



MDS Instructor

3D T-Spine Treatment Planning



This course will give an overview of the radiation treatment planning process for a T-Spine radiation therapy treatment. We will use 3D treatment planning techniques and compare an APPA beam arrangement with a 3-Field Wedge Pair. We will also walk through some of the fundamentals of

≡ Simulation

≡ Contouring

≡ Beam Setup

≡ Treatment Planning

≡ Plan Evaluation

Simulation



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Simulation is a process that allows radiation treatment fields to be delivered in a reproducible manner. The simulator is a large-bore computed tomography (CT) scanner. The CT images are used to delineate targets as well as organs at risk, which allows the dosimetrist or physician to arrange the radiation beams and make a customized plan. It is here that special care is taken to make the patient as comfortable as possible, to ensure treatment can be delivered in the same position each day.

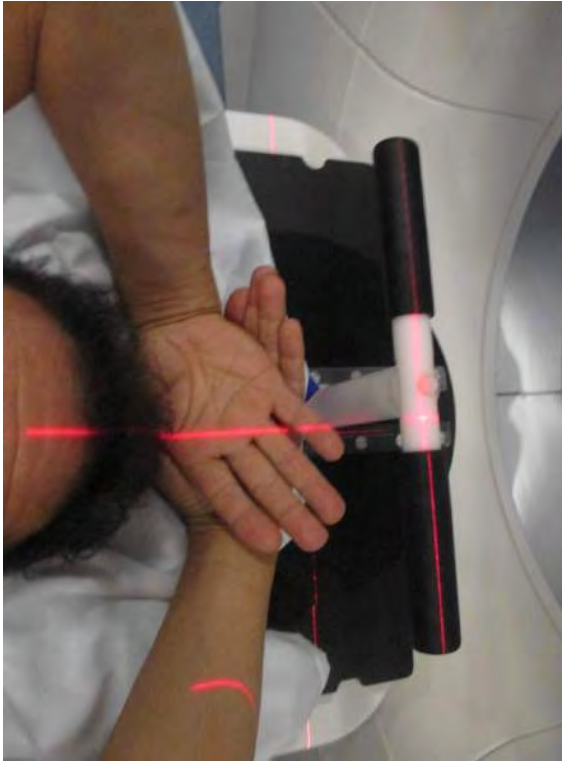
- Imaging: CT simulation, $\leq 0.3\text{cm}$ thickness
- Position: Supine
- Immobilization. Vac Lock or body fixture to allow for consistent set-up
- Technique. 3DCRT
- Image-guidance. At least weekly image verification (EPID, cone-beam CT, megavoltage CT [MVCT])

CT Simulation

Immobilization

Keep in mind that a patient's particular setup may not require any additional tools, or may require a combination of items. We try to anticipate the tools that will be needed prior to simulation.

To capture the treatment site in the scan, the whole thorax region is scanned with the patients arms up.



Simulation

Skin markings (tattoos)

A body fix like a vac lock may be used to help as a positioning device.



Simulation

Skin markings (tattoos)

The isocenter or reference markers are selected and marked on the patients chest and sides.



Contouring



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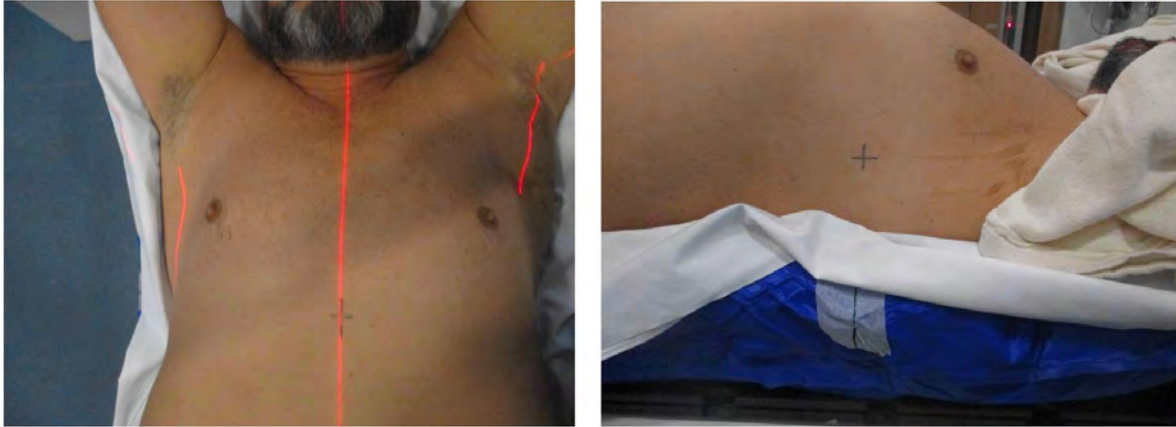


Import & Localization

Each patient starts with the Importing and Localization of the CT images into the treatment planning system.

Step 1

Importing and Localization



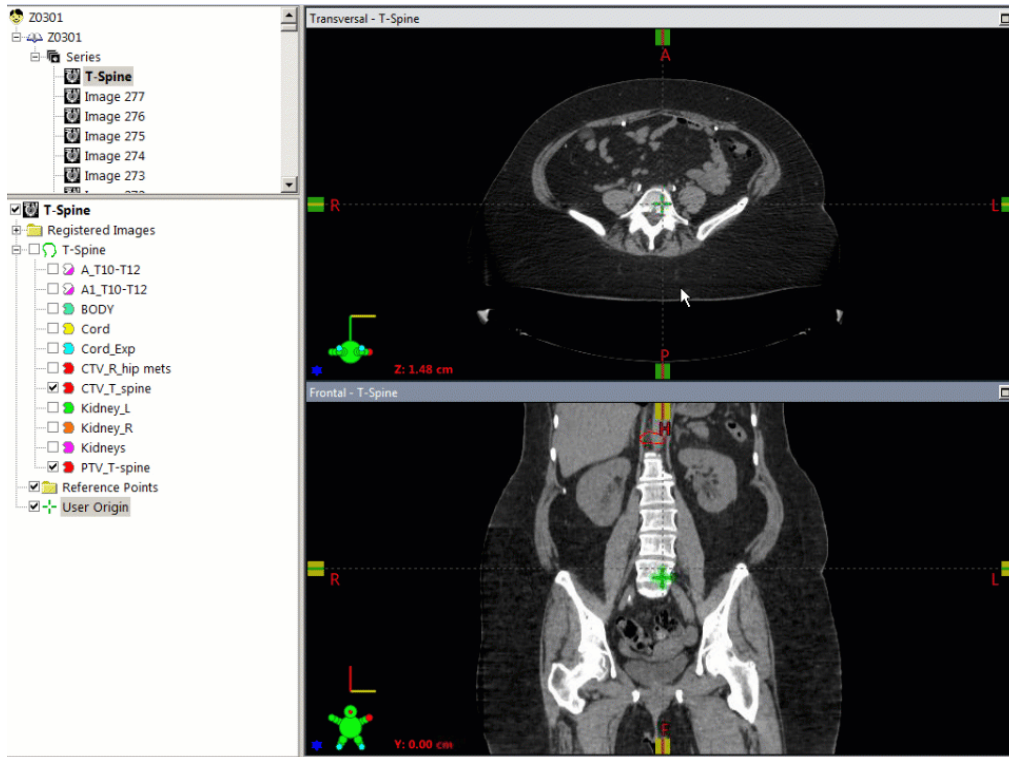
After a patient is simulated, the CT data set is imported into the Treatment Planning System. These images are in DICOM format and you may hear people referring to this folder as the DICOM import folder.

