

Project CyberKnife Center



Prelude Project CyberKnife Center

CyberKnife radiosurgery: Modern tumor therapy

CyberKnife Indication List

Comparison of conventional treatments for cancer therapies

Prelude

Cancer is one of the leading causes of death. The classical pillars of cancer treatment are surgery, chemotherapy and radiation therapy. Recently **radiosurgery** (high dose focused radiation therapy) has become a pillar of its own in cancer treatment.

One of the most modern systems for radiosurgery today is the **CyberKnife robotic radiosurgery system** manufactured by the US Company Accuray Inc of Sunnyvale, USA and mostly developed by German Engineers such as Prof. Achim Schweikard of the University of Lübeck, Germany. About 270 systems are in use worldwide and more than 200,000 patients have been treated until today, 50,000 alone in 2012.

The **CyberKnife Center Northern Germany** – referred to as **German CyberKnife Services** - has in the very few years of its existence gained an excellent medical and especially technical reputation worldwide through its unique CyberKnife and Radiosurgery experts led by Prof Jürgen Dunst and Prof. Achim Schweikard of the University of Lübeck.

Due to this the demand by domestic and foreign colleagues for special qualification and training courses on site in Güstrow as well as the wide range of requests for technical and medical consultations on CyberKnife to the specialists in Güstrow is very high. Also the experts of the CyberKnife Center Northern Germany contribute highly regarded work within the work groups of the **German Society for Radiation Oncology** (DEGRO) with its current president Prof. Dunst, the International Radiosurgery Society (RSS) and the Accuray Exchange of Radiation Oncology (AERO) group.

Of particular importance for the excellent medical standards at the CyberKnife Center Northern Germany is its contractually guaranteed membership in the **Baltic Medical Network** including in particular the 4 universities of Lübeck, Kiel, Rostock and Greifswald, and major hospitals in Northern Germany. This guarantees all patients requesting treatment at the CyberKnife Center Northern Germany the full range of advanced cancer therapies rather than “only” radiosurgery. Which treatment or combination of treatments is used for a specific case is determined by expert “tumor boards”, in which the leading specialists of the network work together.

In addition, the well-known experts from the respective medical and technical fields of the Baltic Medical Network form the **Scientific Advisory Board** (SAB) of the CyberKnife Center Northern Germany led by the direction of Prof. Dr. Dr. h.c. (mult.) Horst Klinkmann (F.R.C.P.) and Prof. Dr. med. Jürgen Dunst (Past

President DEGRO). This board is dedicated to drive new medical and technical studies for the CyberKnife, Radiosurgery and new therapeutic cancer treatments in Germany and worldwide.

A high priority of the SAB is the direct integration of the CyberKnife Center Northern Germany into the research and development projects of the Lübeck **Institute for Robotics and Cognitive Systems** which consists of the development of control algorithms for the CyberKnife as well as of comprehensive system quality assurance for Radiosurgery for many years now. This ensures the CyberKnife Center Northern Germany worldwide first access to new technical developments of the CyberKnife system, as well as a comprehensive CyberKnife quality assurance workflow. The results of this research and development activity is and will be found in new soft- and hardware packages and solutions of the CyberKnife implemented by its manufacturer Accuray Inc (USA) and for quality assurance by third vendors.

Based on this outlined excellent medical and technical competence of the CyberKnife Center Northern Germany and with its unique partnerships in industry and academia and taking into account the worldwide high reputation of "Health Made in Germany" a special offer at the international level, the "**CyberKnife Project**", has been developed and is now presented here.

This CyberKnife project contains all hard- and software components and even includes their basics and advanced usage training that are required for a CyberKnife center, not just the CyberKnife, including all imaging technology such as CT and MR and all testing and measurement tools (Physics Work-Tools) for verification of their functionality and reliability and for comprehensive quality assurance aligned with the high **German Standards** and in accordance with international regulations, guidelines and recommendations. Also within this project structural and radiation protection requirements for the building and the rooms where the technology is operated will be provided. Of course any adjustments to specific operator requirements to this default configuration are possible.

