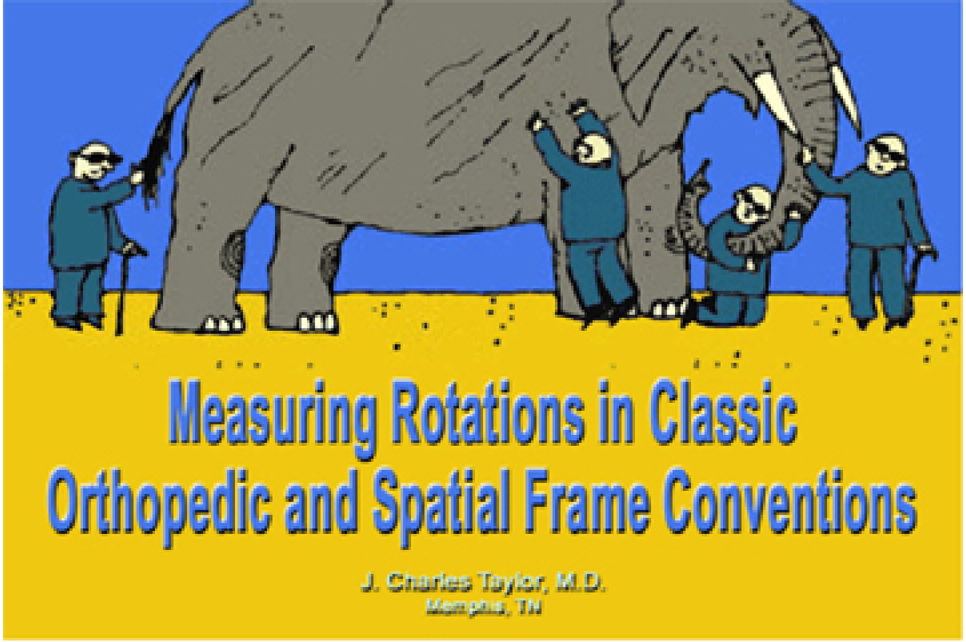
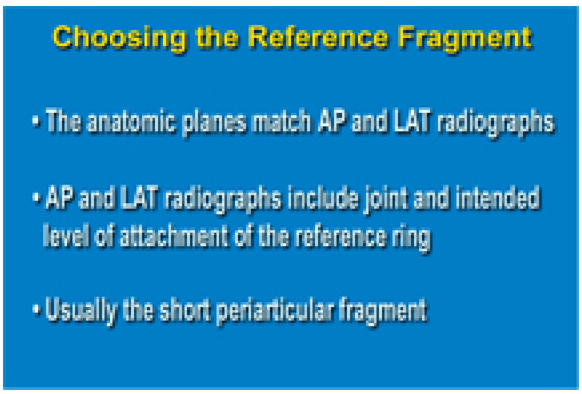
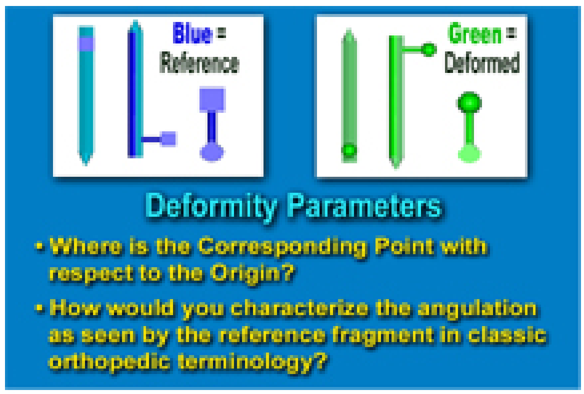
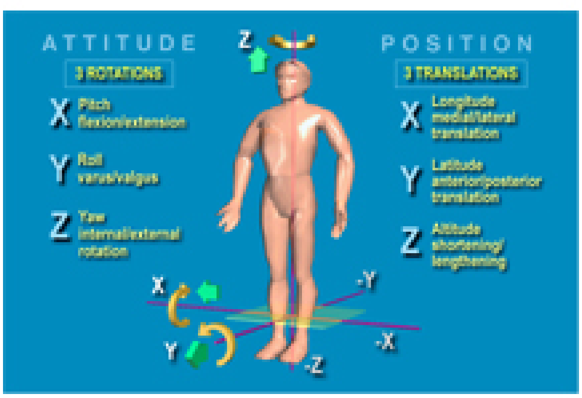


I want to talk about measuring rotations in deformity analysis, and comparing what we find in proximal versus distal references. Classic orthopedics only considers the relation of the deformed distal fragment in relation to the normal or Reference proximal fragment.