Once imported, the CT scan is used to localize the patient in a system of coordinates/markings is used to track the patient's geometric location in space.

At the time of sim, a patient is often marked to facilitate set up during treatment, BBs are often used to mark this setup location in a triangular fashion, generally 3 points (anterior and laterally). We will set the user origin or localization at this location.

Step 2

Set User Origin Eclipse (Localization)



Next, we will set the user origin for the image. This will localize the coordinate systems to the TPS.

To Localize the patient, scroll to the slice of the bbs and set user origin to viewing plane intersection

Step 3

Set User Origin RayStation (Localization)

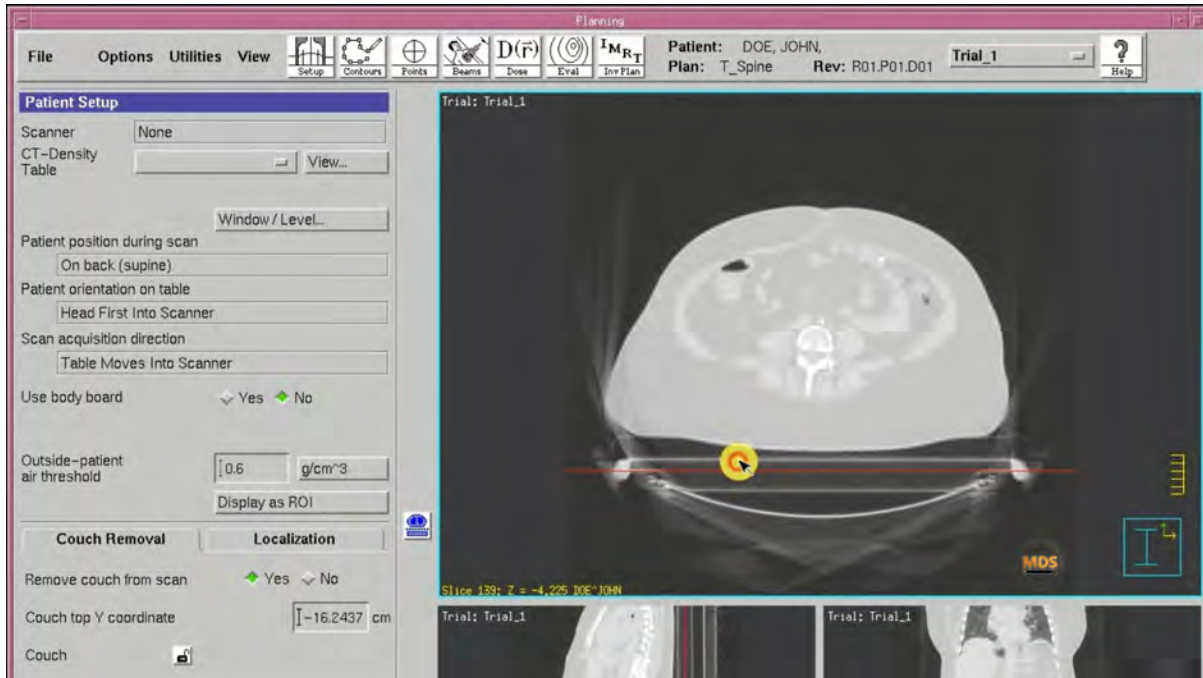


Set the Localization for the image. This will localize the coordinate systems to the TPS.

To Localize the patient, scroll to the slice of the bbs and set user origin to viewing plane intersection

Step 4

Set User Origin Pinnacle (Localization)



Set the Localization for the image. This will localize the coordinate systems to the TPS.

To Localize the patient, scroll to the slice of the bbs and set user origin to viewing plane intersection

Summary

You can use this workflow for other treatment sites as well. (Brain, Thorax, Abdomen, Pelvis, and Extremities).

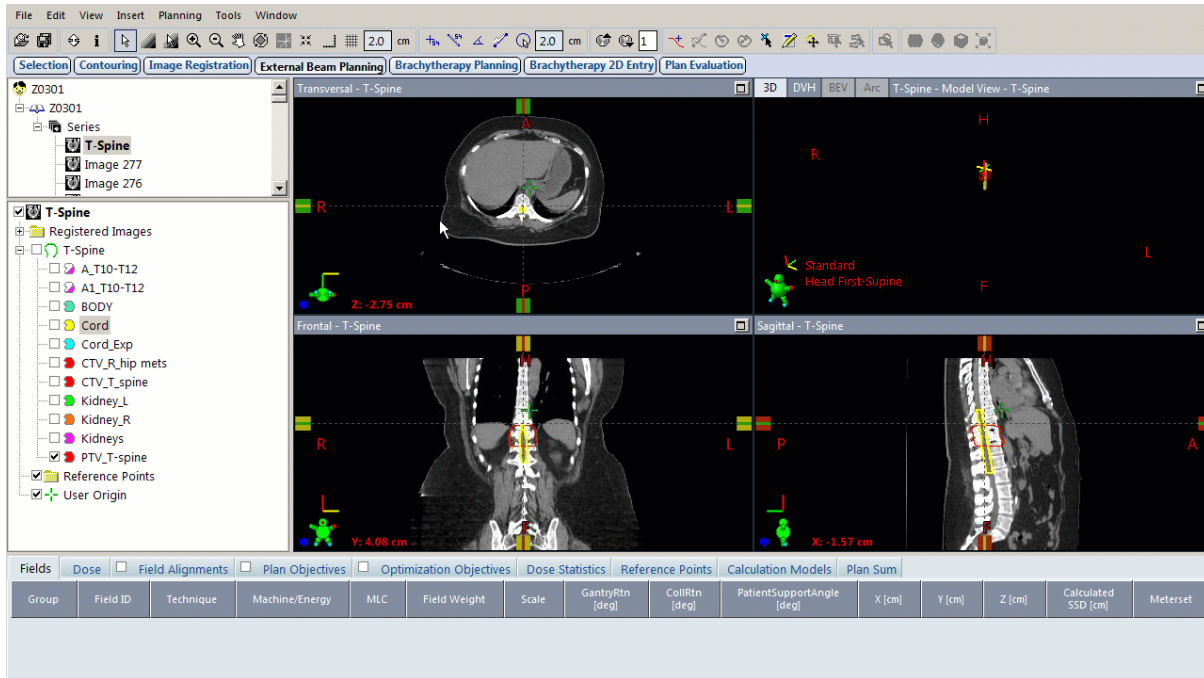
Just import the DICOM images, scroll to the setup marks and set the user origin to the triangulation location.

