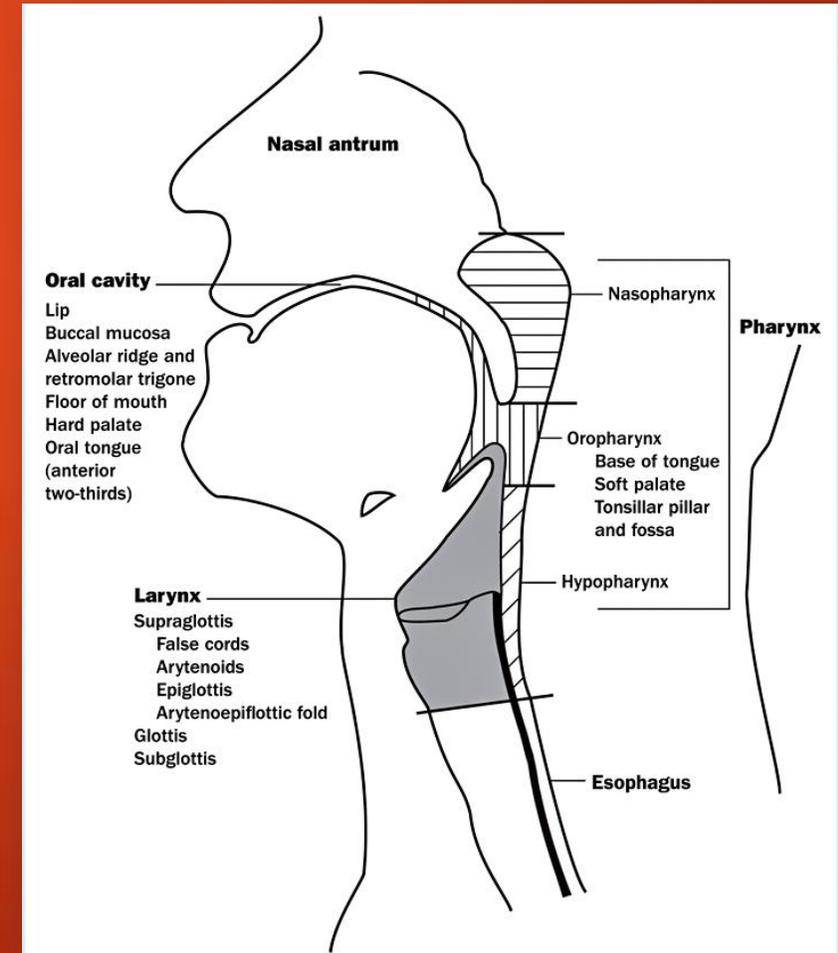
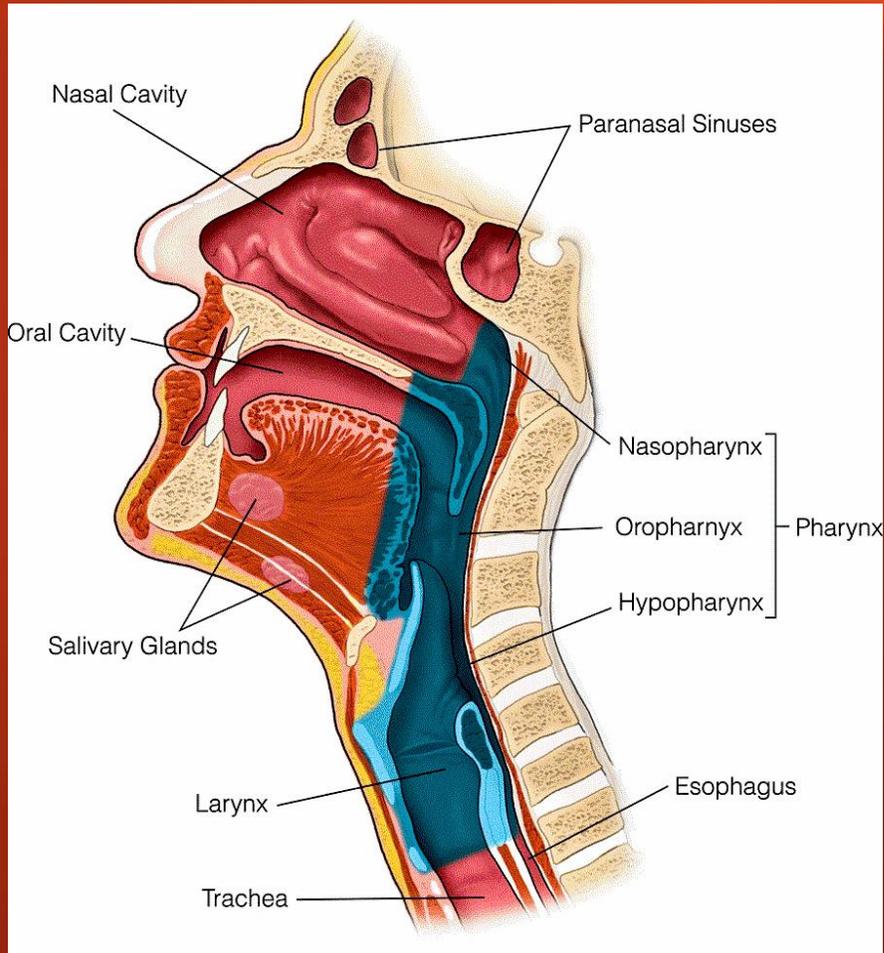


Addressing the specific  
situation in the positioning  
and immobilization of  
patients for RT of the neck  
region

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RTT - DAVOR PRODANOVIĆ, IORS BELGRADE

The use of radiotherapy in the region of neck often faces specific challenges relating to the postulates of the radiotherapy. And this is the necessity of using large doses of radiation to the tumor and the target accurately, to hit homogeneously full volume, and with minimal radiation dose to surrounding healthy tissue. A specific approach to radiation in this region is conditioned by the anatomy and organs of risks, which are often close to the most common cancer locations of the neck region.