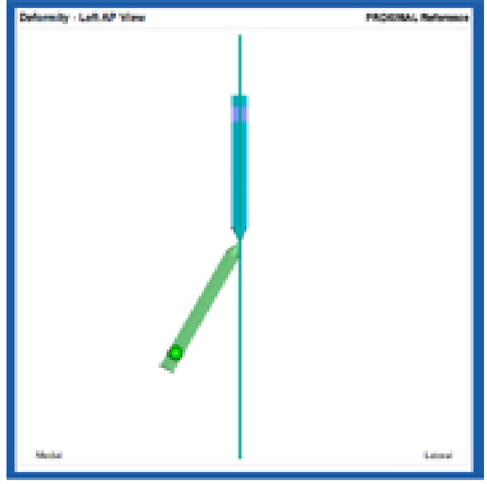


In the Spatial System we can also choose a distal reference and measure the deformity of the proximal fragment. In general our radiographs should be aligned to the reference fragment. The xrays should include the nearby joint and level of attachment of the reference ring. Usually the short periarticular fragment is the best choice of reference. Probably 75% of my cases use a distal reference. The spatial computer program presents the reference fragment as blue. We will discuss in detail how to characterize rotations.

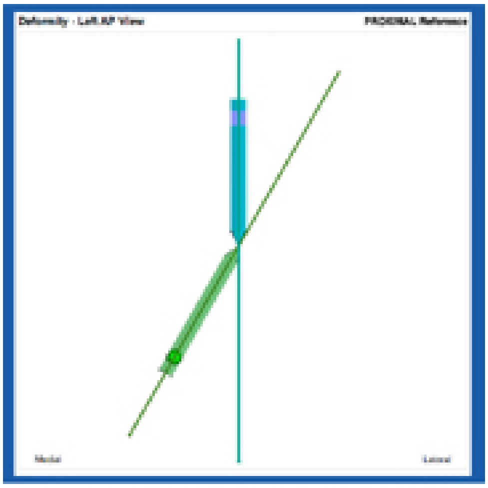


The 6 deformity parameters consist of 3 rotations and 3 translations about the cardinal axes. If we were physicists or engineers we would measure rotations as either positive or negative rotations about the axes based on the Right hand rule. But what we have is a strange way based on tradition.

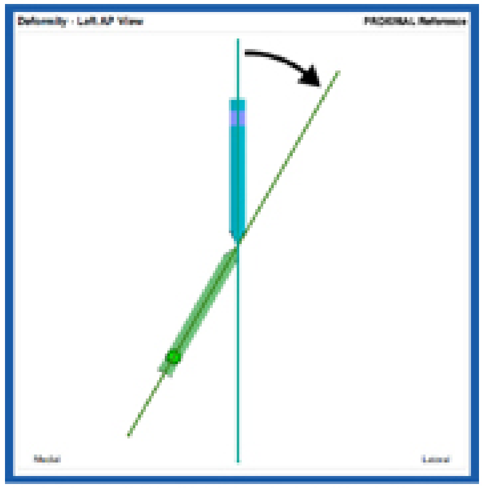
Look at this left tibia with a single angular deformity.



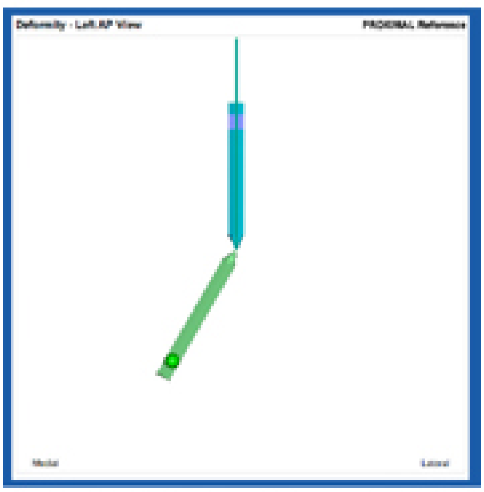
Draw the mechanical axis of the proximal fragment, in this case the reference fragment.



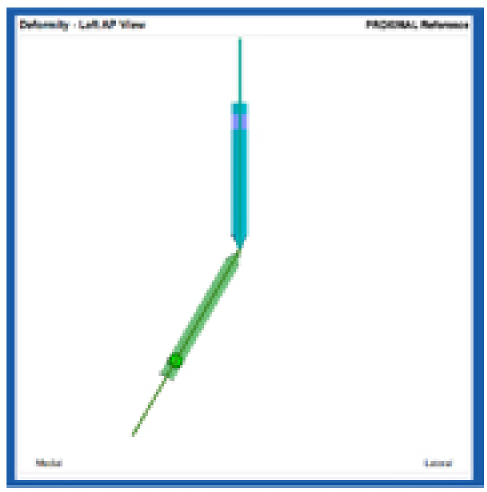
Draw the mechanical axis of the deformed distal fragment.



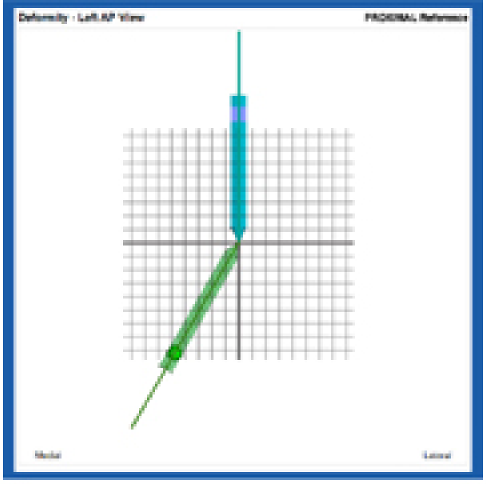
If we were true scientists we would measure the arc between the two positive limbs of the Z axis. In this case a negative 30º.