Contouring

Here we'll contour in the structures relevant to the T-Spine treatment plan.

Step 1

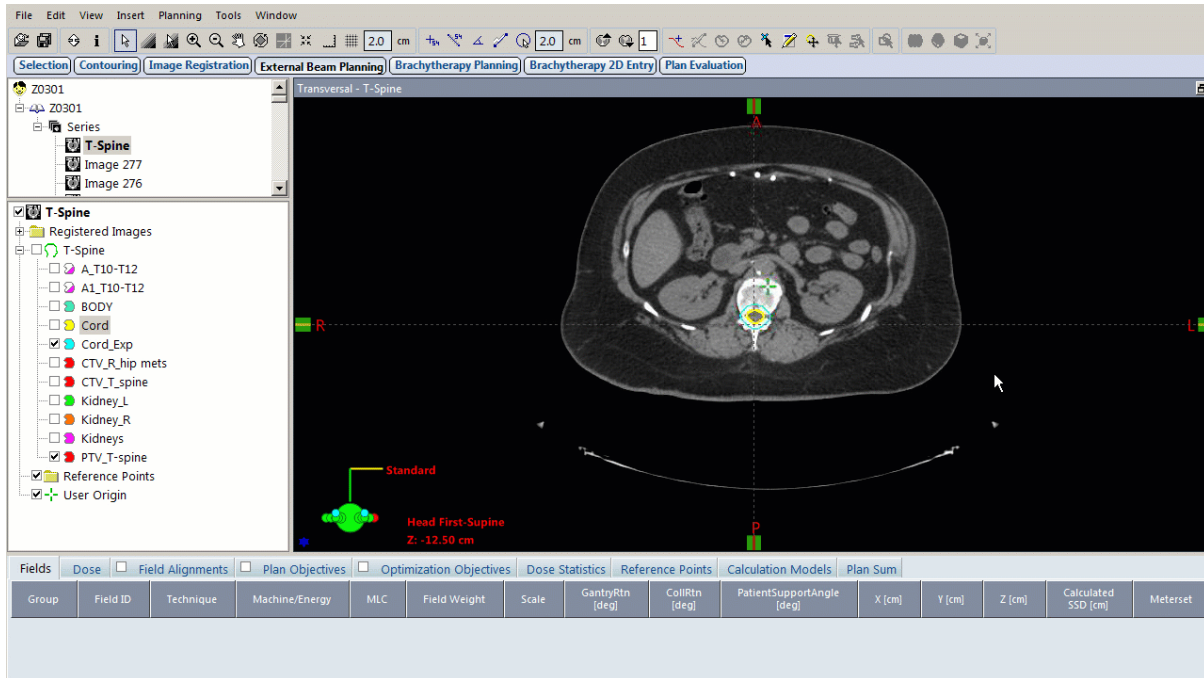
Spinal Cord



Depending on your institution, you may contour the true cord or spinal canal. In this example, we will contour the entire canal.