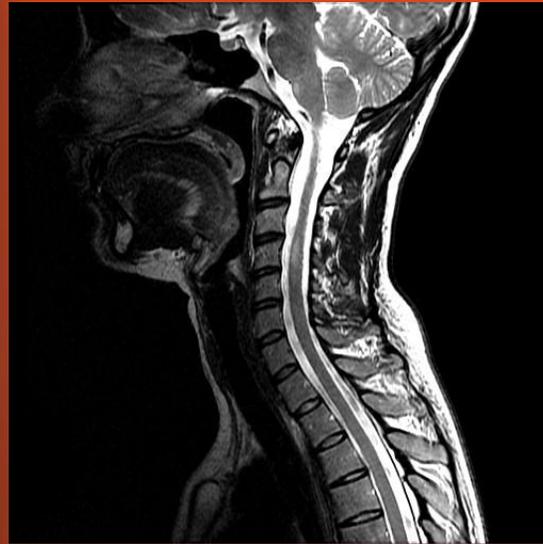
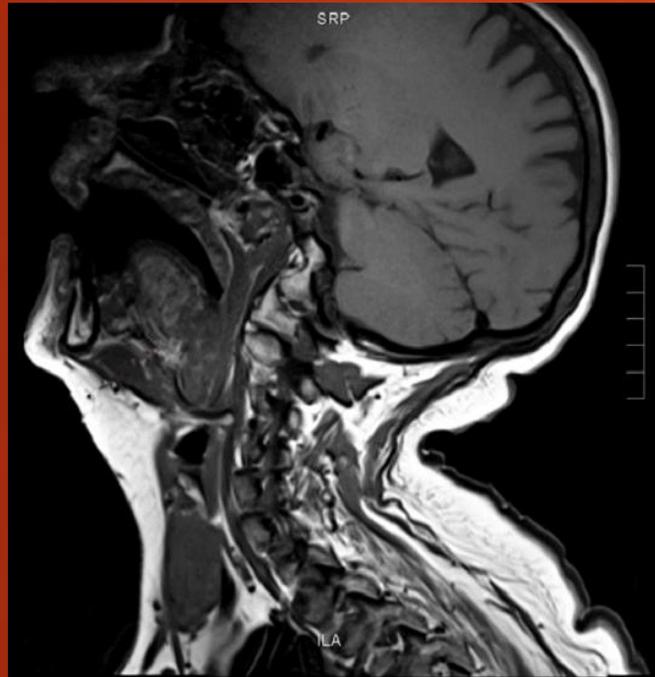


The physiological movements of the head and neck, as well as the anatomy of the region are a precondition, that the patient and neck region, must adequately positioned and immobilized, for purposes of the application of radiotherapy.

The mobility of the head and neck is in all directions, as well as their rotation, extension, and flexion.



Everyday RT planning and implementation of radiation requires to approach each of them individually and to take into account all the specificities of the disease and its location, the anatomy of the patient, his physical and mental condition, the manner of application of the RT, as well as the equipment that we have in our radiotherapy centers, which relate to the positioning and the immobilization of the patients.



One of the main anatomical conditions that dictate the proper choice of immobilization equipment is the appearance of the cervical spine.

Easier access to the planning RT and immobilisation that we use and the way we apply the radiation, have patients with long, curved necks, low set, drooping shoulders, which make us free access to the neck region. Location of the tumor causes us to pay attention to the organs of risk and adequate fixing and immobilization of the patient, maximum isolate the tumor from them. The spinal cord, parotid and submandibular gland, the thyroid cartilage of the larynx glottis, teeth, neck muscles are some of the organs of the risk. We should avoid the bad side effects of radiation: painful and difficulty swallowing, mucositis, xerostomia, etc..



Target the tumor, with the exception of normal, healthy tissue, and in a larger number of identically repeatable radiotherapy treatments carried out the same activity, requires adequate, often individual immobilization equipment. Some of the basic standards that immobilization equipment manufacturers are trying to follow are:

- Adequately immobilize the target region.
- Comfortable for the patient.
- More times repeatable.
- With minimal attenuation of the radiation beam.
- Financial - price available.
- Easy to use.



## Some of the characteristics that immobilization equipment should have

- With immobilization, we place the patient at the optimum position, so to minimize the complications of the healthy tissue.
- Equipment must not constitute an obstruction to the passage of the radiation beam to the target region.
- The equipment must be compatible for use on RÖ simulator, CT / MRI and radiotherapy machines.
- It must not substantially increase the surface dose of radiation.
- To have adequate area to set up - marking reference points.
- That is sufficiently rigid and maintains constant over time the desired shape and form.
- That does not require a large staff for preparing and setting up immobilization equipment.
- That continuously produced and can be supplied by the manufacturer in a sufficient amount for a longer extended period of time.
- It does not require too much storage space.

Basically all immobilization systems of the neck region, of all manufacturers are parts of equipment that are under the patient and the one that is placed on the patient.

And this requires lying position of the patient on the table.

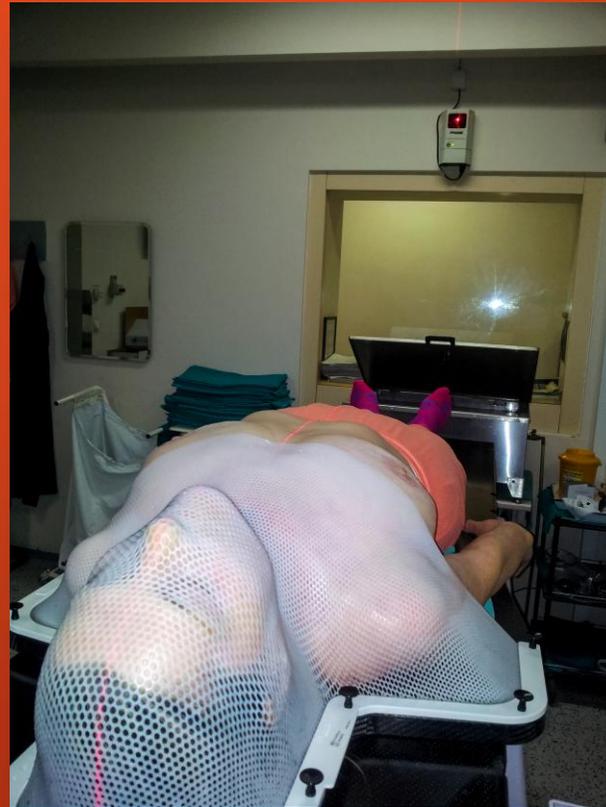
This meets the compatibility and repeatability of positioning of all devices in which the patient passes during radiotherapy procedures.



Mould room



CT



RÖ Simulator



Radiotherapy machines

Immobilization of the neck region, according to its specificity is not separated and generally not different from the immobilization of the head, but complement to each other because of their anatomy and equipment used in both regions make up one whole.

Systems for the immobilization of the neck region consists of:

- ❑ Fixator - equipment connector for a patient couch, according to the system of indexation.
- ❑ Base plates - solid material (carbon fiber); individually forming vacuum bags - pillows, foam-filled cushions - mold.
- ❑ Different head and neck supportors
- ❑ Thermoplastic immobilization mask.
- ❑ Additional fixators for the head and shoulders (Bite block, retractors for shoulders ...)
- ❑ An additional immobilization equipment that improves positioning and patient comfort (Supporters for knees, feet ...)

# Fixation of equipment for indexed patient table

## INDEXING BARS



**RE-6**  
For Siemens and Elekta



**RE-7**  
For Varian Exact



The base plate is the basis on which the patient lies and determines the position of the patient on the table and is also a place where we connect immobilization masks and other accessories. Made of carbon fiber, often filled with foam, low attenuated substances. It contains spaces for the reception of head and neck supports, immobilization masks and other equipment.