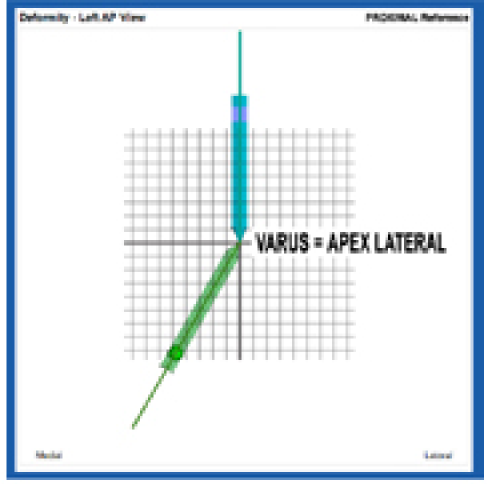


But in Ortho convention, we hang on to the positive Z axis of the proximal fragment.



And we hang onto the negative Z axis of the distal fragment, and describe the apex.

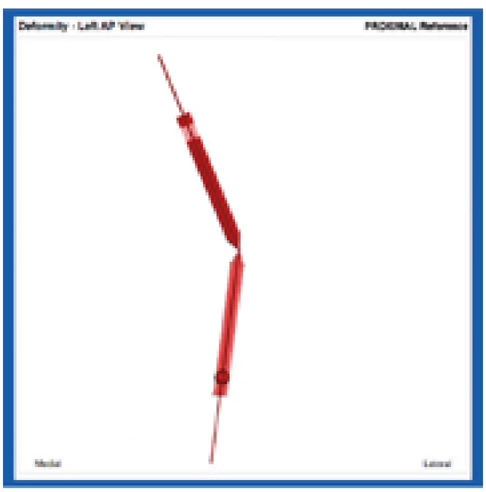

Snap the measuring grid to the reference fragment.

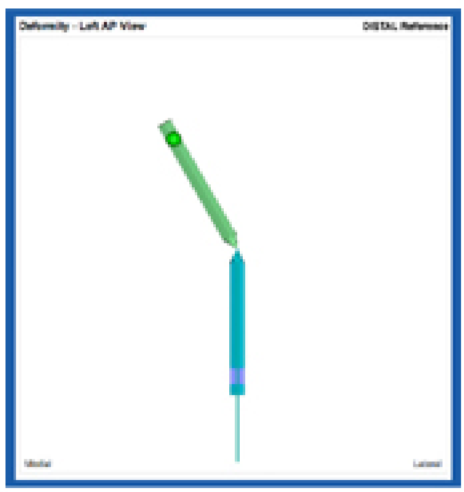


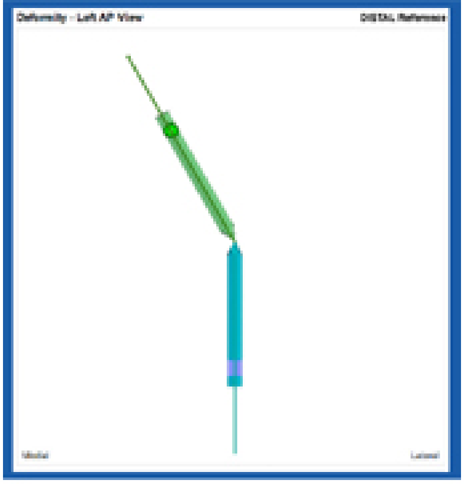
And describe the apex. In this case the apex is lateral and by definition a varus deformity.


Now gradually reposition the fragments until the distal fragment is reference and its mechanical axis is vertical.

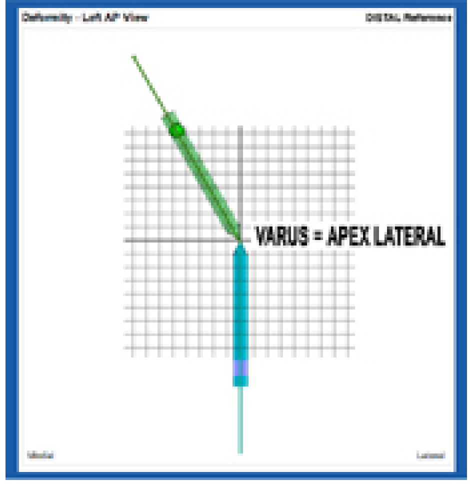

This is the midway position. Interestingly this midposition is what we consider for Ilizarov and all other type hinged corrections.


Now almost aligned to the distal fragment.