Step 2

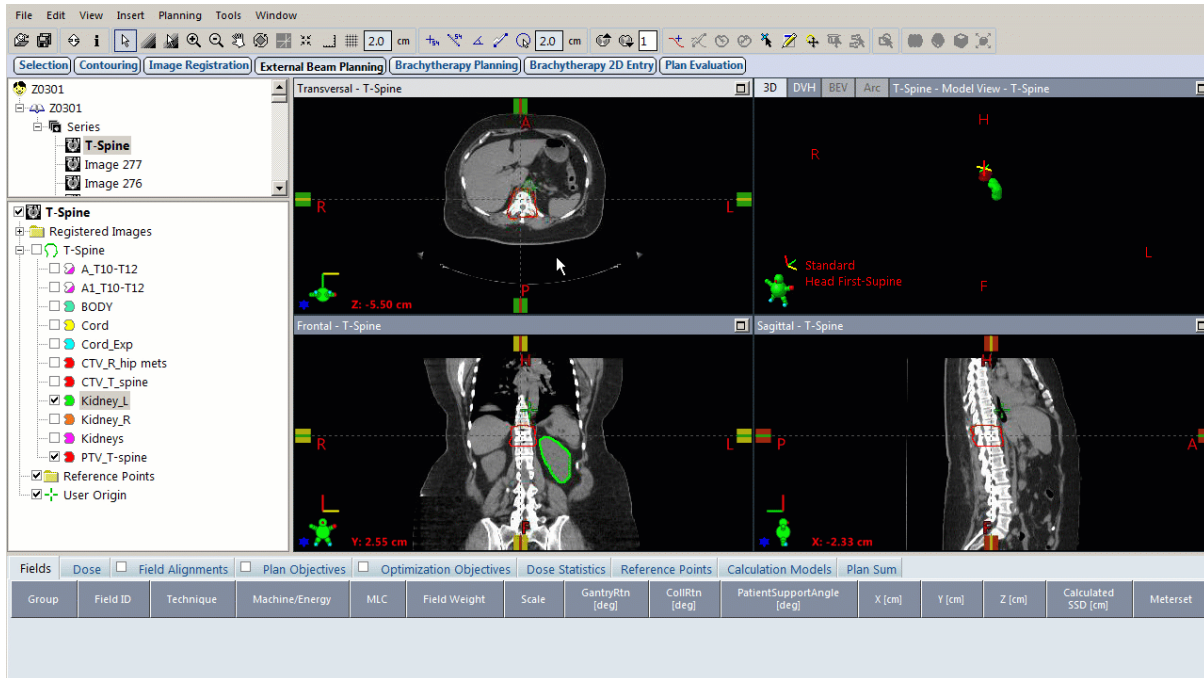
Expanded Cord



You can also consider contouring the cord and adding a margin

Step 3

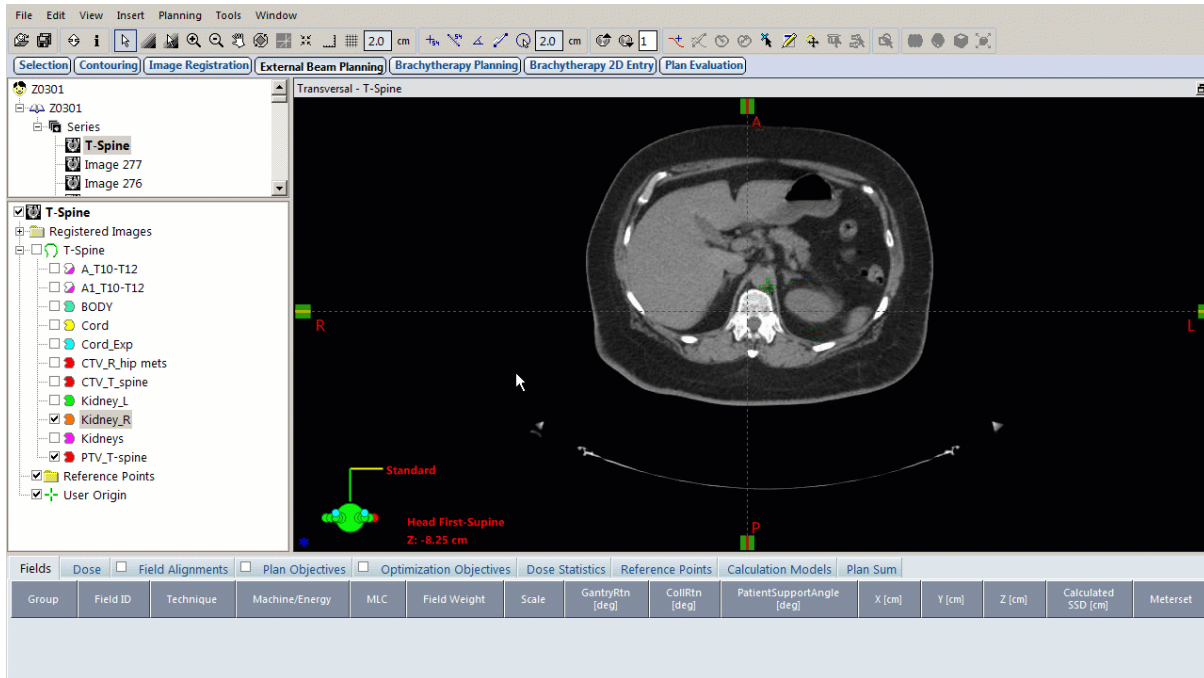
Kidney_L



Contour the left kidney.

Step 4

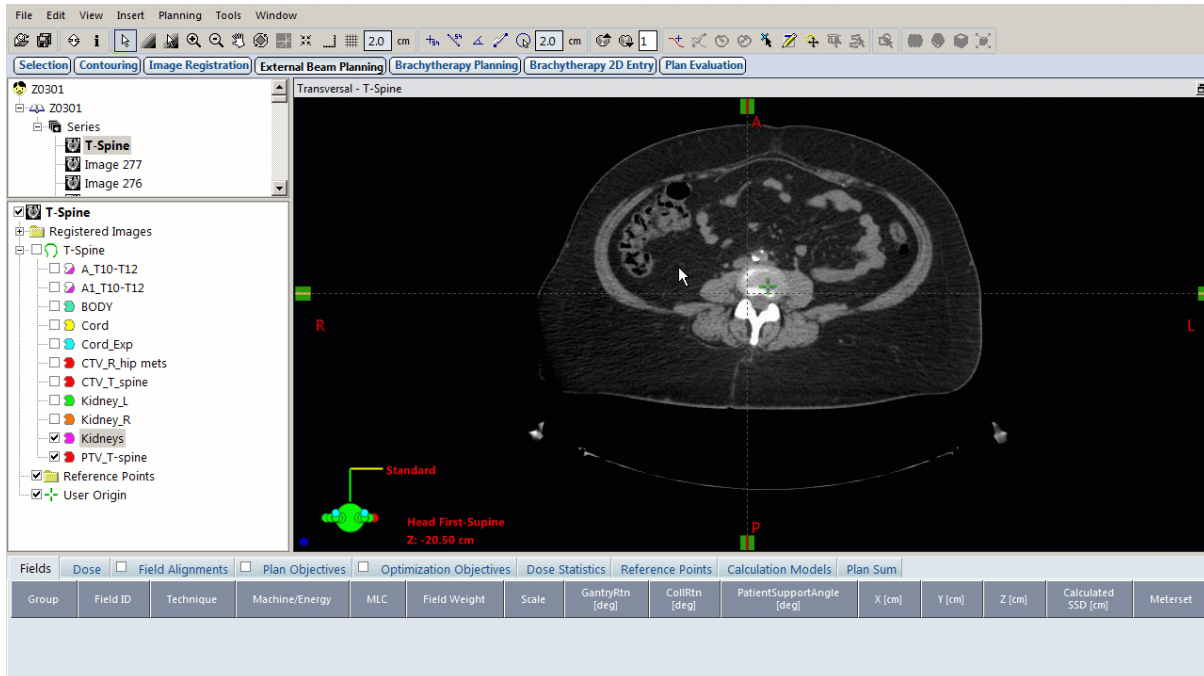
Kidney_R



Contour the right kidney.

Step 5

Kidneys



Now use the Boolean tool to combine the right and left kidney structures— name this structure Kidneys.

Step 6

Any Critical Structures?

Contour any additional critical structures relevant to the case.

Step 7

Density Overrides

If there are artifact, or materials that need to be overridden this is a good time to do so.

Summary

Ok now that we've completed our list of contours, We're ready to start planning.



Complete the content above before moving on.

Takeaway

Remember to review automated contours such as the Body and have a second pair of eyes review your contours.