In addition a range of additional services of the CyberKnife Center Northern Germany such as **marketing material and concepts or remote consultancy** programs are presented.

If you are interested, we are happy to provide further details.

CyberKnife radiosurgery: Modern tumor therapy

1. CyberKnife Method

- Image-guided high-dose radiotherapy (radiosurgery) by the robot-guided linear accelerator CyberKnife (Accuray, USA)
- External high-energy X-ray irradiation to locally defined target structures as outpatient treatment in a few sessions

2. Indications

Small and locally defined tumors as an alternative to conventional surgery and radiotherapy, after pre-treatments without any further therapeutic option or as an additive method to maximize treatment effectiveness (see Appendix 1: Comparison of treatment methods):

- An operation is not advised or only performable at increased risk due to age, general condition, existing comorbidities, high anesthetic risk or location of the tumor
- Conventionally fractionated radiotherapy is less effective due to the specific resistance of the tumor or due to pre-treatments radiotherapy no longer feasible
- Conventionally fractionated radiotherapy over several weeks provides a relatively higher burden on patients in terms of increased risk of side effects, repetitive ambulance services, job loss, and reduced quality of life

Indication for intracranial and extracranial targets, even in moving organs (see Appendix 2)

3. Added value for the patient

- Outpatient treatment: non-invasive, painless, less stressful
- Significantly shorter duration of therapy than other methods
- High precision of the CyberKnife minimizes the radiation exposure
- This will reduce the risk of side effects and without the fixation of the patient

4. Added value to the healthcare system

- Outpatient treatment with foreseeable cost structure (other than surgery)
- Reduce travel costs by reducing number of therapy sessions
- Reduced risk of side effects due to high precision treatment
- This will prevent sick leave, long lost work time and medical rehabilitation
- CyberKnife is a treatment option with a high annual savings

5. Benefit of a German cooperation

- Information regarding viable CyberKnife treatments and their benefits in your country
- Offering of this treatment to your patients in leading German CyberKnife centers today
- This will establish CyberKnife Treatment until there is a center in your own country
- Integration of the CyberKnife through extensive help from Germany: intensive planning and training by German engineers who helped develop the technology
- Secure long-term quality of the radiosurgical treatment in your own country

Indication List

Currently treatable tumors (up to 5 cm, clear definable):

Skull, brain, neurocranium
Trigeminal neuralgia (tic douloureux)
Arteriovenous angiomas
AVM in neurocutaneous syndromes
Dural arteriovenous fistulae
Acoustic neurinomas
Schwannomas (neurinomas of other cranial nerves)
Neurofibromas of the cranial nerves
Meningiomas (WHO grades 1 and 2)
Anaplastic (malignant meningiomas) (WHO grade 3)
Cerebral metastases
Sarcomas or metastases from sarcomas
Choroid metastases
Hemangioblastomas
Gliomas
Ependymomas
Subependymomas
Plexus papillomas
Central neurocytomas
Neuroblastoma of the olfactory nerve
Neuroepitheliomas of the olfactory nerve
Pineocytomas
Transitional (mixed pineal tumors)
Hypothalamic neuronal hamartomas
Adenomas of the pituitary gland
Tumors of the pituitary gland
Craniopharyngiomas
Paragangliomas (chemodectomatoses, glomus tumors)
Chordomas
Chondromas
Malignant hemangiopericytomas

Skull base, viscerocranium, neck
Nasopharyngeal carcinomas
Viscerocranial tumors
Tumors of the skull base
Paranasal sinus carcinomas
Tumors of the neck region

Spinal column, nerve roots, skeleton
Spinal metastases
Spinal tumor pain
Spinal osteosarcomas
Spinal leiomyosarcomas
Spinal Ewing sarcomas
Spinal gliomas
Spinal hemangioblastomas
Spinal vascular malformations
Spinal schwannomas
Spinal meningiomas
Chordomas of the spinal column