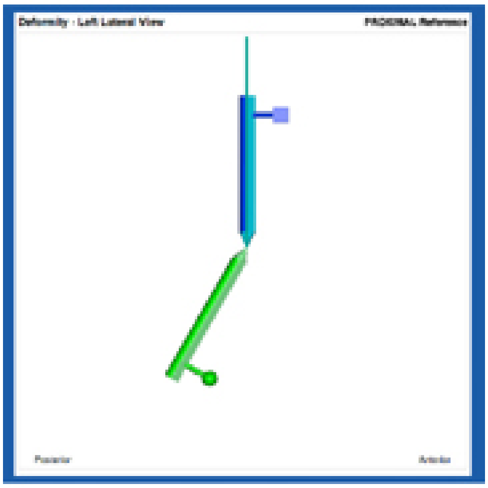

Now describe the deformity with a distal reference. Notice the distal fragment is now blue. Draw the negative Z axis of the distal fragment,



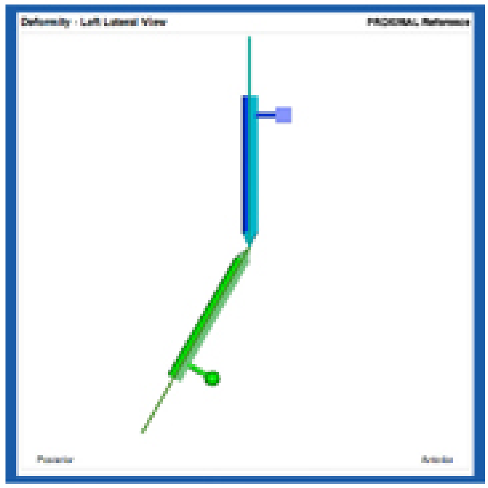
And draw the positive Z axis of the proximal fragment.



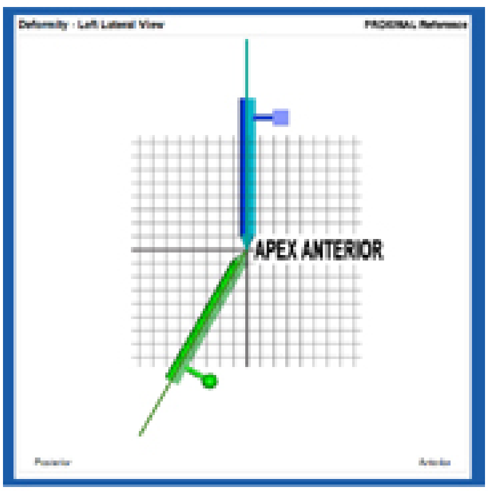
Snap the grid to the distal fragment and describe the apex, which in this case is lateral, which equals varus. In this case of an isolated angulation the proximal and distal reference agree to magnitude and direction.



Here is an isolated lateral view angulation with a proximal reference. Similarly, hang onto the positive Z axis of the proximal fragment.



Draw the negative Z axis of the distal fragment.

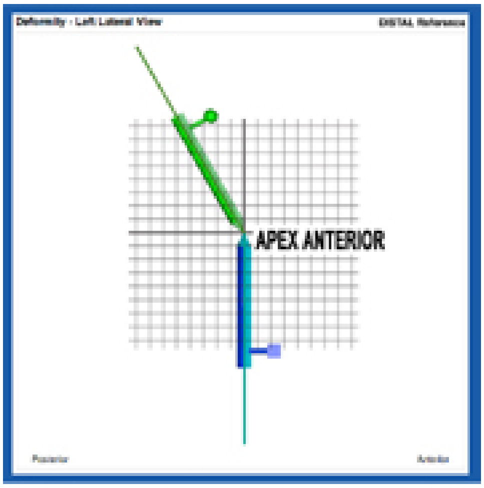


Snap the grid to the reference fragment and describe the apex, in this case apex anterior or procurvatum.

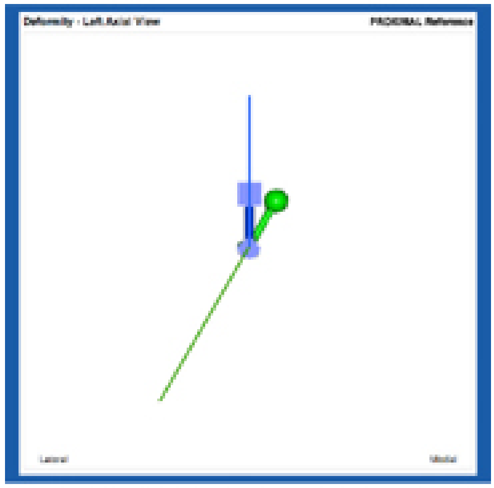
Similar to the AP view now realign the distal fragment until it is vertical.

Midposition.

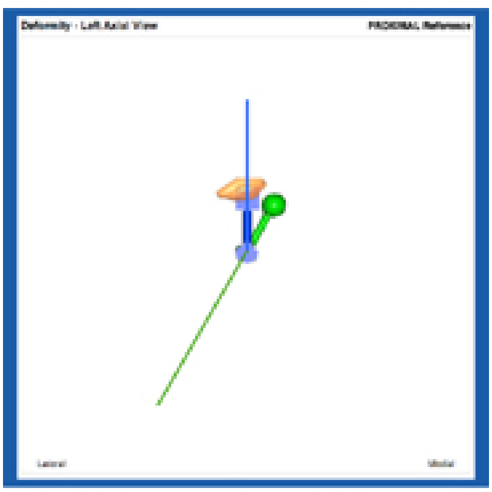
Almost aligned.



