

Use of Surface Guidance in the Pediatric Setting



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I have no conflicts of interest to disclose



My Background

- Staff Radiation Therapist at Children's Hospital Los Angeles (CHLA) for 8.5 years
- Worked with VRT since its implementation at CHLA in September of 2013



Vision RT at CHLA

- Vision RT was implemented at Children's Hospital Los Angeles in September of 2013
- Initially therapists were reluctant to implement VRT and change the work flow
 - It took several months of trial and error to find the best work flow and methodology



Work Flow

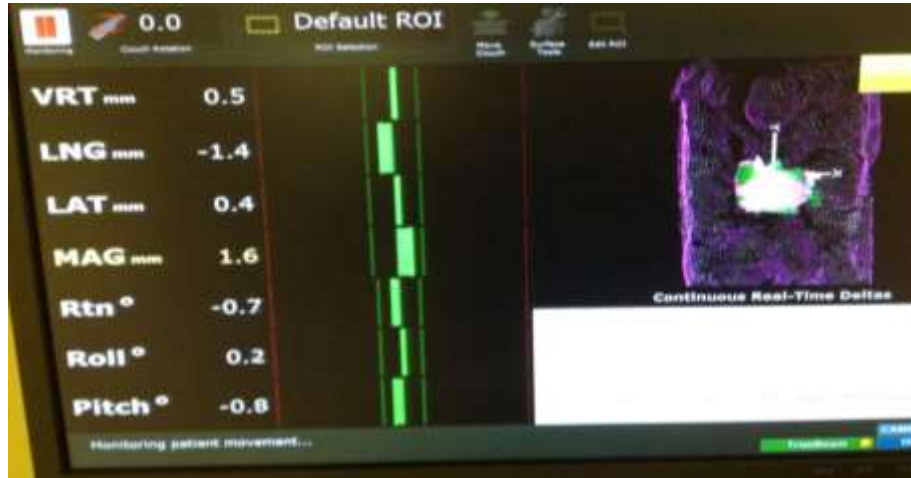
- The patient is brought into the treatment room and positioned using their custom immobilization and indexing
 - Vacuum-assisted mouth piece for brain or head and neck with custom head mold with S frame
 - Body fix bag for any other part of the body
- The table is brought to the acquired position
- The patient is then set up using the VRT set up field
 - CHLA typically uses a VRT set up tolerance of 2mm for vert, long and lat and 1° for rotation and roll (pitch of 2° due to the difficulty of correcting pitch completely)

Work Flow Continued

- After the desired set up is achieved based on VRT a new monitoring reference is taken before leaving the room
 - The monitoring field is taken before IGRT to monitor for motion from the end of set up until applying shifts
 - We typically do this in room with gantry upright and images retracted to minimize camera blockage
- After leaving the room imaging is completed
- Before applying any shifts we verify the patient is still within tolerance
- We capture a new reference after applying shift to monitor the patient during treatment

Patient Monitoring

- For many patients we would get them as close as possible to “zero” on VRT, however there were still some delta’s
 - This caused some uncertainty if the patient moved after we leave room or during treatment



Patient Monitoring

- We now zero the delta's while in the room with the patient by taking a new monitoring reference and any movement is then easily quantified



Set up



Monitoring Reference



Patient Monitoring

- In order to be able to both monitor the patient as well as maintain a set up reference, we implemented the use of two fields (set up and monitoring)
- We use the set up field for initial positioning and then use the monitoring field for the rest of treatment