## OPTEK™ OVERLAY SYSTEM



The OPTEK™ system was developed to provide the highest degree of stability for the head, neck and shoulders. The system is ideal for IMRT and conformal treatments in a 360° arc. Dual-configured for adult and pediatric treatments.



**R630**  
OPTEK™ Carbon Fibre Overlay

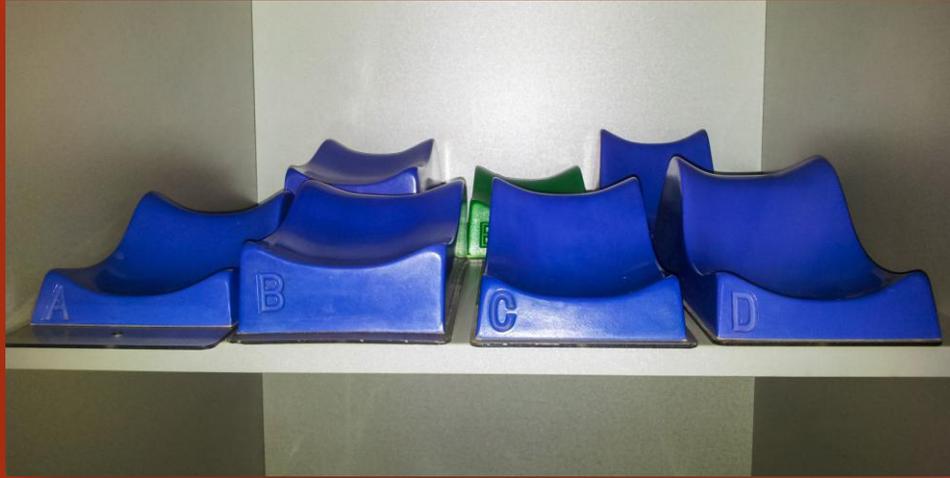


To put the neck of the patient in the desired, optimal therapeutic position is necessary to use different kinds of head and neck supports.

Depending on the specific case, we will select one from the large number of different types of head supporters, in terms of material, shape, size and position, on which will place the patient. They are classified as solid, formed shapes and those whose shape is modeled, and take shape of the head and neck of the patient which is modeled. They can be transparent, or filled with low-attenuated materials.



What makes the specificity in this region is the necessity of having a larger number, in many ways different supporters for the head and neck and their additional blocks and wedges which raise the head and neck, or bring the head and neck in a greater extension or flexion. What kind of model and form we choose the most dictates anatomy of the patient, as well as the location of the tumor. Choosing one of them leads to optimal, comfortable, stable and repeatable position of patients for RT.

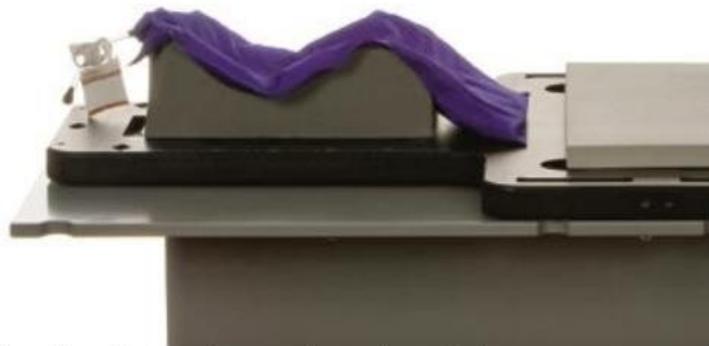


<p>Model 1 with lateral neck flaps AIO SOLUTION® code: <b>HS-NL-F</b> Article No. : 35755</p>		
<p>Model 2 without lateral neck flaps AIO SOLUTION® code: <b>HS-NL-N</b> Article No. : 35765</p>		
<p>Model 3 (age: 6-12 years) with lateral neck flaps AIO SOLUTION® code: <b>HS-PL-F</b> Article No. : 35753</p>		
<p>Model 4 (age: 6-12 years) without lateral neck flaps AIO SOLUTION® code: <b>HS-PL-N</b> Article No. : 35753ZF</p>		
<p>Model 5 with lateral neck flaps AIO SOLUTION® code: <b>HS-SL-F</b></p>		

<p>20 mm block AIO SOLUTION® code: <b>AC-BL-20</b> Article No. : 35703</p>	
<p>40 mm block AIO SOLUTION® code: <b>AC-BL-40</b> Article No. : 35706</p>	
<p>9° wedge AIO SOLUTION® code: <b>AC-WL-9</b> Article No. : 35704</p>	
<p>13.5° wedge AIO SOLUTION® code: <b>AC-WL-13.5</b> Article No. : 32424</p>	
<p>18° wedge AIO SOLUTION® code: <b>AC-WL-18</b> Article No. : 35707</p>	

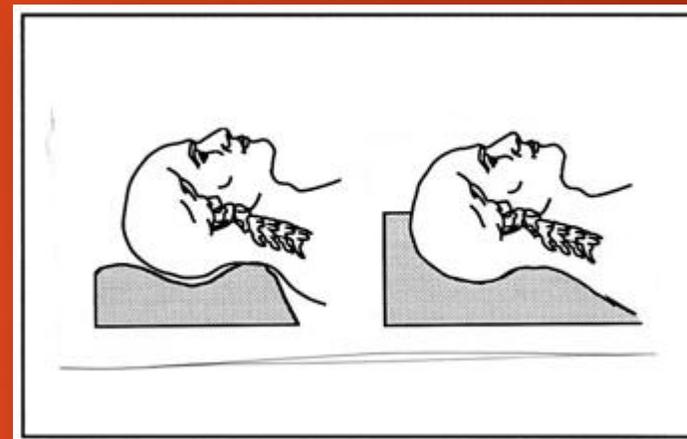
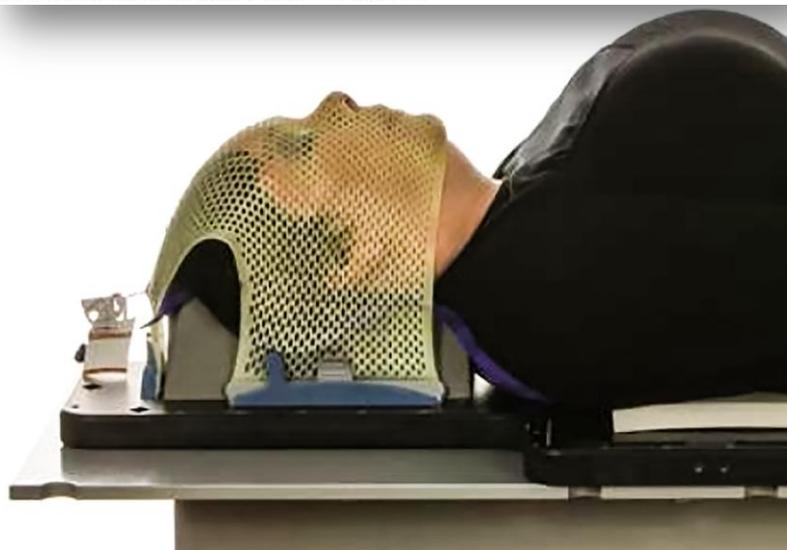
Forming pillows for head and neck are a special form of individual support for head and neck which fix the position of the patient.