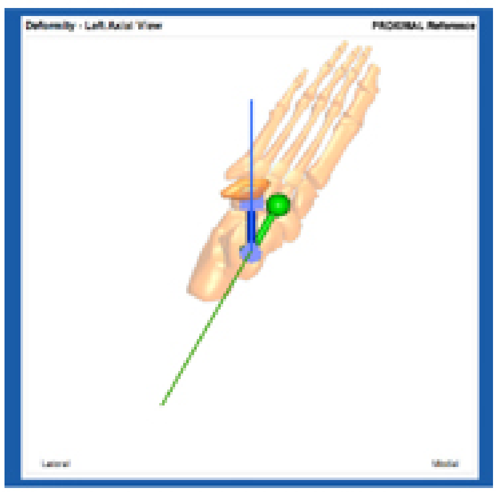
The same angular deformity now with a distal reference. Draw the negative Z axis of the distal fragment and the positive Z axis of the proximal fragment, snap the grid and describe the apex, also anterior.



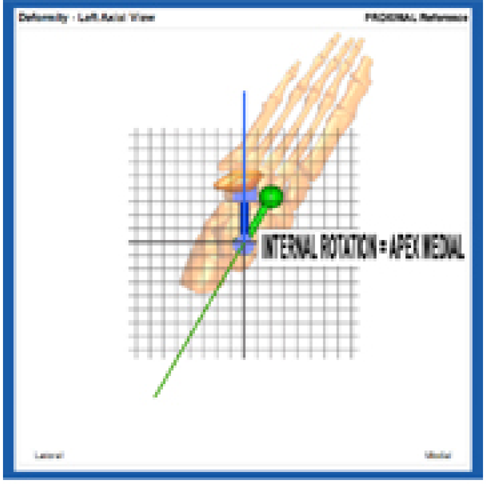
Now for axial rotation. The computer always looks down from the knee when it presents the axial drawing. So in this case of an isolated rotation the knee is blue the second toe is green. Draw the positive Y axis of the knee and the negative Y axis of the foot (which is essentially the calcaneus).



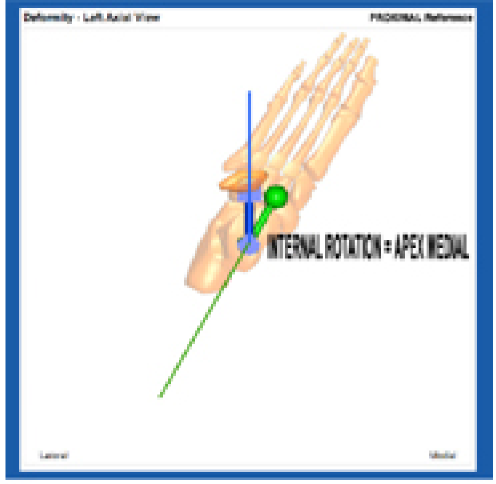
So the blue axis is the patella.



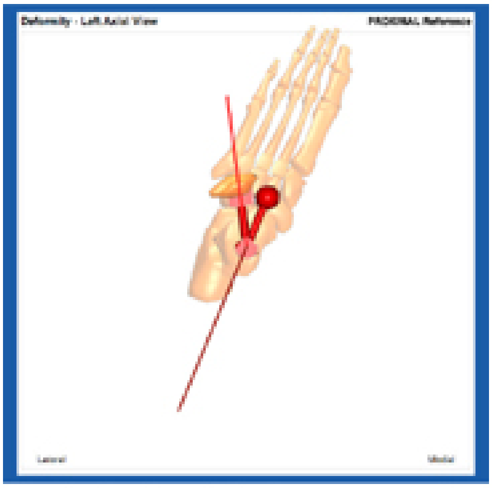
The negative Y axis is essentially the calcaneus.



Snap the grid to the reference proximal fragment and describe the apex. In this case the apex is medial which by definition is internal rotation.

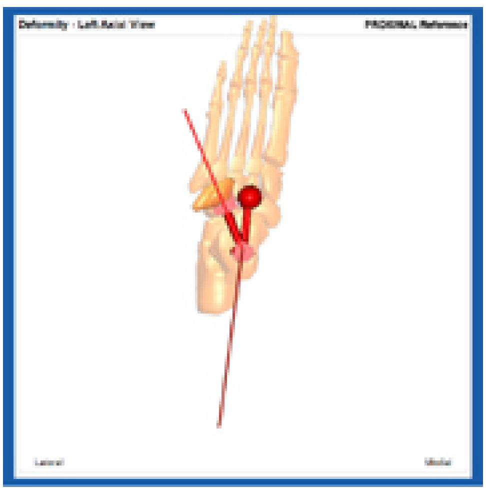


So Apex Medial equals Internal Rotation.