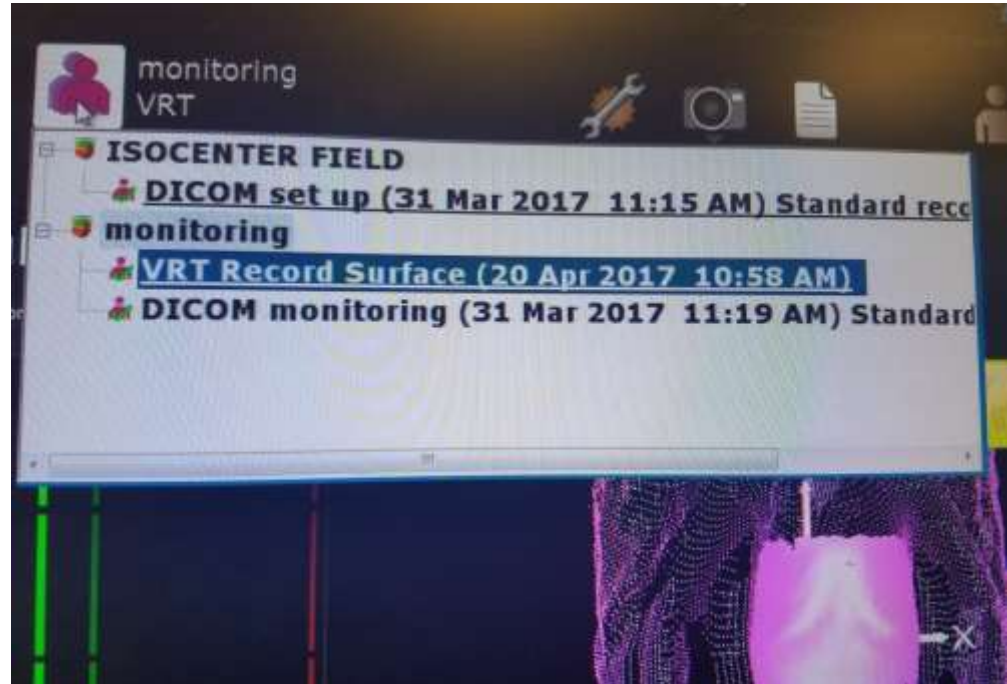


Set Up Field

- The set up reference image is used to position the patient daily
 - The first day of treatment we use the DICOM data to set up the patient
 - We capture a new reference image under set up if necessary when the films are optimal (typically the first day)
 - We do not routinely recapture the set up reference
 - » May be done if child has lost or gained a lot of weight or was bloated at the simulation and now is back to “normal”

Monitoring Field

- After we have filmed but before we apply shifts we verify the patient is still within tolerance
- We then apply shifts and take a new monitoring reference image (replacing in-room acquired reference) to use for treatment monitoring



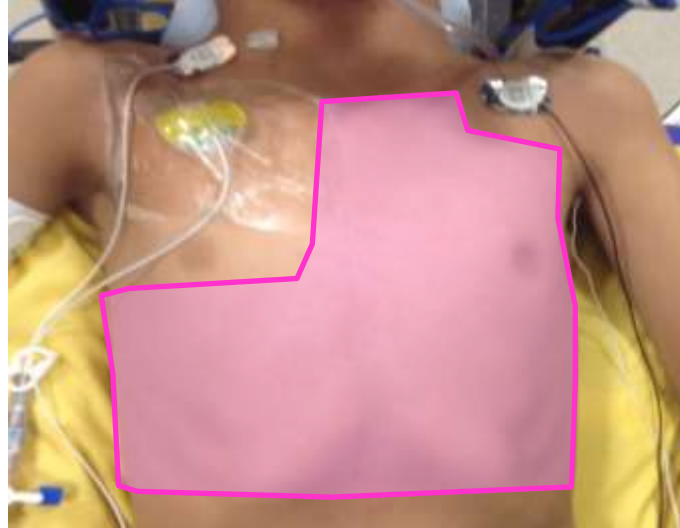
Treatment Areas

- We use Vision RT for a variety of treatment areas including: Chest, abdomen, pelvis, craniospinal, SRS and FSRT, head and neck, and extremities, DIBH
- Each treatment area has different methods of implementation to make it the most beneficial



