

SPECT/CT in evaluation of anterior knee pain following patellofemoral arthroplasty

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Data and images courtesy of Engereid Hospital, Bern, Switzerland

History

A 50-year-old man with a history of patella-femoral arthroplasty for patella-femoral arthritis of the right knee joint presented with persistent anterior knee pain, which accentuated on flexion and lateral rotation of the knee. Routine radiographs were unremarkable, with the exception of a wide patellar tilt. The patient was referred for a ^{99m}Tc -DPD bone scintigraphy to evaluate joint pathology.

A three-phase bone scan was performed on a Symbia Intevo™ SPECT/CT after an intravenous (IV) injection of 600 MBq of ^{99m}Tc -DPD. Initial dynamic planar perfusion images were followed by planar bloodpool images of both knee joints. Delayed-phase planar whole-body images were acquired three hours post injection, followed by a SPECT/CT of both knees in which CT and fused SPECT/CT images were reviewed together for final evaluation.

Findings

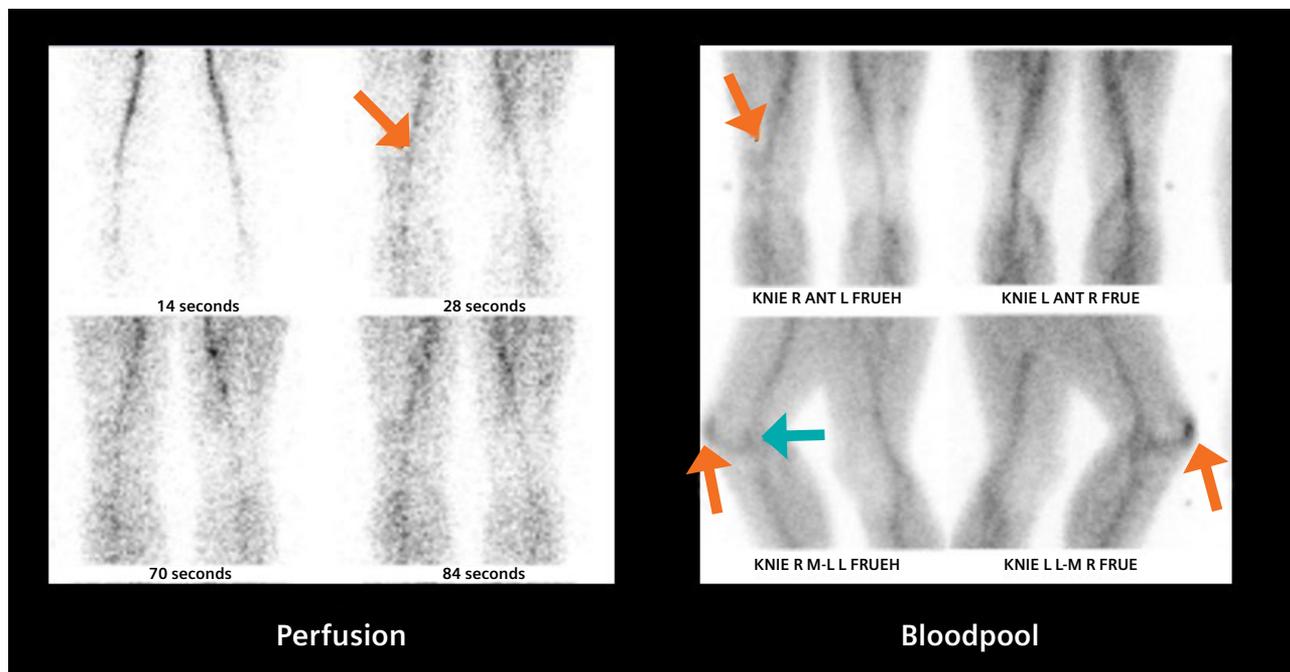
Radiography in this patient shows an abnormal gap between the flat patellar-articular surface with sclerosis following resurfacing and the anterior margin of the patella-femoral arthroplasty prosthesis, which is attached to the trochlear groove with suggestion of exaggerated tilt of the right patella. The mild hyperemia of the right patella seen in the bloodpool images correlates with the lateral patellar hypermetabolism seen on the planar whole-body image, which reflects patellar overload secondary to patella-femoral arthroplasty (Figures 1 to 3). Although the mechanical axis of the right femur and tibia are aligned and no valgus or varus deformity is visualized in the right knee, the minor hypermetabolism in the medial femoro-tibial compartment probably reflects slight medial femoro-tibial overload. In this context, bone SPECT/CT is key to the accurate identification of focal stress overload and evaluation of patellar, articular and prosthetic instability, displacement, loosening, periprosthetic fracture, and mal-alignment.