The Individual Head Support is designed for use in combination with one of the standard HP head supports. It should be

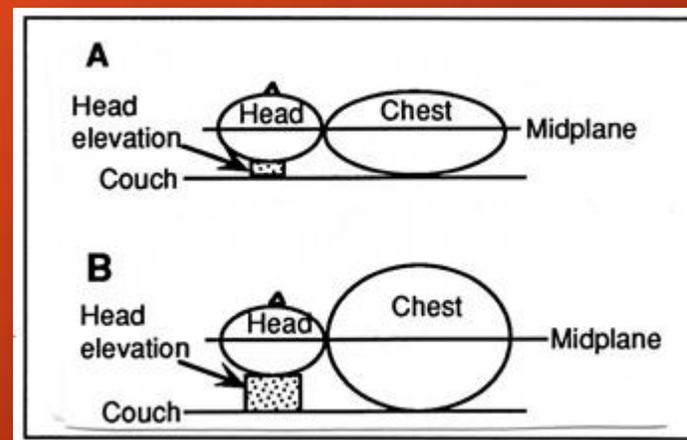


positioned on the head support as shown below.

This ensures that the vacuum bag follows the contours of the head support, which results in a highly reproducible position for each fraction. It also ensures that the patient's neck region is well supported. The final result is a highly accurate and patient dependant head and neck support.



The standard base plate in relation to the individual



The difference in the size and shape of the head and chest is one of the reasons why we prefer to decide for the forming pillows and use individual support for head and neck.

Individual head supportors represent a form plus compared to conventional head supportors because they form exactly according to the anatomy of the head, neck, and sometimes the shoulders of the patient, and still provide the breadth of work for the RTT, to set the neck region of the patient in the position required for optimal application of RT . Some of these supportors are repeatedly applicable and can be repeatedly used and the modeled, and some do not. A majority of these pillows is used in combination with conventional supportors for head and neck. They are made with a partial filling of polystyrene beads, and the rest of the bag is vacuumed, or are made of charging special thermoplastic material.

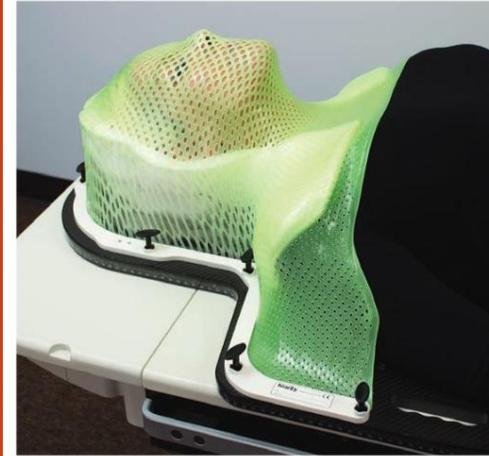


The use of modeling cushions that provide maximum individual support and immobilization of the head and neck may come as already prepared like this in a single package. Just need the matter, which cushion is filled with, a little splash with water and cause a reaction of matter, which is now ready for modeling. Then with a cushion we cover standard head support and set the patient to an adequate position. Time to shape these cushions, according to the anatomy of the neck gives us enough time to get these pillows totally adapt to the head and neck of the patient, which makes it very comfortable to use.



## Klarity Shell System™

*An ultra-precise, economical method for stereotactic cranial, c-spine and shoulder immobilization, where sub-millimeter margins are required.*



The Klarity Shell System creates a completely encompassing head support, stabilizing the head from above, below and all sides. The unique Klarity Shell guides and holds the moldable head cushion as it forms under and around the patients head. Shell size adjusts to meet any patient's head size thereby creating a comfortable yet rigid head or head and shoulders support that is unique to each patient creating a greater level of immobilization once mask is in place. After the cushion forms, the shell is removed and a Klarity thermoplastic mask is molded over the patient and the cushion, securing to the baseplate. The mask hardens to securely hold both patient and cushion, creating a comfortable yet highly rigid, fully encompassing, support. Configured for head only or head & shoulder immobilization.

## Cushion

Klarity

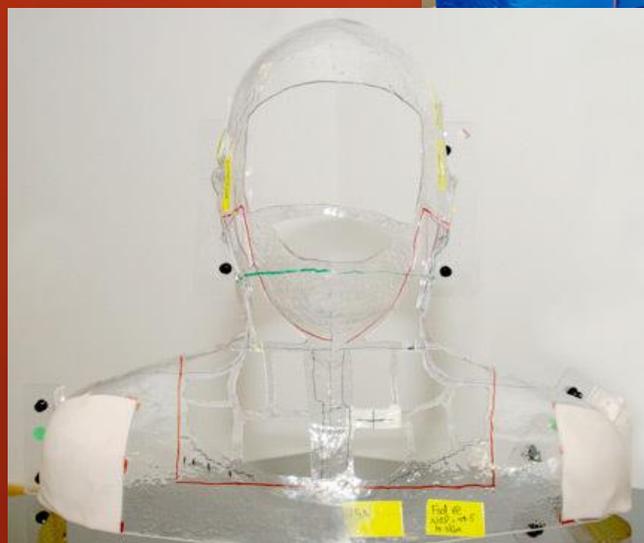


- Comfortable and extremely secure
- Once heated, cushions form easily and quickly
- Can be reheated and reshaped
- No odor

Thermoplastic mask is today already a standard, widely used part of immobilization equipment and applied as the immobilization of almost the entire body. Its use is particularly evident and the most common is the immobilization of the head and neck. All major manufacturers of radiotherapy immobilization equipment have in its offer various types of thermoplastic masks.

Although basically all the masks are made of the same or similar types of thermoplastics, each of the models of masks has its own specifics and in accordance with the needs, in an optimal, efficient, yet comfortable way to perform immobilization of patient neck.