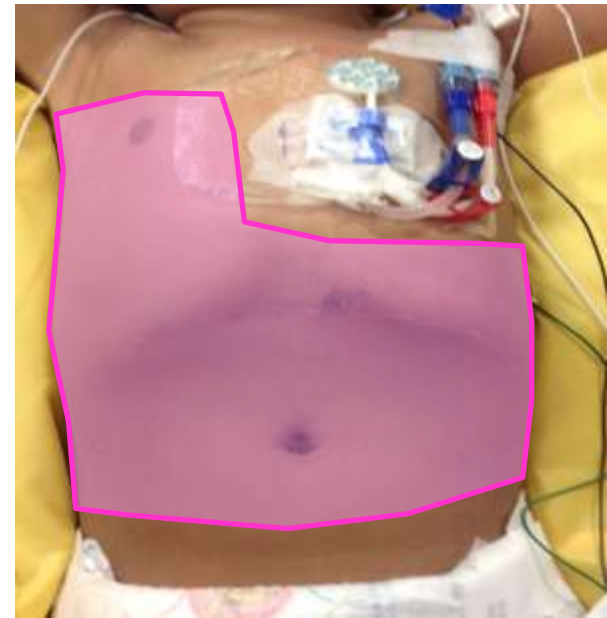
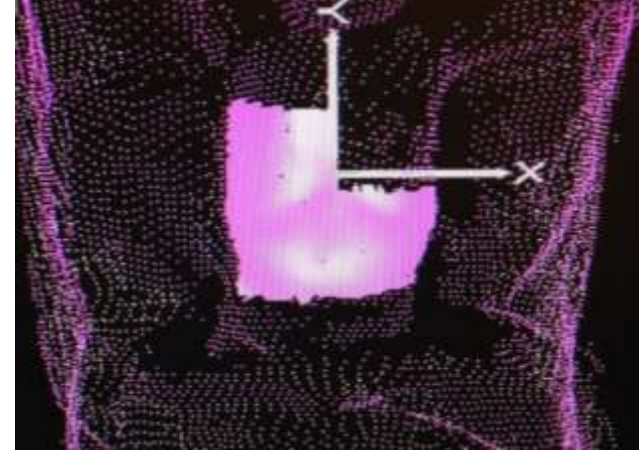
Chest

- Chest ROI's sometimes interfere with a central line (awake children as well)
 - We adjust our ROI's to not include the central line
- We try and wrap the ROI around laterally to at least mid depth of the patient
 - We have adjusted how we make our body fix bags and now only make the bag to mid depth (previously as high as possible)



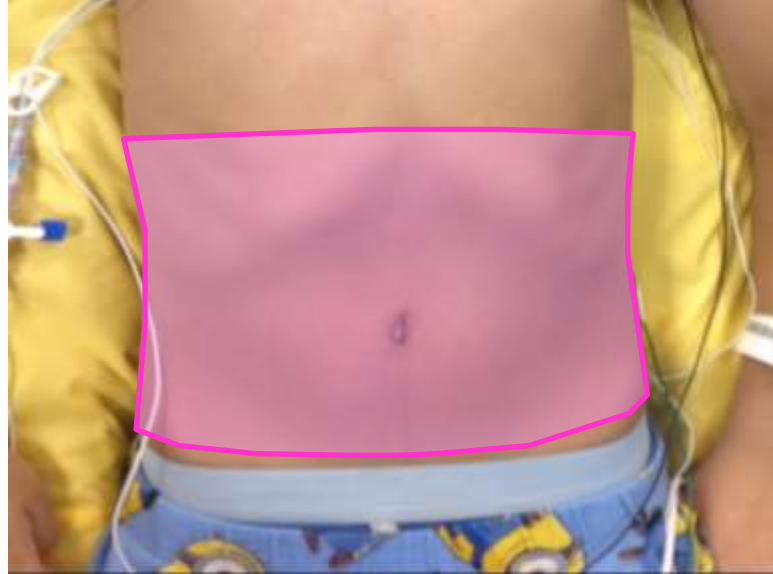
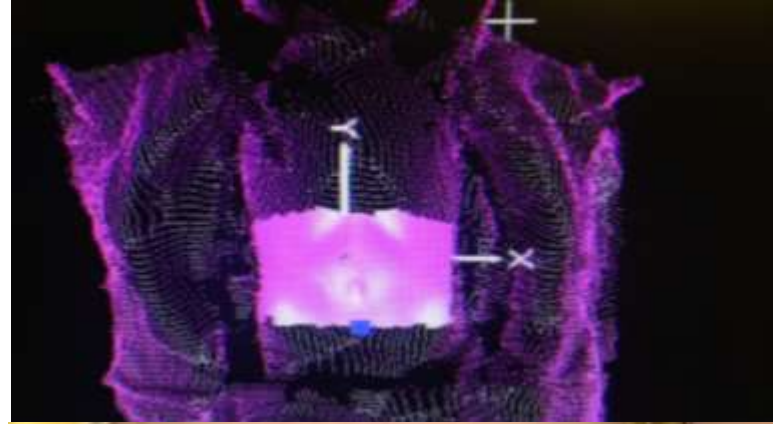
Abdomen

- ROI's may have to extend outside the treatment area due to lack of contours in this area as well as the size of younger patients
 - We also try to create the ROI to at least mid depth to give VRT as much information as possible