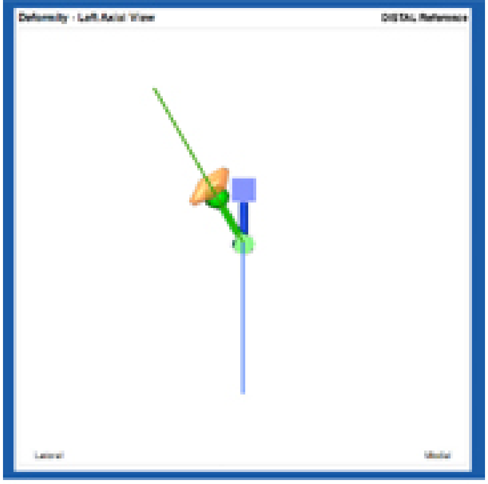
Similar to the AP view now realign the distal fragment until it is vertical.

Midposition.

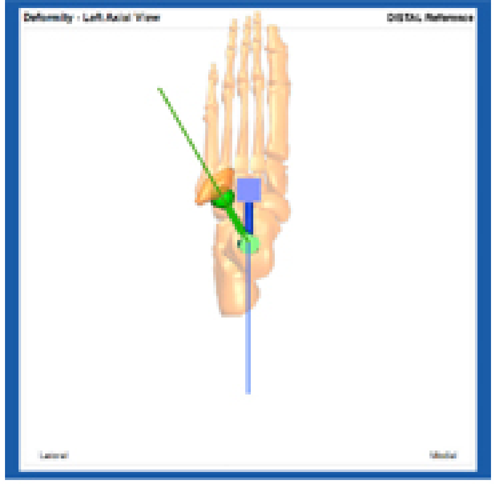


Almost aligned.

Now look at the same isolated rotation with a distal reference. The green is the deformed knee and the blue is the second toe. Draw the positive Y axis of the proximal fragment and the negative Y axis of the distal fragment.



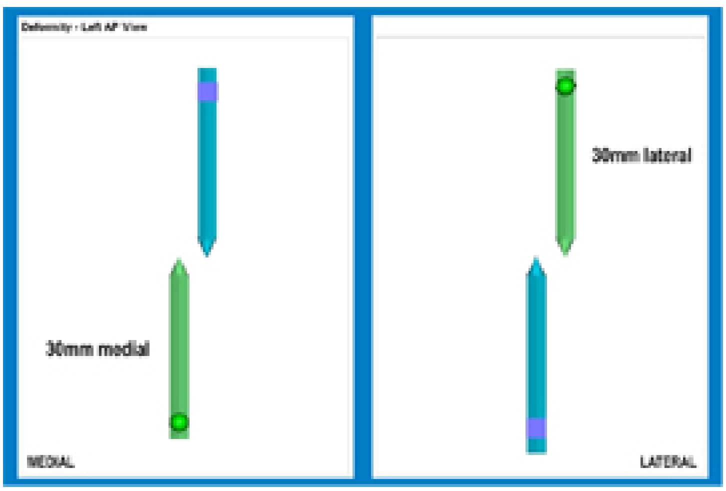
So this is the patella.



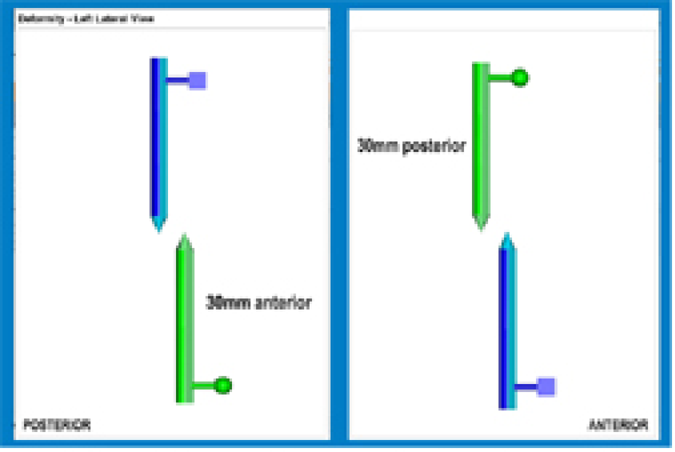
Here is the foot.

Snap the grid to the reference fragment, describe the apex which in this case is also medial. So by definition this is also an internal rotation deformity.

So distal reference, but still apex medial and thus still internal rotation.



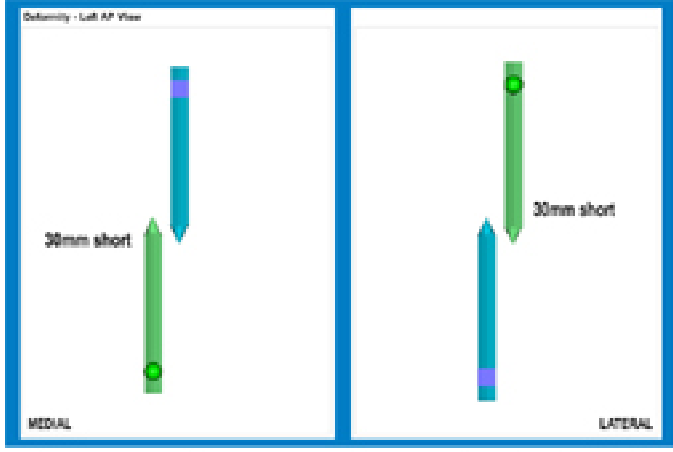
Let's look at isolated translation. In this case a 30 mm translation. Each half of the slide represents the same boney situation, but with a left tibia and proximal reference the first deformity would be classified as a 30 mm medial translation.On the right part of the slide with a distal reference this would be calssified as a 30 mm lateral translation



