X-Ray protocol
Overview

The Smith & Nephew VISIONAIRE® X-Ray protocol is essentially an AP leg length image. The images are preferred to be done erect, but can be done supine if necessary due to the type of equipment available or patient safety issues. The protocols below describe multiple ways in which this imaging can be performed.

Acceptance criteria for all protocols

1. The correct name identifier and date of birth must be present on or associated with all images.
2. The correct letter markers are required to be applied to all images.
3. To ensure that all anatomy is adequately exposed from the hip joint to the ankle joint. Three exposures are ideal, but four exposures are acceptable. Adequate overlap is required to allow stitching of images. (No overlap markers are required for X-Rays done with single exposure films.)
4. No overpenetrated/underpenetrated images, hip to ankle. All anatomy must be visible to achieve accurate measurements.
5. Unilateral X-Rays are preferred, but not required.
6. All joint spaces must be visible: hip, knee and ankle. Images should not stitch/overlap at the knee joint.
7. If possible, the ankle must be in a true AP position. The patient’s hips should be squared with, or parallel to, the Bucky. The patient’s foot should be perpendicular to the Bucky. If a true AP cannot be attained while standing due to joint deformity or patient instability, the supine X-Ray procedure should be used.
8. No patient movement between any of the images that make a complete image set.
9. CT localizers can no longer be accepted. CT localizers, surviews or scouts are not accepted.
10. All X-Rays acquired on the whole leg standing exam should be sent even if your software autostitches images together. (Stitched image set plus original set of images must be sent).
11. X-Ray images must be saved and uploaded in full DICOM format only. No viewer is required. If your PACS system also produces JPEG images with the DICOM set, this is acceptable. No lossy or lossless DICOM files can be accepted.
Protocol #1
Multiple overlapping images (erect)

1. Patient is standing in true anatomical position in front of a wall Bucky or X-Ray table with a foot board that can be placed in vertical position with feet forward and legs straight. Do not place feet/ankles together. If deformity of patient anatomy will not allow entire leg to be in true AP position, it is most important to have the foot/ankle in a true AP position. See Figure 1.

2. Four radiopaque markers are placed on the patient so as to be seen on overlapping images. These can be anything radiopaque (i.e., pennies, small coins). These markers are used by Smith & Nephew to “stitch” multiple images together as though taken as one. See Figure 1.

3. The “stitched” long leg X-Ray is used to identify the patient’s mechanical axis, which is one of the most critical measurements used by the VISIONAIRE® Engineer when determining correct alignment. Advise patient of importance of not moving between exposures. The only things that should move between exposures are the image receptor and X-Ray tube, and this should only be a vertical motion. To be sure that moving the image receptor will not cause patient to adjust position, be sure that the patient is not touching or leaning against wall Bucky. See Figure 2. If using vertical X-Ray table, patient can lean against table because patient will be able to maintain same position when table or image receptor are moved. Verify acceptable patient movement between exposures by checking to see if at least 50% of the fibula lines up. See examples of resulting images.

4. Leg centered to cassette.

5. SID can be any distance as long as it is the same on all exposures.

6. Exposure 1 shows hip joint and most of the femur. See Figure 2. The entire femoral head must be visible as this is critical to establish the mechanical axis of the femur.

7. Exposure 2 shows the knee joint and overlaps exposure 1. See Figure 3. There should not be a break in the knee joint, any stitching should be on the shaft.

Note: Center knee as close as possible to the center of the image receptor.

8. Exposure 3 shows lower leg/ankle and overlaps exposure 2. See Figure 4. The entire ankle must be visible as this is critical to establish the mechanical axis of the tibia. This is also used as an indication of tibial rotation.
Protocol #2
Multiple overlapping images (supine)

1 Patient is positioned supine with legs positioned in true anatomical position to appear as though they are standing. Do not place feet/ankles together and be sure that the foot of interest is dorsi-flexed. Ensure that the ankle remains in a true AP position throughout the exam. If concerned that patient may not be able to hold position through multiple exposures, immobilize the leg before taking first exposure. If deformity of patient anatomy will not allow entire leg to be in true AP position, it is most important to have the foot/ankle in a true AP position. See Figures 5-7.

2 Four radiopaque markers are placed on the patient so as to be seen on overlapping images. These can be anything radiopaque (ie pennies, small coins). These markers are used by Smith & Nephew to “stitch” multiple images together as though taken as one. See Figure 5.

3 Advise patient of importance of not moving between exposures. The only things that should move between exposures are the image receptor and X-Ray tube, or the table top.

4 SID can be any distance as long as it is the same on all exposures.

5 Exposure 1 shows hip joint and most of the femur. See Figure 5.

6 Exposure 2 shows the knee joint and overlaps exposure 1. See Figure 6.

7 Exposure 3 shows lower leg/ankle and overlaps exposure 2. See Figure 7. The resulting images should appear the same as Protocol #1.
Protocol #3
Digital leg length X-Ray

1 Patient is standing in true anatomical position in front of image receptor with feet forward and legs straight. Do not place feet/ankles together. If deformity of patient anatomy will not allow entire leg to be in true AP position, it is most important to have the foot/ankle in a true AP position.

2 Expose entire leg from hip to ankle according to machine manufacturer’s recommendation ensuring that patient does not move between exposures.

3 Figure 8 shows an acceptable digital image.
Quality X-Rays are imperative to the VISIONAIRE® process. Rotation in the full leg X-Ray can alter the measured mechanical axis of a patient. Rotation between images that require stitching can cause the same outcome. Also not being able to identify all of the required anatomy makes defining the correct mechanical axis difficult. Below is an example of how much variation can be seen between acceptable and unacceptable X-Rays.

Looking at these images side by side, it is obvious that since the accepted images correctly represent the patient’s anatomy, that using the rejected X-Rays would have caused much of the alignment to be inaccurate.

**Femur alignment**
The rejected radiograph appears to have a bigger femur bow angle and is severely more externally rotated than the accepted images. This would result in an alignment with the incorrect femur valgus angle.

**Tibia alignment**
As can be observed in the tibia, the rejected image would not have provided the correct tibia mechanical or anatomical axis value. The tibia is externally rotated, which would have caused a much larger tibia bow angle to be measured than what is reality. With this information being incorrect, it would cause the tibia coronal alignment to also be inaccurate.

**Overall alignment**
With the tibia and femur images being as poor as they are in the rejected image, the measured full leg deformity would be wrong as well.

Knowing the magnitude of the full leg deformity affects how Smith & Nephew approaches aligning the case. Without proper X-Rays, it is not possible to align a case accurately. Smith & Nephew aligning a case based off of the rejected X-Rays on the left would not be confident in the alignment or the blocks that are provided to the surgeon.