As evident from the SPECT/CT images (Figures 4 to 8), the primary site of stress overload is localized to the lateral part of the right patella but without any evidence of patellar fracture, prosthetic loosening, or periprosthetic focal bony stress or fracture. Predominant lateral patellar stress in absence of any other evidence of significant femoro-tibial focal hypermetabolism suggests presence of patellar overload with a lateral patellar tilt, which may reflect incorrect positioning of the prosthesis with the patellar-articular surface.

The indices of knee joint stability such as the IS ratio and TT-TG distance (Figures 9 and 11) as calculated from the CT data are normal for the right knee, thereby confirming absence of any prosthetic displacement, mal-alignment, or joint instability. The larger-than-normal right patellar tilt (Figure 10) measured on the axial CT images clearly shows the lateral tilt of the right patella, which may have an impact on the lateral patellar overload.



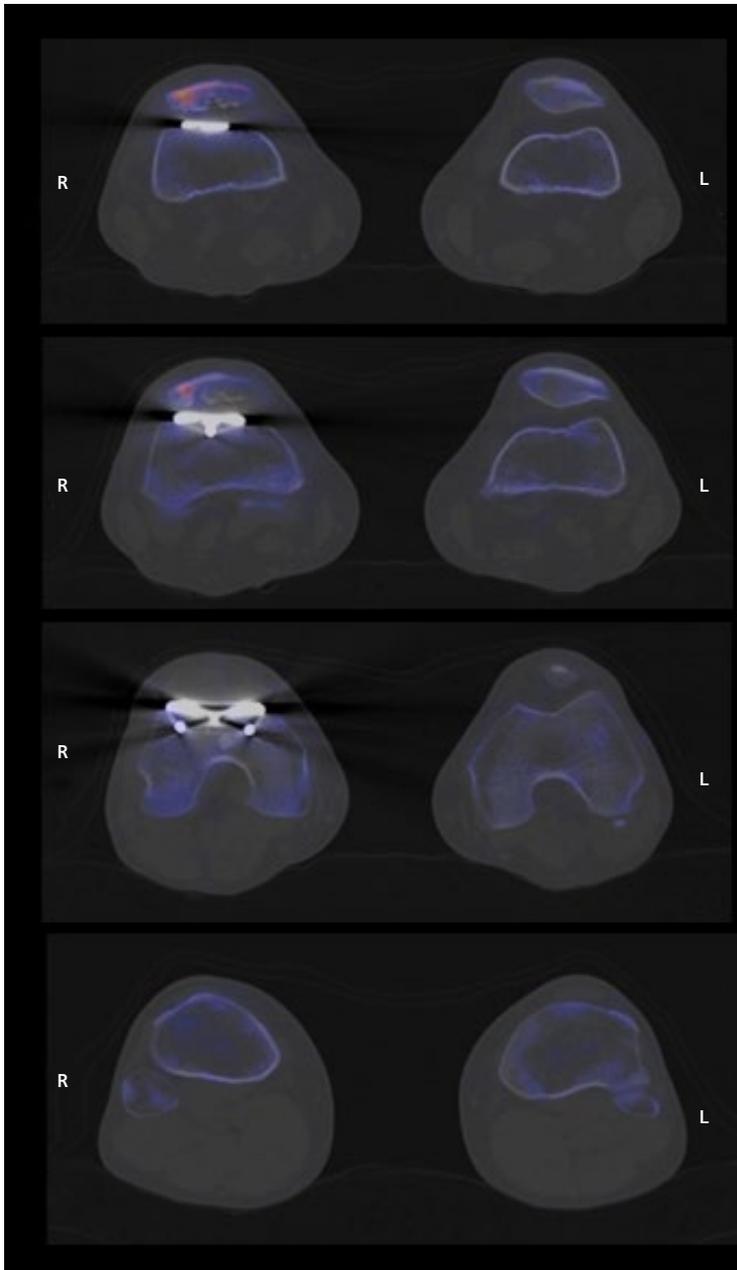
1 Anterior, lateral, and end on radiographs of the right knee joint show the patella-femoral arthroplasty prosthesis fixed on the trochlear groove, extending to the medial aspect of the upper part of both the medial and lateral femoral condyles, and articulating with the patella. There is no visible gap between the femoral condylar bone and prosthesis, which suggests an absence of loosening. The articulating surface of the patella is flat with bony sclerosis (arrow) rather than concave, which is probably secondary to patellar resurfacing at the time of arthroplasty. There is a significant gap between the prosthetic trochlear concavity and the patellar articular margin with larger gap medially suggesting a slight lateral shift of the patella with pathological tilt.