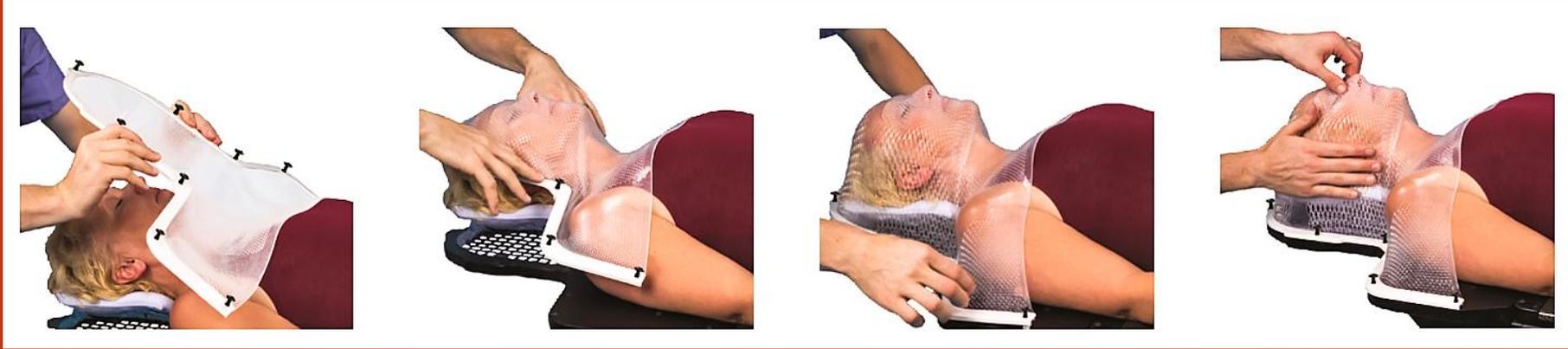
There are basically two types of masks, which differ in appearance and manner of making.



Perspex mask



Thermoplastic masks which are prepared by heating in "water bath" or thermal chambers.



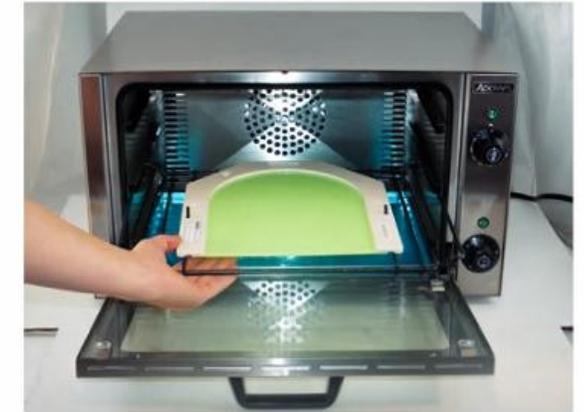
**Klarity**oven-plus™



**Finish:** stainless steel  
**Outer dimensions:** 27.5x27x12 in (70x68.5x30.5 cm)  
**Weight:** 100 lb (45 Kg)  
**Voltage:** 110V and 220V

**Klarity**oven-mini™

*Suitable for head masks only*



**Finish:** stainless steel  
**Outer dimensions:** 21x19x13 in (53x48x33 cm)  
**Weight:** 34 lb (15.5 Kg)  
**Voltage:** 110V

In the market of medical devices which refers to radiation therapy, there are several manufacturers of thermoplastic mask. In selecting purchases may decide the specifics of mask with which manufacturers come out in their offerings. Colors of mask are the least important thing, but useful in the way for distinguishing. Specifics that need more attention are the rigidity of molded mask that define the immobility of head and neck region, because on that way we reduce % of radiotherapy errors. Reinforcements on the masks are in body parts that tend to a larger moving. The time required for the "heating" of mask. As well as ways of connecting mask.



Patient Positioning Systems	ZENTEC™ Type S™ Uni-frame®	Standard White Type S Uni-frame	Mastercast™ Pro Posifix®	Posicast® Posifix
Description	Highly conforming to patient contours, this material provides a comfortable cast. It is our most rigid continuous frame mask.	Our core thermoplastic material offers proven performance in a variety of patterns and configurations.	Our most rigid material for drape and mold style masks. This material also offers reduced shrinkage compared to other masks.	This material offers high conformality and moderate hold.

### Heating Times and Temperatures

Thermoplastic Type	Heating Time	Waterbath Temp
Zentec™ (violet) IMRT Reinforced™ Mask	2 - 3 min	
Standard Perforation (white) Mask Head Only	4 min	
Standard Perforation (white) Mask Head Neck & Shoulders	6 min	
IMRT Reinforced (white) Mask Head Only	5 min	75° C / 165° F
IMRT Reinforced (white) Mask Head Neck & Shoulders	7 - 9 min	
Thermoplastic Strips (solid white)	4 min	
Breast Support Thermoplastic	6 min	
HipFix® Thermoplastic	7 - 9 min	
Posicast® Mask	1 min	70° C / 158° F
Mastercast™ Pro Mask	1 min	



Certain models of thermoplastic masks stand out more or less "openness," and for the purposes of making masks with claustrophobic patient can choose the ones with holes for eyes, nose, mouth, or full-face (open face). The benefit of an "open" mask is administered to the patient with the placed nasogastric tube, or patients with general anesthesia. Today, the offer includes and masks that do not crease, do not stick to, which prevents the creation of grooves, which increase the % of attenuation and require that the mask remodels, or re-create a new mask. Also important is the percentage of shrinkage masks after modeling, and represents a common problem that comes to the fore with the long wait for the start of RT and is particularly discomfort for patients. Sometimes with a change in weight of the patient, or a greater degree of swelling due to illness, it requires the creation of new masks and new planning of RT.



FreedomView

FreedomView IMRT Style 18 Head Only	
3.2 mm	MTAPUID1832CL
FreedomView IMRT Style 27 Head, Neck & Shoulders	
3.2 mm	MTAPSID27NR32CL
ClearVision Head Only	
3.2 mm	MTVRT20
PureVision Head Only, Reloadable	
3.2 mm	MTVRTR



## Nelepljive termoplastične maske

**Introduction:** Thermoplastics in Radiation Therapy have made great strides over the past twenty years. With all of the improvements, one main problem still exists, that being the shrinkage of the masks. This shrinkage causes the patients discomfort and in some cases the making of a new mask. We will look into this by comparing three different masks.

**Method:** Using the Klarity Green, Klarity White, and CIVCO head only masks we will look at the differences in shrinkage. All three masks were placed into a water bath at a temperature of one hundred sixty degrees Fahrenheit for two minutes. Each mask was removed and placed on a phantom head and left to dry. Once dry the masks were measured with a caliper. The masks were again measured after twenty four hours. The difference in the size would determine the percentage of shrinkage.

**Results:**

Characteristics	Results		
	Klarity Green	Klarity White	CIVCO
Thickness	3.2 mm	3.2 mm	3.2 mm
Molding Time	90 - 120 sec.	30 - 45 sec.	45 - 60 sec.
Drying Time	≅ 8 mins	≅ 5.5 mins	≅ 7 mins
Amount of Shrinkage	6%	13%	15%

**Conclusion:** Out of the three masks, the Klarity Green had the least amount of shrinkage. It also allowed the greatest amount of time to mold the mask on the phantom head. These two together make for a more comfortable mask, which leads to less patient movement. Taking these into account, Klarity Green would be the choice for Radiation Therapy.



The EFFICAST® thermoplastics are materials with a density of 1.13 g/cm<sup>3</sup>.