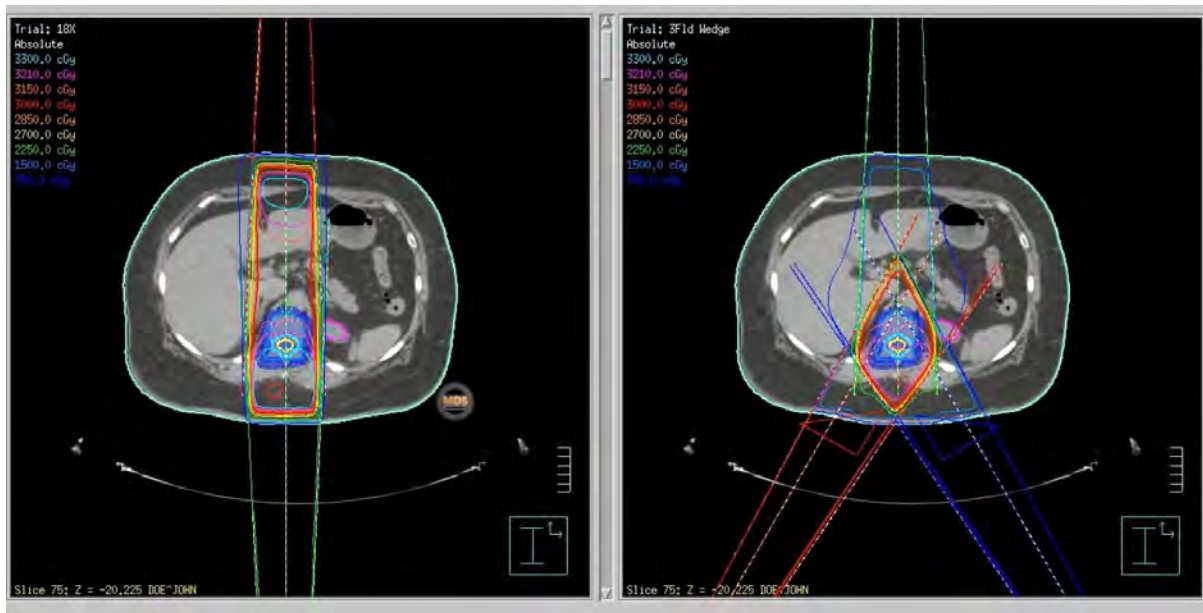
Beam Setup



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Beam Arrangement & Field Placement



3D T-Spine treatments commonly use either APPA or 3Field Wedge Pair beam arrangements. APPA fields are opposed anterior and posterior fields to treat the entire target.

Historically, the appropriate target volume to be irradiated for spinal metastases is 1-2 vertebral bodies above and below the level of involvement for three reasons: (1) to avoid missing the correct level in the absence of simulation or (2) to account for the possibility of spread of disease to the adjacent level, and (3) to account for beam penumbra.

In this lesson we'll treat the vertebral body with 1cm margin and use the linac on-board imaging for image guided radiation therapy.

Step 1

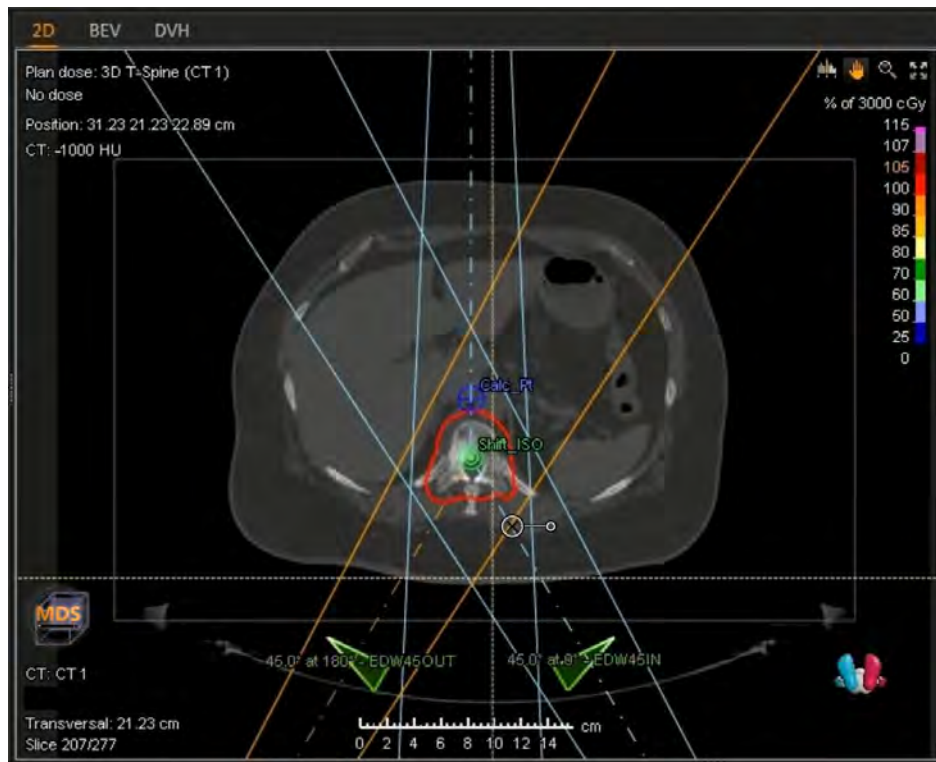
APPA eld arrangement



Field Arrangement APPA. (AP=0 , PA=180). The APPA fields spare the kidneys slightly better, but deposit more dose anteriorly.

Step 2

3Field WedgePair



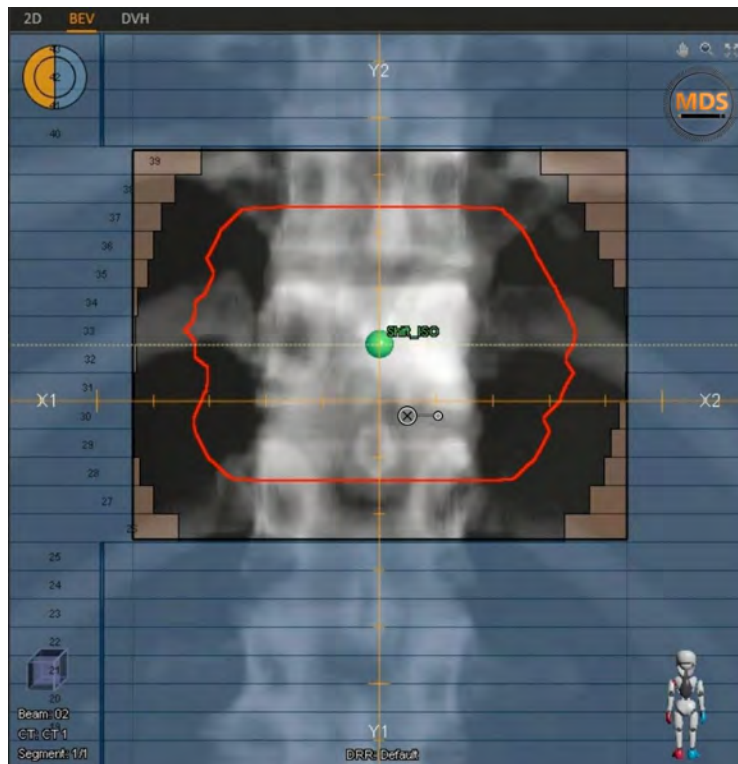
A 3 field arrangement allows for better dose distribution sparing tissue anteriorly. The cost of which might be a slight increase to the kidney dose.

3Field Arrangement consist of RPO, AP and LPO fields. (RPO=210, AP=0, LPO=150).

The RPO and LPO field will include wedges. If dynamic wedges or motorized wedges are used, the collimator of the fields will also need to be rotated 90 degrees.

Step 3

Field Blocking



While setting up the field borders please keep these items in mind.