Total body, moving organs
Lung tumors (bronchial carcinomas, metastases)
Pancreatic carcinomas
Liver cancer, liver metastases
Renal cancer, adrenal cancer
Prostate cancer
Irresectable local recurrences from breast cancer

Further tumors, treatable with the CyberKnife
Colon
Gall bladder
cervical
Endometrial cancer
Ovarian carcinoma
Testicle cancer
kidney
heart

Comparison of conventional treatments for cancer therapies

	Method		Advantages		Weaknesses / Cons
1.	Operation	1.	Everywhere available and established	1.	Treatment risk e.g. by anesthesia, infections and co-morbidities
		2.	Tumor is completely removed	2.	Pain and possible injury and damage to healthy organs
		3.	No size or amount limit of solid tumors	3.	Expensive after treatment costs (rehabilitation)
		4.	Minimally invasive procedures possible	4.	Long treatment time and also long downtime of the patient
		5.	Goldstandard therapy for nearly all tumor types	5.	Operation expensive up to over 20,000 €
2.	Radiation therapy (x-rays, brachytherapy, protons, but not heavy-ion)	1.	Organ-preserving therapy without surgical risks	1.	Long treatment time of about 4-6 weeks
		2.	Utilization of radiation biology (large effect in cells with frequent cell division: Tumors)	2.	Only limited doses possible due to inaccuracies of the systems, resulting in higher likelihood of complications and side effects
		3.	Favorable costs of < 4500 EUR (except protons) and follow-up with short treatment times of <5 min	3.	As a result, and due to the long treatment times, high downtime of patients and follow-up costs
		4.	Goldstandard therapy of many tumors, treatment of large and tissue connected tumors, postoperative and prophylactic treatment possible and effective	4.	Ablative completely destructive effects on local tumor rather limited, except for brachytherapy (implantation of radionuclides), which in turn is an invasive procedure again
3.	Chemotherapy	1.	No surgical procedure and associated risks	1.	Long and expensive treatment, chronic therapy possible
		2.	Effective systemic Goldstandard therapy, particularly with metastasis and circulating tumor types	2.	Complications / side effects sometimes at the limit of tolerance with significantly reduced quality of life
		3.	Fast simple palliative therapy	3.	For primary tumors rarely an effective treatment

		4.	Postoperative and adjuvant possible and effective	4.	For solid tumors only effective in the short term
4.	Radio-surgery for example CyberKnife	1.	Organ-preserving therapy, so no surgery needed and associated risks	1.	Restriction to locally definable tumors up to a size of 6 cm and a maximum of 5 tumors (5-10% of all cancer patients)
		2.	Utilization of radiation biology, as well as the destructive ablative radiation dose for solid tumor component	2.	High investment costs (though much smaller than proton facilities which are as effective), high maintenance and technical understanding needed
		3.	Very high accuracy required, hence high local treatment effectiveness possible and side effects are rare	3.	Exponential distribution of the CyberKnife without spread of Expertise (application without expert training)
		4.	Short outpatient treatment under 1 week with 1-5 short treatment sessions under 1 hour	4.	Because of the novelty of the CyberKnife treatment insufficient long-term results for some cancer treatments (> 10 years)
		5.	Goldstandard treatment for many tumor types, re-treatments and combined treatments (better response / break of chemotherapy / radiotherapy boost)	5.	Higher costs than radiotherapy alone, but locally much more effective with fewer risks if applied correctly (e.g. lung tumors: radio-chemotherapy 30-50% versus radiosurgery 90-100% local tumor control!)
		6.	Favorable treatment over surgery or protons, with comparable results and fewer side effects	6.	Lower costs than surgery or combined radio-chemotherapy, but also higher costs for the health care system: Re- and combination treatments, bringing thus a prolongation of life for the patients which is clearly not a down side for the health care system and county providing this method
		7.	With CyberKnife very high patient comfort and high safety of the treatment (Goldstandard system)		