**Attenuation (at 6 and 15 MV) and skin build up (SBU) values:**

Type	Attenuation (± 0.15%)		SBU (± 0.1 mm)
	6 MV	15 MV	mm H <sub>2</sub> O equiv.
1.6 mm micro	0.40 %	0.20 %	1.7
2.0 mm maxi	0.40 %	0.20 %	1.7
2.0 mm micro	0.45 %	0.25 %	2.2
2.4 mm maxi	0.50 %	0.35 %	2.3
3.2 mm maxi	0.70 %	0.45 %	2.9
Hybrid	0.65%	0.45%	3.0

The L-shaped profiles used to attach the mask to the base plates have the following dosimetric properties:

Attenuation factor (± 0.13 %)

6 MV	0,73%
15 MV	0,53%
Skin Dose	2,4 mm H <sub>2</sub> O equivalence

Note: Use these numbers as a guidance only. Perform the measurements again in your department to verify these results.

**D. METHOD OF ACTIVATION AND APPLICATION**

- Place EFFICAST®/PELVICAST™ in a water bath at a temperature between 65°C and 70°C (149 °F and 158°F). This is the ideal softening temperature. Do not heat EFFICAST®/PELVICAST™ above 80°C (176°F). Do not heat EFFICAST®/PELVICAST™ longer than 20 minutes. When using a heat gun, do not exceed the temperature of 250°C (482°F) to avoid breakdown of the material. Never use an open flame to activate EFFICAST®/PELVICAST™.
- Place the patient in the correct treatment position on the suitable positioning devices (base plate, head supports, blocks, wedges, cushions, etc.). Observe the following minimum heating times to obtain ideal working properties:

EFFICAST® 1.6 mm	3 minutes
EFFICAST® 2.0 mm	3 minutes
EFFICAST® 2.4 mm	4 minutes
EFFICAST® 3.2 mm	4 minutes
Hybrid (EFFICAST® 2MA + ORFILIGHT® 16MI)	4 minutes
PELVICAST™	4 minutes

In making the thermoplastic masks important characteristic is the ease of handling and the number of staff required for modeling. Specificity is also a way of connection mask to a base plate, which in some way describes the rigidity of masks and strength to immobilize the patient. Masks can be connected with the frame and the pins in them, and in „Orfit“ masks with holders that are inserted into slots on the base plate. The thickness of masks is expressed in millimeters and is an important item in determining the degree of attenuation. The thickness of masks also determines the length of the "warm-up" before modeling, and conversely affect the ease of moving the patient under it and the percentage of possible errors during irradiation, so that the relative thickness and size of perforation should find the right balance. The method of storage is equally important, because according to some manufacturers, they usually requires a minimum temperature range of 10° to 30° maximum. Specific humidity, as well as the way of maintenance - disinfection, not with any substances, because all of it can to influence the later characteristics of the mask.

Introduce a patient with the reason and need for making thermoplastic masks and steps in the further procedure are essential part of the preparation. The patient took off his clothes, jewelry, get of dentures and hearing aid if any used, and if required removed ORL cannula, remove makeup. Then the patient is properly positioned and placed on the table, using adequate immobilization equipment. Positioning and the whole course of making masks should be performed with the use of lasers in order to meet the first condition for quality, the correct position of the patient for a CT scan, and then RT planning and later the entire of treatment.

We prepare mask, laying it in the water bath, and during that time again checks the position of the patient body, the position of the chin, and put the patient's head in desired position. Place of the passage of the sagittal laser should follow the path of the body, thus confirming the point: umbilicus, ksifoideus, jugular pit, the middle chin, nose and forehead.

The prepared mask we set to the patient, placing masks from the chest to the head. The procedure performed RTT 2, where the one holding the chest part and modeled it, and the patient's shoulder, and another RTT head and the other shoulder.

We secure the mask to a base plate and continue with the hands and fingers to shape the mask to the patient's anatomy, especially emphasizing the nose, chin, shoulder, ears, as places that will be parameters confirming the correct position of the patient in the mask in further procedures and during radiation.

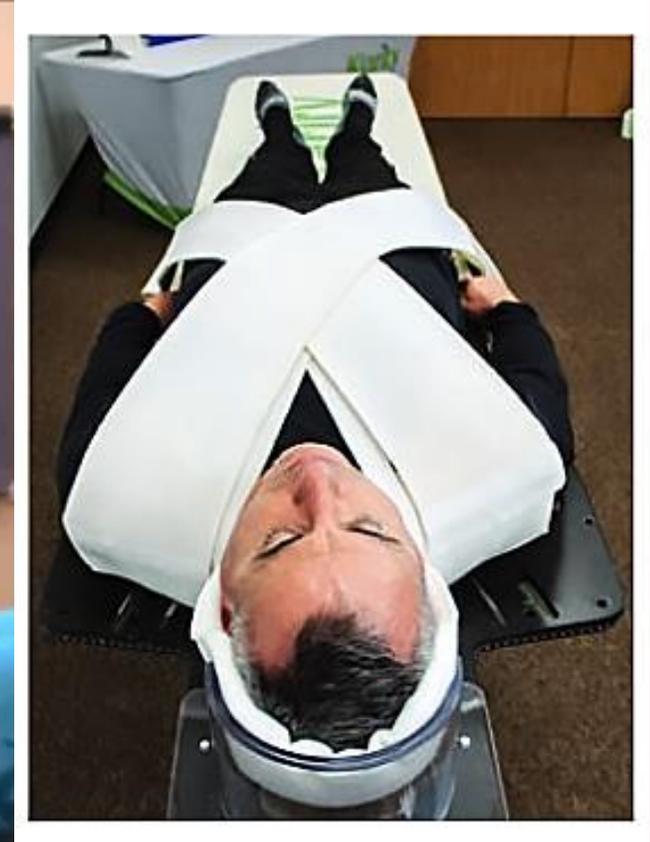


When the mask is cool and took on its final form, the mask is dried and removed from the patient and the patient's face is cleared of the remaining water.

Specificity to which attention should be paid during the positioning and immobilization patient for therapy of neck region, is correct drooping shoulders. Such a system and equipment for the retraction of the shoulders is used by us at the Institute.



Patients with anatomical high shoulders, short neck, or in patients who because of the scars on the neck, can not be optimally lowered his shoulder without our assistance, could be solved by adjusting the intensity of retraction in different ways, and one of these was previously shown in our system, the pulling arm with the help of tape. Other systems are pushing their shoulders down.



OPTEK™ Carbon Fibre Overlay

Shown here with optional shoulder supression and hand grips.