- Treat the entire vertebral body plus adequate margin.

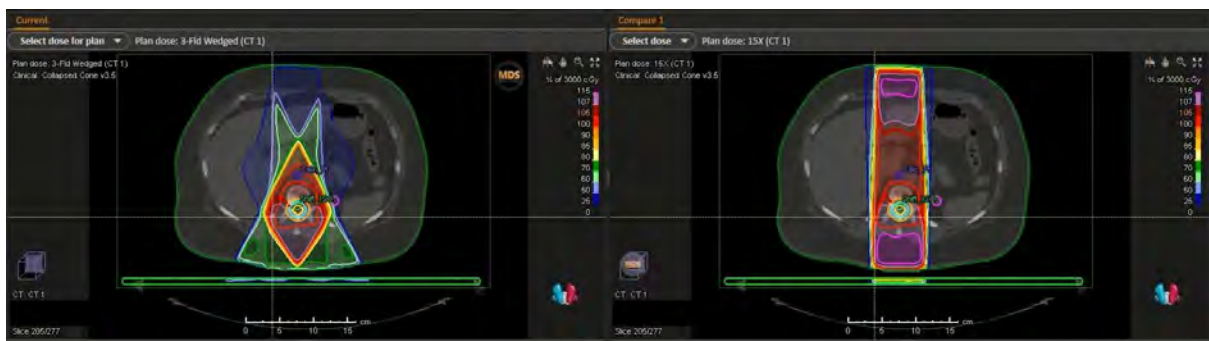
Step 4

Field Blocking (continued)



Ensure the field edge or the MLCs adequately cover the transverse process on the transverse plane or BEV.

Summary



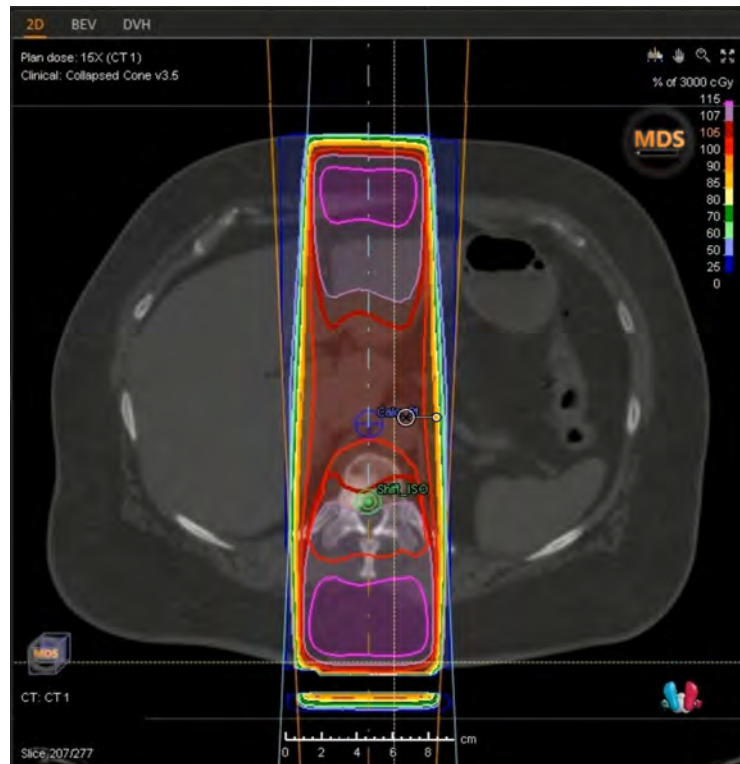
Now things are setup and we'll create a plan similar to the one shown.

Treatment Planning



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Introduction



Once we place fields and set field blocking. We need to calculate the dose and look at the dose distribution.

Step 1

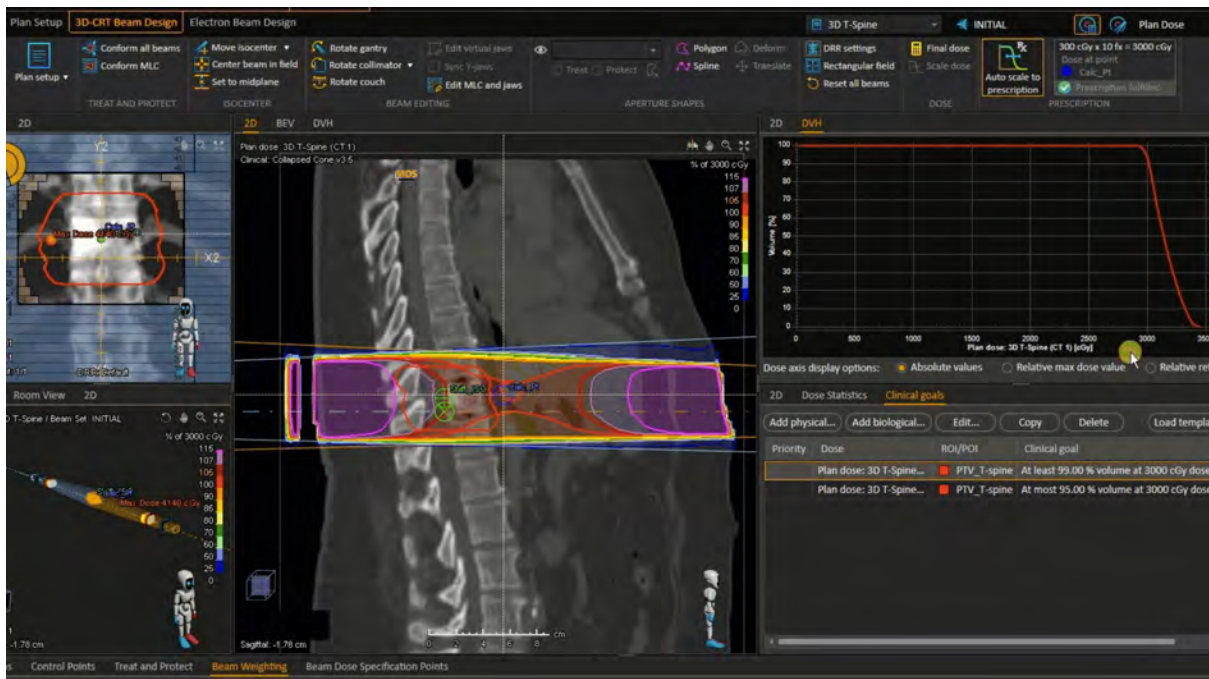
Calculation Point



For T-spine treatments we can place the calculation point at the isocenter and normalize the plan for coverage, or place the calculation point anterior to the vertebral body. In either case the plan might still need to be normalized to cover the target.