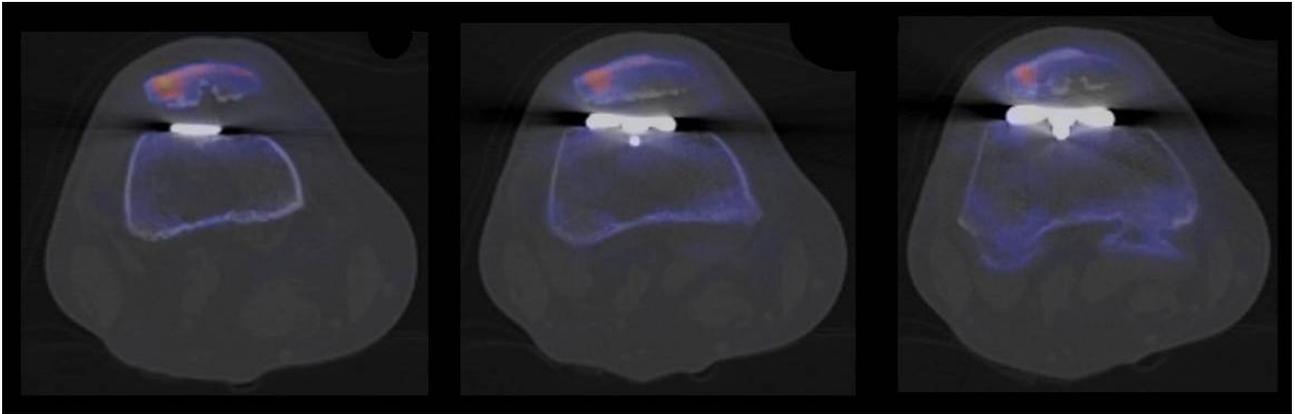
2 Dynamic planar perfusion and static bloodpool images show mild hyperperfusion and slightly increased bloodpool in the right patellar region (orange arrows) reflecting bone hypervascularization reactive to overload stress. A slight increase in bloodpool activity in the articular region (blue arrow) reflects minor synovitis.