Conditionally said "additional" immobilization equipment, because it is not directly immobilized or positioned on the neck, may further strengthen the positioning, improve patient comfort, assist in facilitating the achievement of the desired position of the patient, because it is often a few millimeters of crucial importance, if we have a problem with the patient, to be properly brought into the set position. In that kind of equipment includes various coasters for other parts of the body, which we raise, bend or pressing the body of the patient. Supporters for knees, feet and back, various adhesive tapes which fix the extremities, can greatly facilitate the positioning of the patient whom is applied radiotherapy. More comfort for the patient lying down means and peaceful position facilitating cooperation, reduced possibility that the patient will move during the planning and the application of RT.

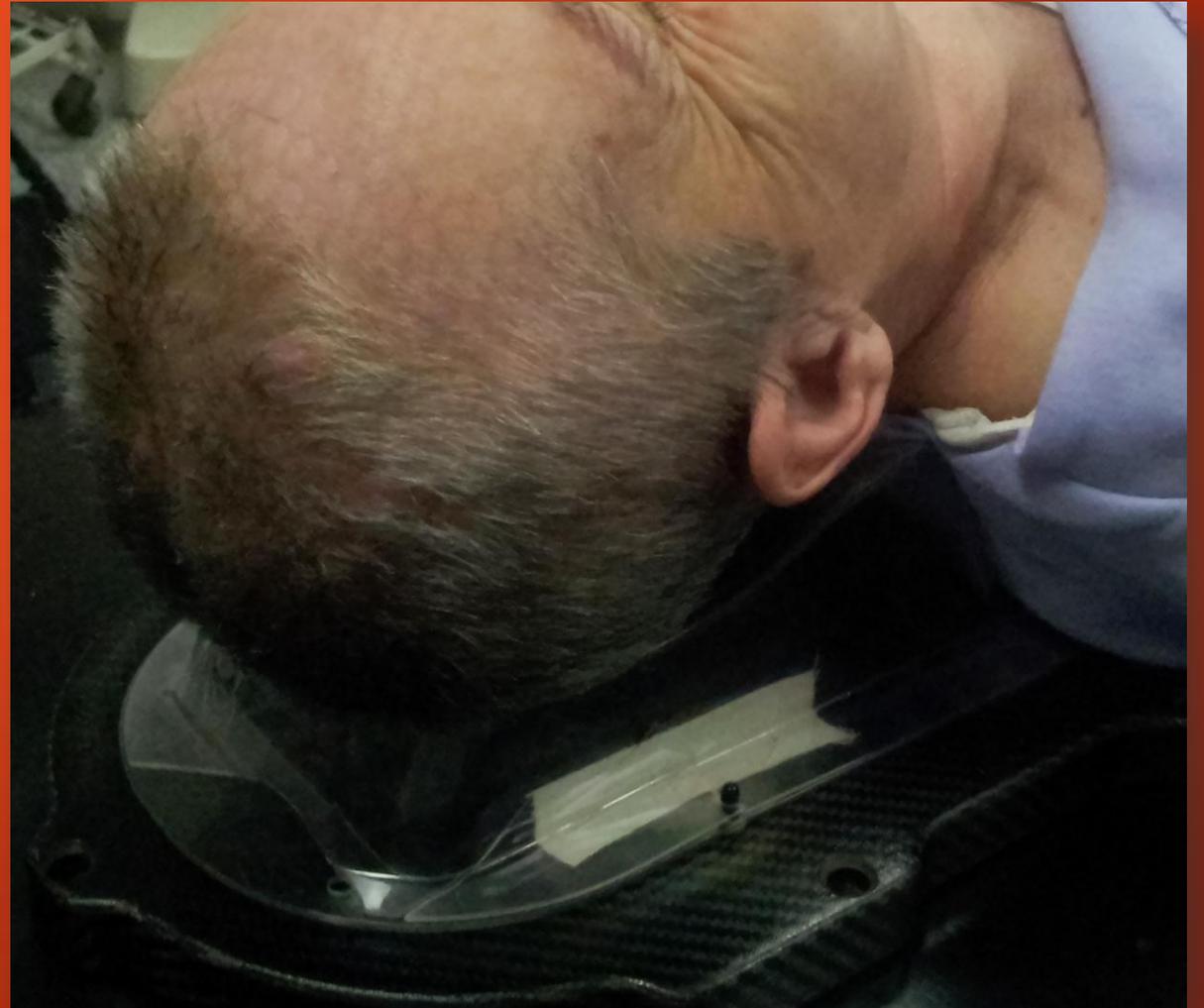


Solving specific cases is especially noticeable when you have to cope with a situation where you have a challenge with non-standard problems and lack of equipment. That in everyday practice, not all is idyllic, like all previously shown, demonstrates the fact that rare radiotherapy centers have a large number of various equipment, covering all the of RT machines, mold room, Ro / CT simulator and so on. The same is true for the continuity of equipment supply, always the same thermoplastic masks, not to mention the purchase of recent editions immobilization equipment, from the latest catalog of a manufacturer. In support of our reality speaks following examples.

Lack of various models of thermoplastic masks, while the „ non-stick masks " not to mention, we solve by cutting masks with scissors to open the nose, eyes, mouth, place for the opening of the cannula. We also often working with a damaged knee supporters.



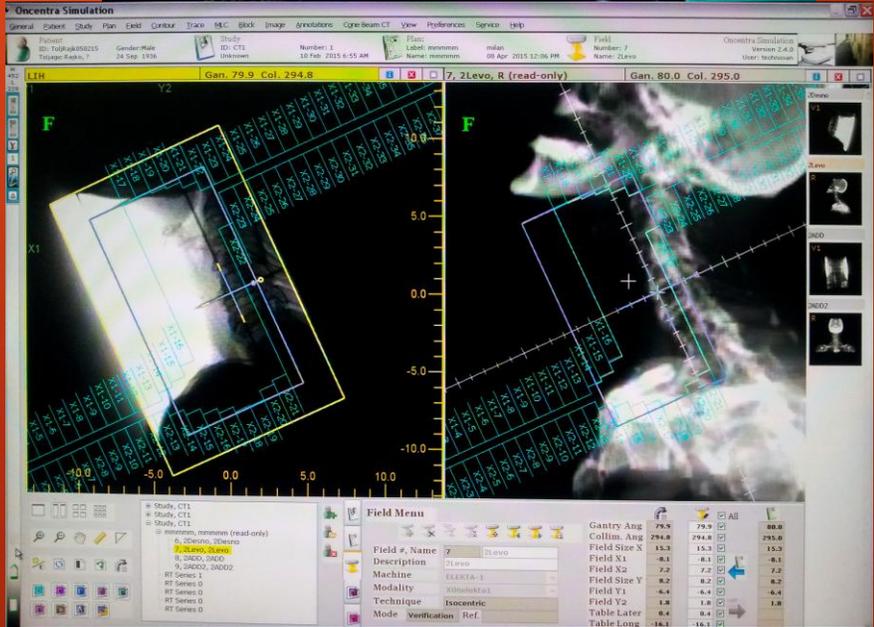
Finances are also a problem to replace already damaged head supporters ( we simply stick them ) .