Step 2

Normalize the plan



Normalizing the plan to a calc point and prescribing to an isodose value helps to ensure good coverage to the vertebral body. The plan is normalized by a few % to get full coverage. Here's an example of plan normalization to a calculation point.

Step 3

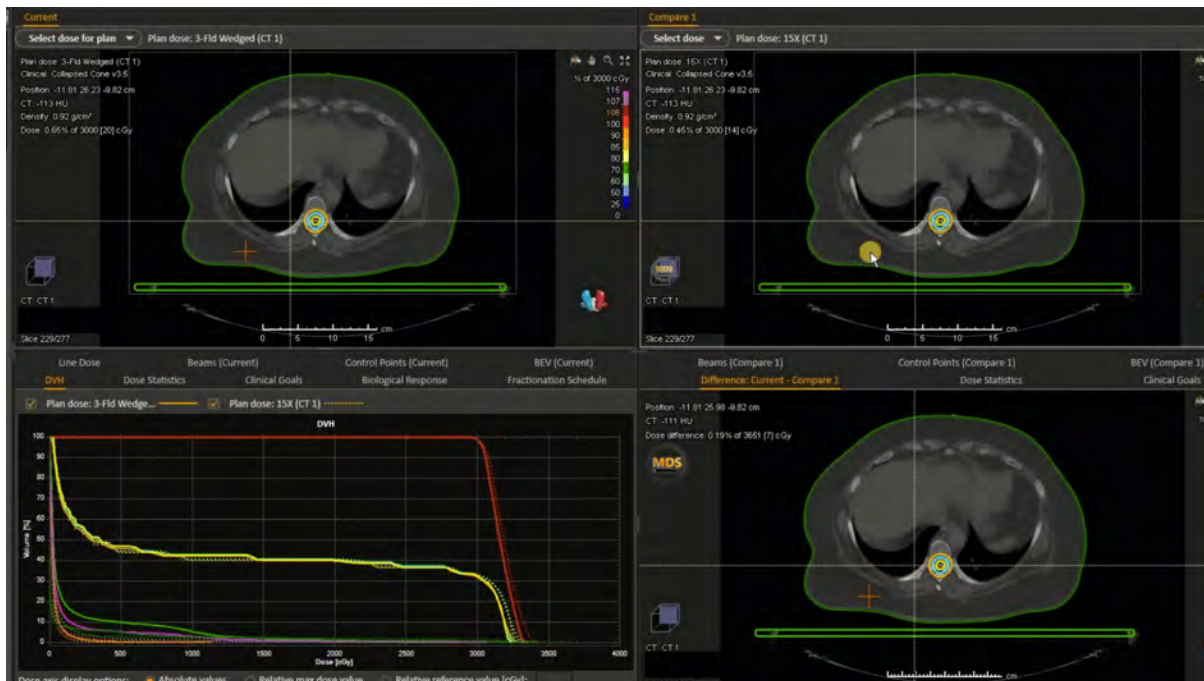
Field Weighting



To improve the distribution apply field weighting to create a more even dose distribution.

Step 4

Review Dose Distribution



Once complete a dose distribution is created. We will review dose distribution for coverage and conformity and make adjustments to our liking.

Summary

Next let's evaluate the plan to see if it achieves the dose distribution we're looking for. We'll also check the max dose of the plan and OAR dose statistics.

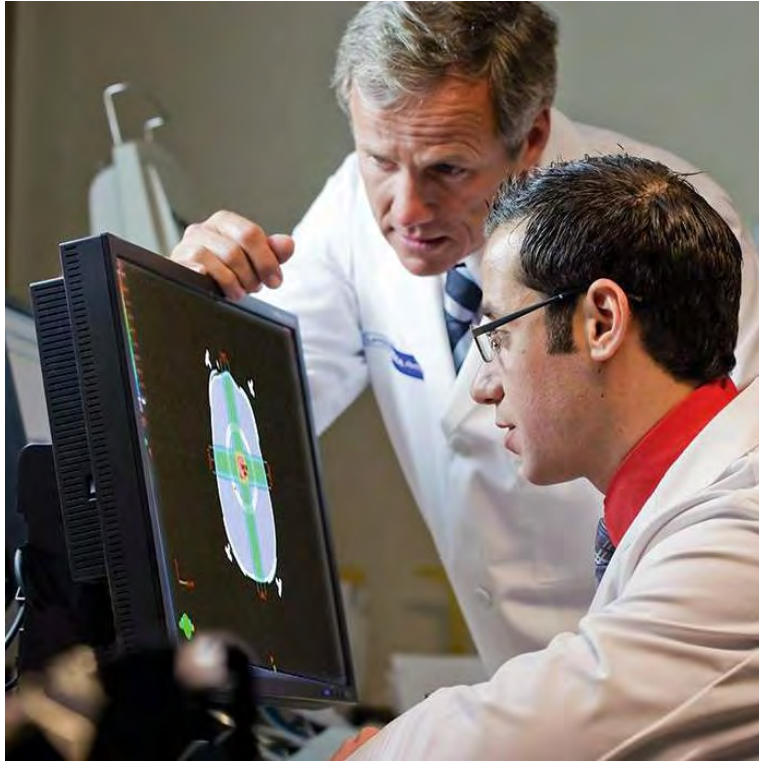
Plan Evaluation



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Introduction



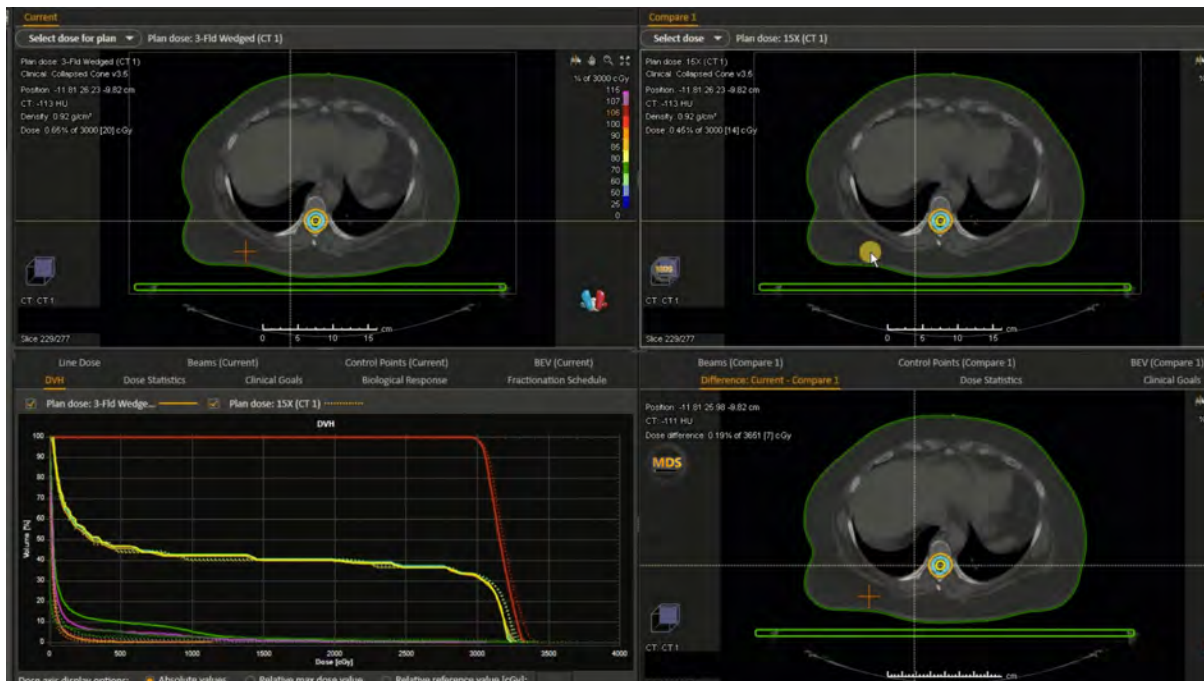
Once we have good plans for review, we'll begin the plan evaluation with the physician.