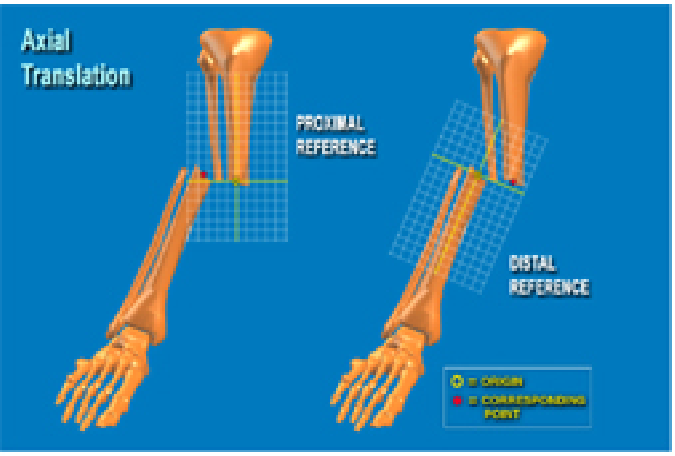
On lateral view with a proximal reference the left hand deformity would be classified as a 30 mm anterior translation.

The right portion of the slide illustrates the same boney deformity, but with a distal reference we classify this as a 30 mm posterior translation.

If there is only a translational deformity, the AP View and Lateral View translations will flip-flop for Proximal vs Distal Referencing.



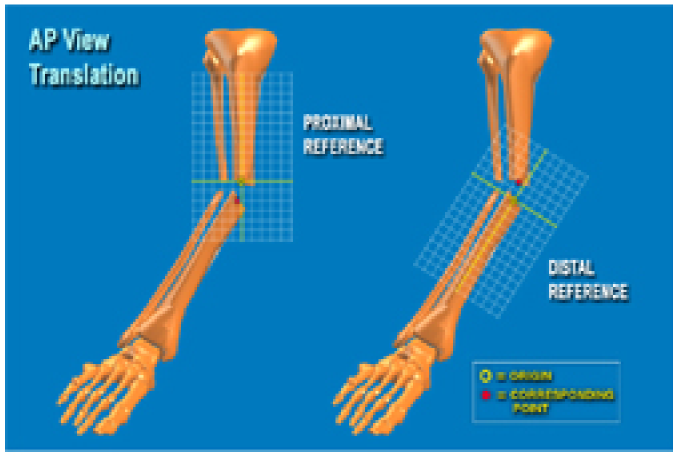
Because of the convention or terminology in the Spatial System, for isolated translational deformities the Proximal and Distal References will agree on Axial Translation.



However, with only the introduction of a single angular deformity the translational deformities will differ quantitatively. You would think that a deformity is either short or distracted. And that it could not be both.

The boney relation is identical on left and right portions of the slide. On the left we pick a proximal reference and snap the grid to the proximal fragment and see that the corresponding point is short.

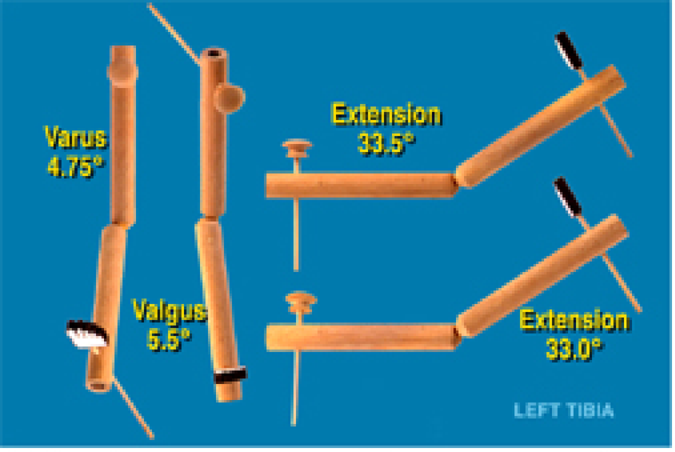
On the right we pick a distal reference, snap the measuring grid to the distal fragment and see that the corresponding point is distracted, or long.



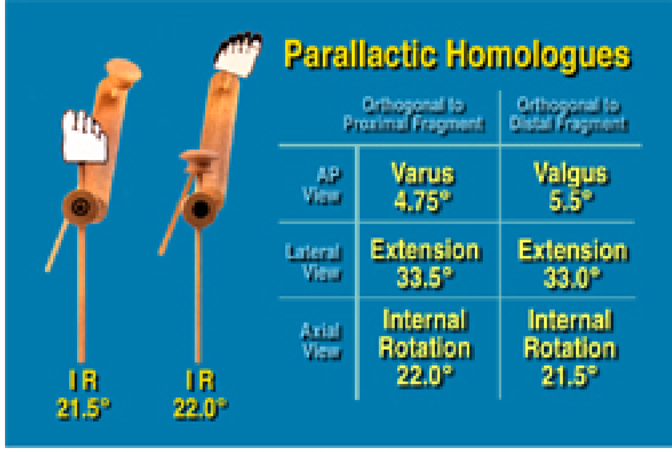
I had mentioned that with translations only, that the AP View and Lat View translations flip-flop with proximal versus distal reference.