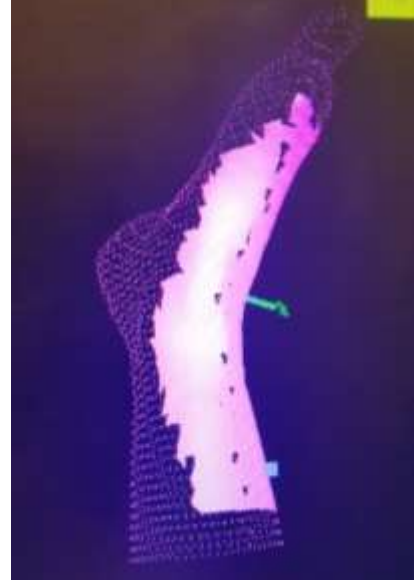
Pelvis

- Pelvis ROI's go inferior to the umbilicus but is dependent on the child as to how inferior
 - Diapers in the young children limit how far down to ROI can go
 - We tuck down the top of the diaper to move as much out of the way as possible
 - Adolescents are more likely to resist and we try to keep them covered as much as possible
 - We now have them take off underwear and cover with washcloth if we are not getting enough data with just the lower ROI



Extremities

- We use body fix for extremities
- For the patients with smaller extremities due to age, we have to expand the ROI outside of the treatment area to capture enough surface area
- The ROI also has to wrap around past mid depth to capture the contour of the extremity



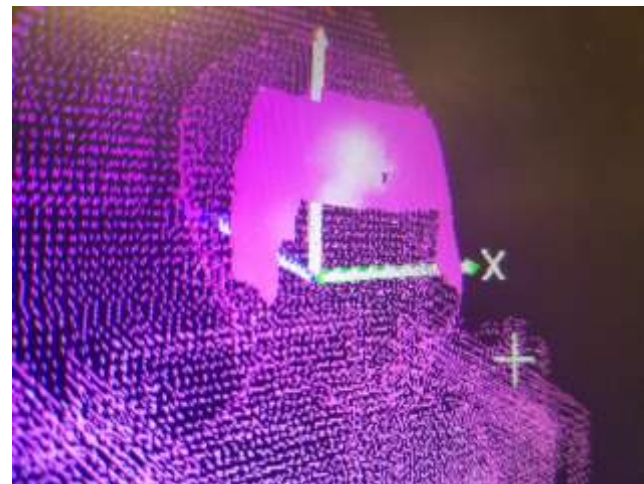
CSI- In-Room setup (Body ROI's)

- Because we only adjust the patient, vertical may be left outside of setup tolerance
- The pitch may be out of tolerance as well
 - We have found weight loss or constipation to be factors (we take new references if it becomes the new normal)



FSRT and SRS

- We now use Vision RT along with our standard head immobilization process.
 - Vacuum-assisted mouth piece and custom head rest



SRS and FSRT

- Prior to the start of treatment:
 - Patient is set up based on VRT and a new monitoring is captured
 - CBCT is performed and shifts are applied
 - A new VRT reference is taken immediately after the CBCT
 - The couch is rotated to any couch angles required during the treatment and a capture at each angle is taken (gantry at 0)
 - This does not override the earlier VRT data taken after the CBCT
 - After all couch angles are captured the couch is brought back to the finalized CBCT position and the patient is checked verify the patient has not moved.
 - Treatment begins
 - At each couch angle the movement of the patient is able to be assessed based on the monitoring capture's taken after the CBCT

Benefits of Vision RT

- Elimination of all skin marking
- Decrease in repeat imaging for set ups
- Treatments are more time efficient
- Allowing younger kids to be treated without anesthesia due to monitoring
 - Palliative cases saw a major benefit due to being able to be treated quickly without the need for anesthesia, less immobilization, and could go home quicker



Decreased Imaging

- The amount of repeated films have decreased
 - This happened slowly over a period of time (3-6 months) as we became more familiar and confident with VRT
 - It took making adjustments to the work flow and creating a process which we all agreed upon such as what VRT deviations we were willing to accept before filming
 - Tolerances for set up deviations using VRT prior to imaging:
 - Vertical, longitudinal and lateral are typically less than 2mm
 - Rotation, roll and pitch are typically less than 1 degree

Efficiency

- Treatment set ups have become more efficient since implementing VRT into the work flow
 - We use indexing, tight tolerances, and the “auto-go” feature on True Beam which allows us to be within millimeters of isocenter
 - By using VRT we are able to adjust multiple translations at once (adjusting roll while laterally moving the patient)
 - Typically we minimize any big translations (most often vertical and/or longitudinal) and then then fine tune the set up and adjust any roll, rotation or pitch