In most cases treatment planners will have multiple trials or plans for comparison. This ensures the patient receives the best plan possible.

While reviewing with the physician in some cases the field may need to be tweaked. The MD may adjust the field borders, or MLC blocking by moving a few MLCs.

Step 1

Dose Distribution RayStation

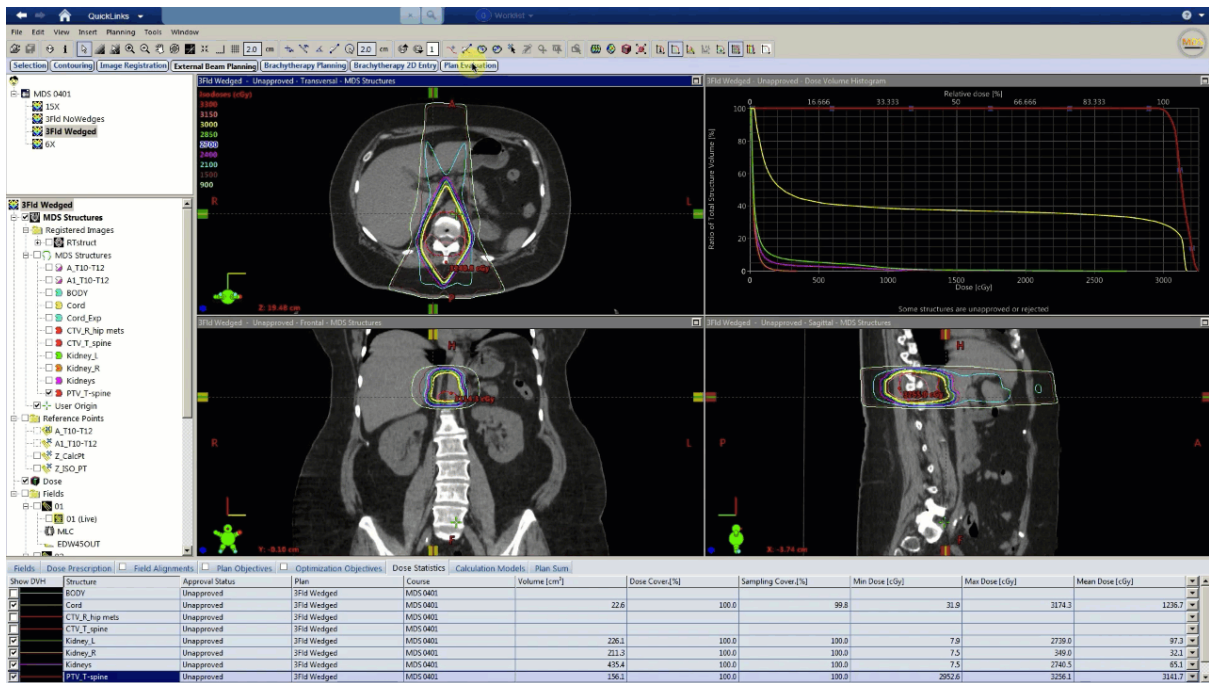


Here are some of the items we are looking for during the plan evaluation. This is done by scrolling up and down the scan and reviewing the dose distribution.

While doing this we note hotspots, max dose of the plan, location of max dose, cold spots, Coverage of the isodose lines around the target.

Step 2

Dose Distribution Eclipse



(Continued)

Look out for hotspots, max dose of the plan, location of max dose, cold spots, Coverage of the isodose lines around the target.

Step 3

Dose Distribution Pinnacle

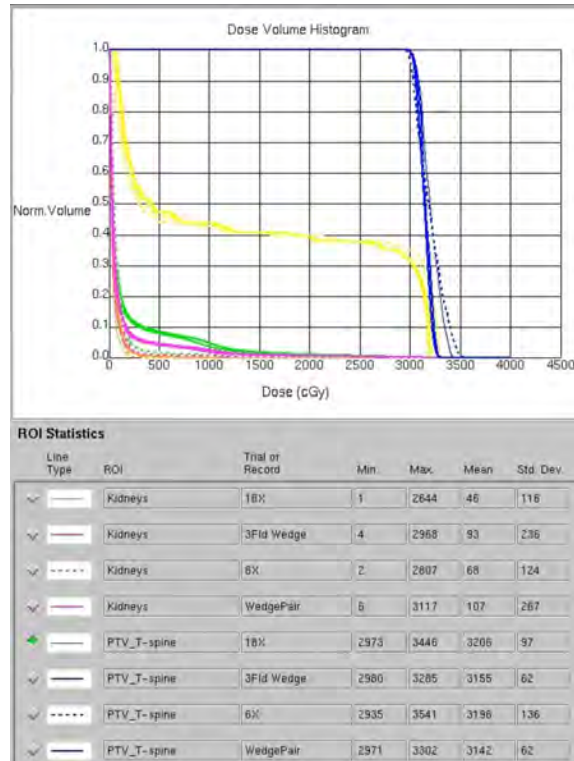


(Continued)

Look out for hotspots, max dose of the plan, location of max dose, cold spots, Coverage of the isodose lines around the target.

Step 4

Clinical Goals and Metrics



The Dose Volume Histogram (DVH) provides a quick review of clinical goals and metrics.

PTV >95% Coverage

Plan Max Dose <115%

Summary



This wraps up treatment planning for T-Spine Radiation therapy.

We covered the simulation, beam arrangement, field borders, field blocking, field weighting and learned how to evaluate for a good plan.

Please watch the treatment planning video demonstration and take the post quiz to test what you've learned.