When angulations are present anything can happen.

In this case of angulation, both the proximal and distal reference see the corresponding point as laterally translated.

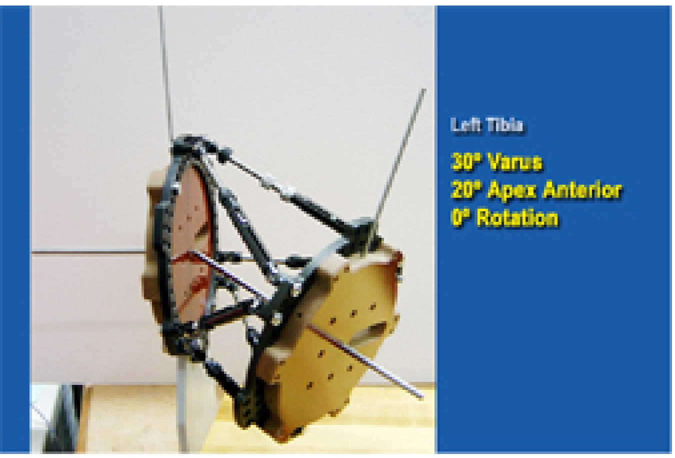


When two or more angulations are present, measurements of deformity based on a proximal fragment will differ from those when x-rays are shot orthogonal to the distal fragment. You see 4 photos of the same wooden model, with an AP and Lat shot orthogonal to the patella and then shot orthogonal to the foot. Notice that the AP measurements differ quantitatively by more than 10º. The Lateral views differ by 1/2º.

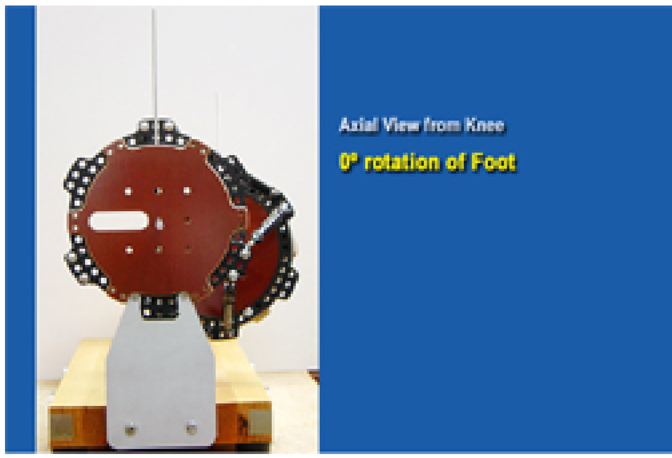


Similarly the Axial views differ by 1/2º. On the right you see the summary of the measurements based on the proximal versus the distal fragment. They both completely describe the deformity and would completely correct the deformity, but they are very different.

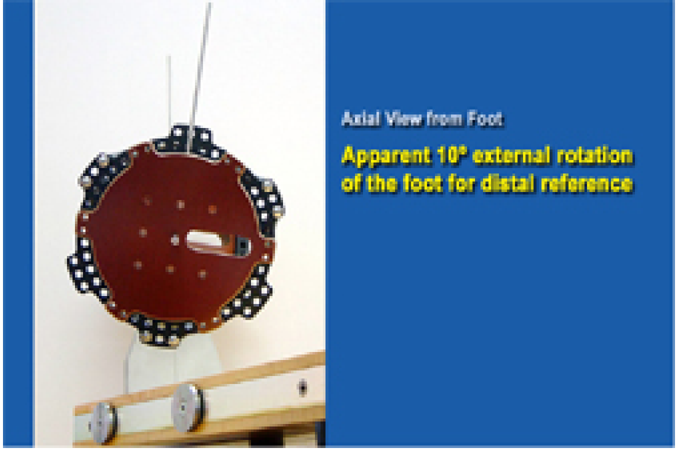
Bottomline- Pick one fragment as reference and make all measurements based on this fragment.



As a final illustration of apparent rotation measured from a proximal reference versus a distal reference, consider the spatial frame simulator above. The frame has been adjusted in the Chronic Mode for a proximal reference to correct 30º varus, 20º Apex Anterior and no rotation. This oblique photograph shows the proximal mechanical axis to the left and the deformed distal mechanical axis to the right. The smaller, more vertical, steel rods represent the patella and the second toe (the Y and Y' axes).



This photograph is taken from proximal almost directly in line with the Z axis of the proximal fragment. Notice there is no rotation between the patella and the second toe, exactly what we had asked for from the the Chronic Program.



However, this photograph is taken exactly in line with the Z' axis of the distal fragment, and shows a 10º external rotation deformity of the distal fragment.

In general if there are two rotations in one reference, there will be three rotations in the other reference. The magnitudes and sometimes the directions will be different from one reference to the other.