If you have a problem with the mask because it is stuck or due to repeated use (2, 3 times) often make the crease, soak it again in the water bath and wriggle through the water. With the help of additional tools under water, mask is more easily detachable.



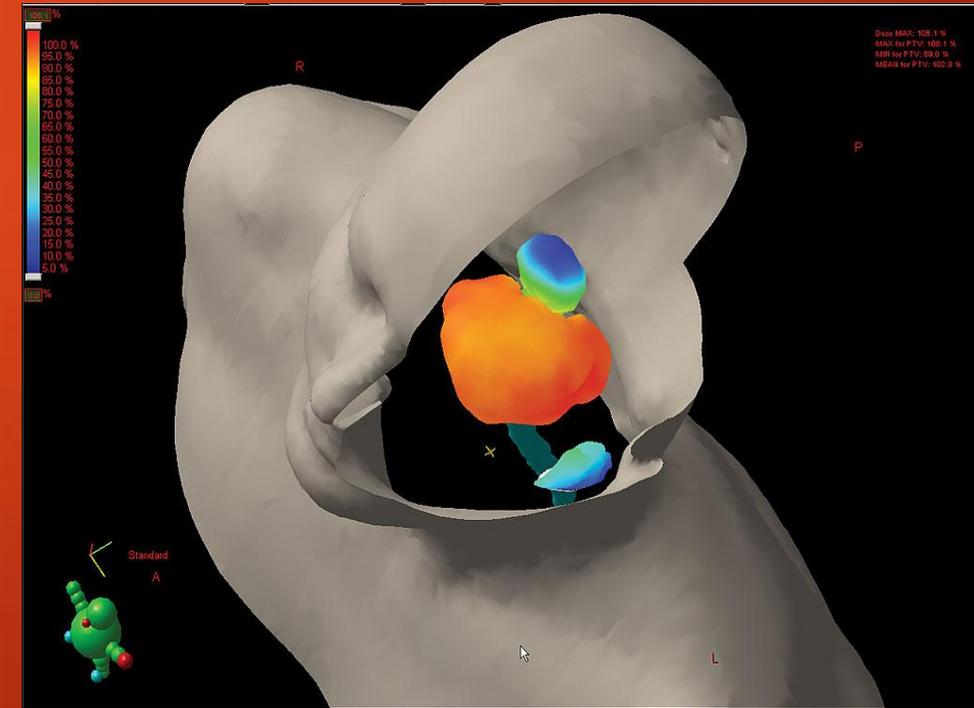
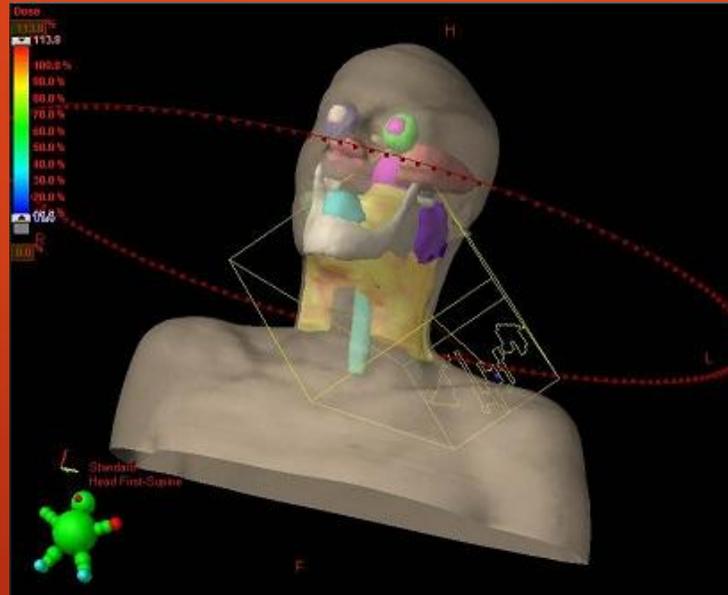
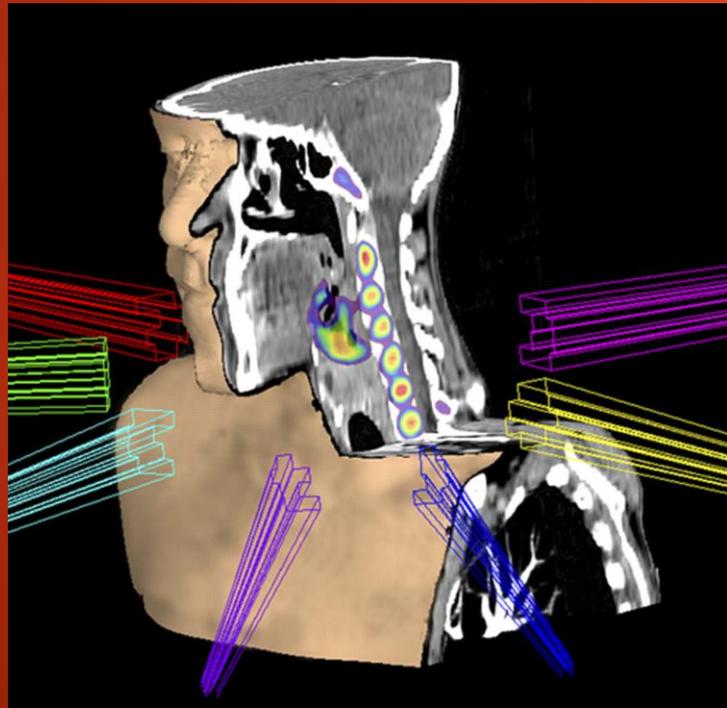
In patient with very pronounced kyphosis, which not allowed to lower his head and neck, even on the largest head supporter, and with painful hardened shoulders for adequate position we could use these individually adaptable system or vacuum bag as an addition to a largest head supporter. In this patient, who radiated neck we have tried everything, but because of what we have, and it is still standard equipment, not a compresses or pillow we decided to make a mask for the head, expanded on part of the neck and put his head partial in flexion, which was the most comfortable position for him. We've added adequate, highly curved head supporter that follows the line of the head and neck of the patient.



Challenges that we encounter daily during the planning and implementation of RT in patients with tumors of the neck region depend on the specifics of patients cases that we need to solve. Contrary to challenge is the supply with equipment, of our RT centers with adequate immobilization equipment, which should at least cover the majority of possible situations, and the rest to finish with inventiveness.

Unfortunately, the situation is not satisfactory, because it is usually in direct conjunction with the available finances of hospitals in which we work.

Only quality and adequate immobilization equipment can follows the story of the modern radiotherapy, about how the patient and the tumor of any location, even the neck region, we should approach and irradiate it from either side.



Until the moment in which the work and the daily challenges will represent ease of operation from a position of a chair, we are left to solve all tasks with additional effort and exceptional commitment to the profession.



**Thank you !**