Benefits of Patient Monitoring

- We now have more confidence that the child has not moved since initial set up
 - Sometimes small movements are hard to be visualized by the human eye (or CCTV), however VRT allows us to see these smaller changes
 - Younger patients (4 and 5 year olds) are now more routinely done awake



Benefits of using VRT on CSI

- We have seen a large decrease in the number of repeated films
 - Visualizing and correcting the roll for the pelvis before CBCT has been the greatest help
 - Because we use Rapid Arc for treatment the roll is important
- Times were reduced to a total of 15-35 minutes per case for rapid arc treatments (Previously this could take anywhere from 45 minutes to an hour and a half)
 - Set up- 5-15min
 - Imaging- 5-10 min
 - Treatment- 5-10 min

Troubleshooting

- Limited body contours in the pediatric population
- Multiple lines and/or tubes in ROI's
- Belly breathing
- Increased movement in unsedated children
- Decreased cooperation in children
- Blanket or other covering inadvertently left on to keep child warm



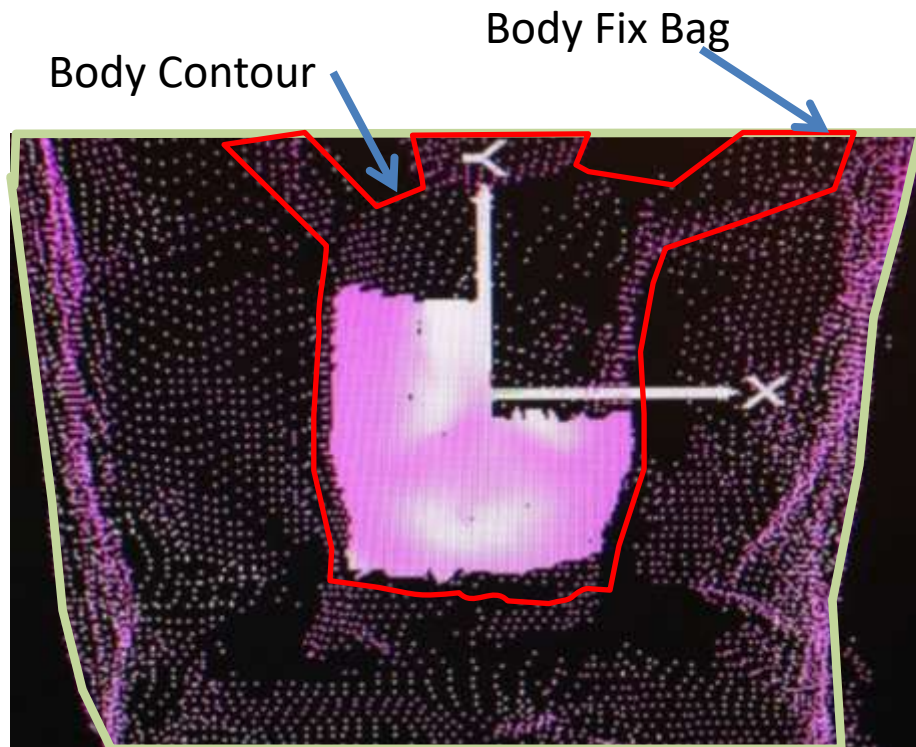
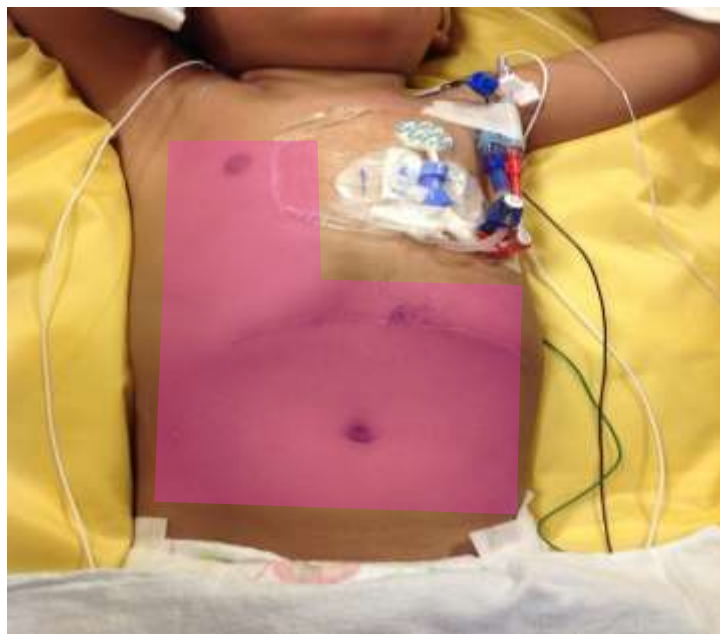
Multiple lines and/or tubes in ROI

