, techniques called Three-Dimensional Conventional Radiation Therapy (3DCRT), intensity modulated therapy (IMRT), or volume modulated arch therapy (VMAT) can be used. Typically IMRT and VMAT techniques, compared to 3DRCT, provide **better coverage, a better homogeneity and a lower total dose**. (5.)

Patient is typically treated either with two opponent bundles scratch fields over the whole mamma or with tangential volumetric modulated arc therapy. This is to **lower the dose in the lung tissue** (figure 1).

The fields typically have a photon energy of 6MV. The scratch field on the side of the thoracic wall should be divergence free to **lower the dose in the lung tissue**. (2,6.)

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IRRADIATION TECHNIQUES

To prevent recurrence a booster dose is sometimes prescribed. The booster **decreases the change of a recurrence**, but it also extents the treatment time and the change of fibrosis formation of the mamma tissue. (2, 7.)

The booster in the treatment planning can be planned sequential or via the Simultaneous Integrated Boost (SIB) technique. In the sequential technique there is a separate treatment planning for the scratch fields and the booster. For the SIB technique the booster is taken into the treatment planning of the scratch fields. The profits of the SIB technique are a smaller treated volume and a better dose distribution. This is better for the cosmetic outcome. For the same radiobiological effect, with the use of the SIB technique, the patient has less fractions in total. (2, 7.)

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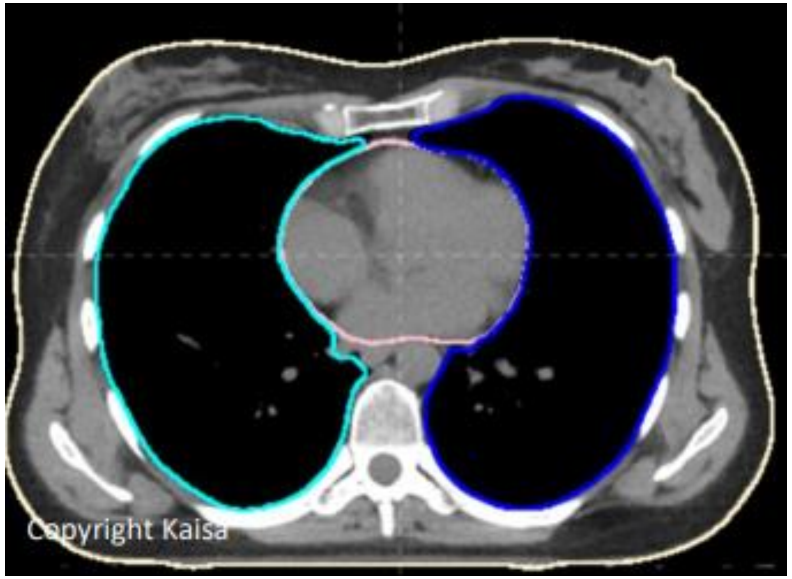
ORGANS AT RISK

The organs at risk (OAR) are the heart, the lungs and the contralateral mamma.

To predict the toxicity of the OARs (and severity of side effects) the **dose is calculated and visualised** in treatment planning software. The side effects have a threshold value **which should not be exceeded in order to reduce side effects**. (4.)



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HYPOFRACTIONING

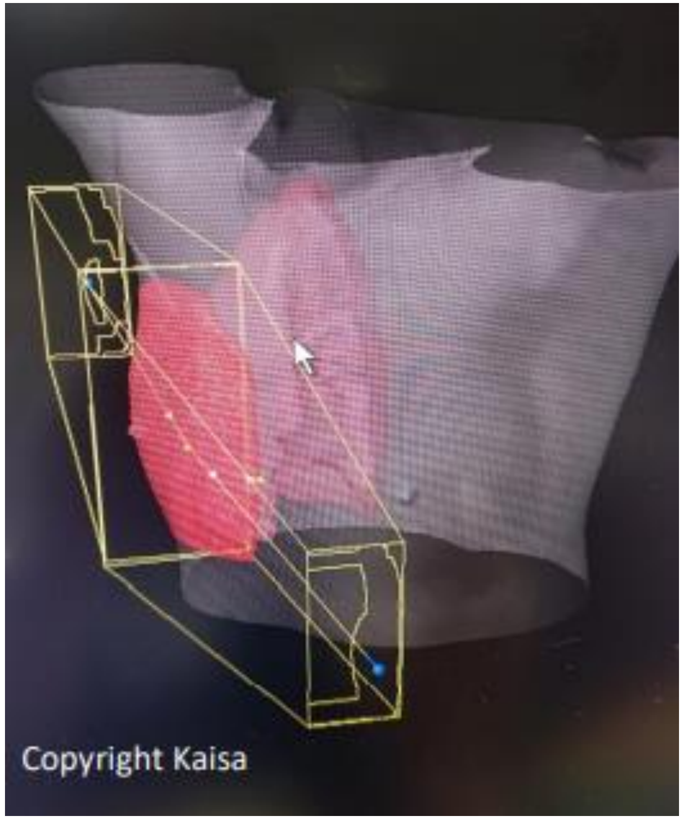
Hypofractioning is an optimization technique where, compared to conventional fractioning, patient receives per fraction a higher dose, but the received fractions are reduced so that the patient receives a **lower total dose**.

Hypofractionation leads to the **same 10-years local recurring chance and a comparable cosmetic result**. Fractions used for treatment plannings for mamma carcinomas are typically 15 to 16 times. (2, 3, 7.)

PATIENT POSITIONING

The patient is positioned with their hand up. By this the **arm of the patient is not in the bundle field**. The patient lays in a supporting pillow which creates a little slope. The supporting device is steep so the mammae is positioned flat and it prevents that the mammae falls towards cranial. By this the **lung tissue can be spared**. (2.)

For left sided breast irradiation the treatment is typically performed in deep inspiration breath hold. This **lowers the dose of the heart** because of the expansion of the thorax. This is visualised in figure 4. (2-3, 8.)



TREATMENT MONITORING

Radiotherapy treatment is monitored by portal imaging. Portal imaging **detects positioning errors and confirms the site of treatment delivery**. Before each treatment, the position of the patient is matched by kilovoltage (kV) or megavoltage (MV) imaging to ensure the position. (2.)

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