- Younger children are treated with anesthesia which adds extra lines and/or tubing to the patient and these can interfere with the ROI and give inaccurate data
 - We have had to adjust patches to exclude the central lines and move other monitoring lines out of the way if possible
 - ROI's may be larger than the treatment field and sometimes exclude part of treatment field if it encompasses a patients access line

Multiple Lines/Tubes in ROI



Multiple lines and/or tubes in ROI

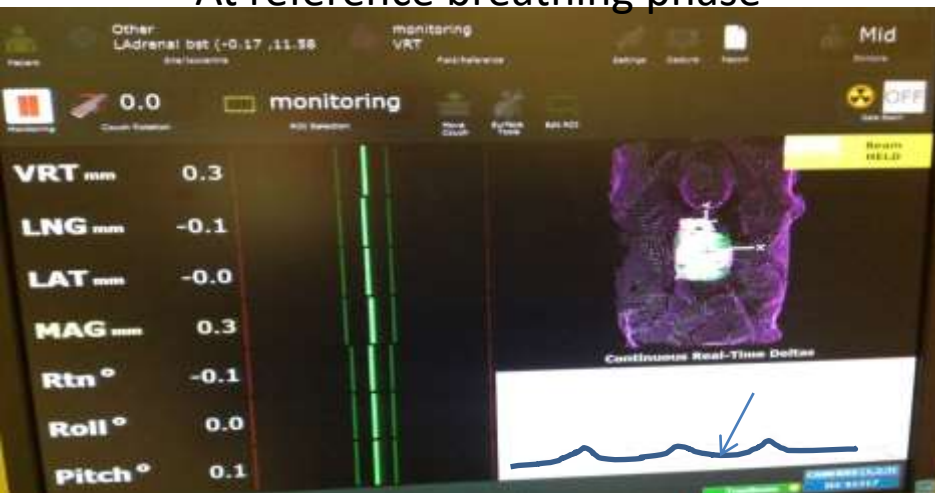


Belly Breathing

- We have found that children (young children especially) are more likely to be belly breathers
- This affects the longitudinal deltas with each breath instead of the expected vertical deltas
 - By knowing a particular child is a belly breather we are aware the longitudinal deltas may “jump” more than the others deltas
 - Gated capture may not completely correct the problem but may lessen the extent
 - We will typically add 1 to 2 seconds to the Beam-Off threshold to account for this

Affect of Belly Breathing

At reference breathing phase



At peak breathing phase



Managing Movement

- Unsedated children have a propensity to move more than adults and adolescents
 - Children who are not comfortable with how we have positioned them may readjust themselves
 - We may minimize moving them as long as they are within VRT setup tolerance and use the 6 Degree of freedom couch to correct the remaining difference through imaging
 - We use VRT to monitor the child for any motion and if they do move the MMI will Beam-Off.

Avoid Blanket or Clothing in ROI

- A blanket or other covering may be inadvertently left on to keep child warm
 - By checking the VRT computer while setting up we look to see if anything (blanket or piece of clothing) is within the ROI of the patient
 - Sometimes anesthesia or other personnel may cover the patient with out us noticing or the patient may cover themselves as well
 - The can lead to an incorrect set up
 - We look to make sure there is nothing obvious in the field as well as taking a treatment capture if there is any doubt

Improving Cooperation

- Children are less likely to cooperate for many different possible reasons. A few may be:
 - The child may be anxious
 - Explaining at their level what we will be doing can decrease anxiety significantly
 - If the child is uncomfortable they are more likely to move
 - For those who fidget constantly we give them options to what they can move
 - If we are treating chest we may allow them to wiggle their foot, we may give them Playdoh or a stuff animal to hold, ect.
 - The red lights from the camera system sometimes cause the younger kids to move or became anxious
 - We have told them they can close their eyes or watch the TV



Cooperation Cont.

- Creating a mold for a stuffed animal to explain the process and show what the mold and/or VRT lighting will look like may help reduce anxiety the child may have.



Thank You!