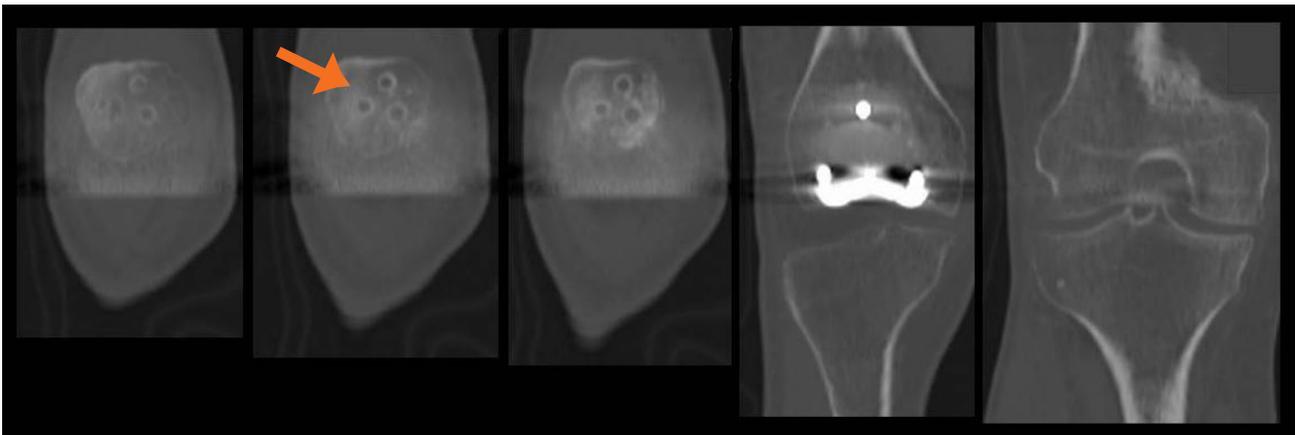
3 Planar anterior and posterior whole-body images show increased uptake in the right patella (orange arrow) along with mild hypermetabolism in the medial condyle of tibia. The mechanical axis of the femur aligns to the tibial shaft axis without significant varus or valgus abnormality, as seen in the anterior whole-body images. The highest intensity of uptake is in the lateral part of the right patella, which appears to be the key focus of bone stress, with the medial tibial condyle showing only minor hypermetabolism that is unlikely to be related to major bone stress in the context of normal femoral and tibial mechanical axes.



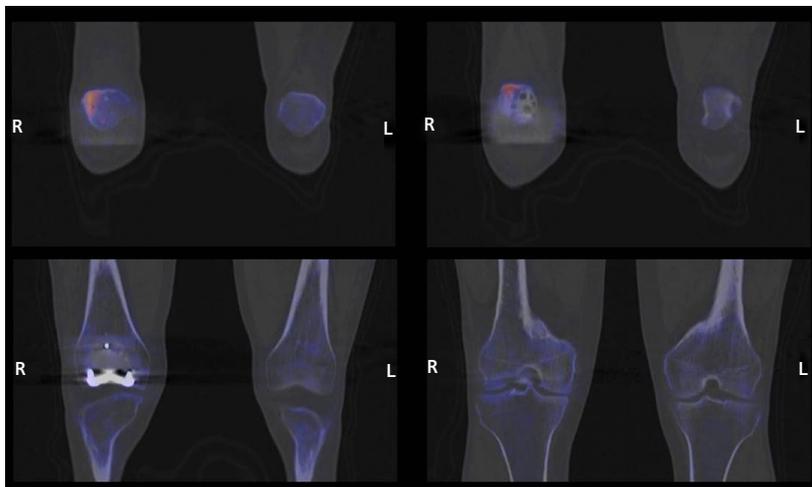
- 4** Axial-fused SPECT/CT slices through both knee joints show focal hypermetabolism within the patella predominantly in the lateral aspect. Patellofemoral arthroplasty prosthesis is properly fixed to the trochlear groove without any periprosthetic lysis. There is also no gap between prosthetic margin and adjacent femoral bone suggesting an absence of loosening or displacement of prosthesis. Additionally, there is no focal abnormal uptake in the periprosthetic femoral bone, which rules out prosthetic loosening, periprosthetic fracture, periprosthetic bone stress related to faulty prosthetic placement, and prosthetic instability.



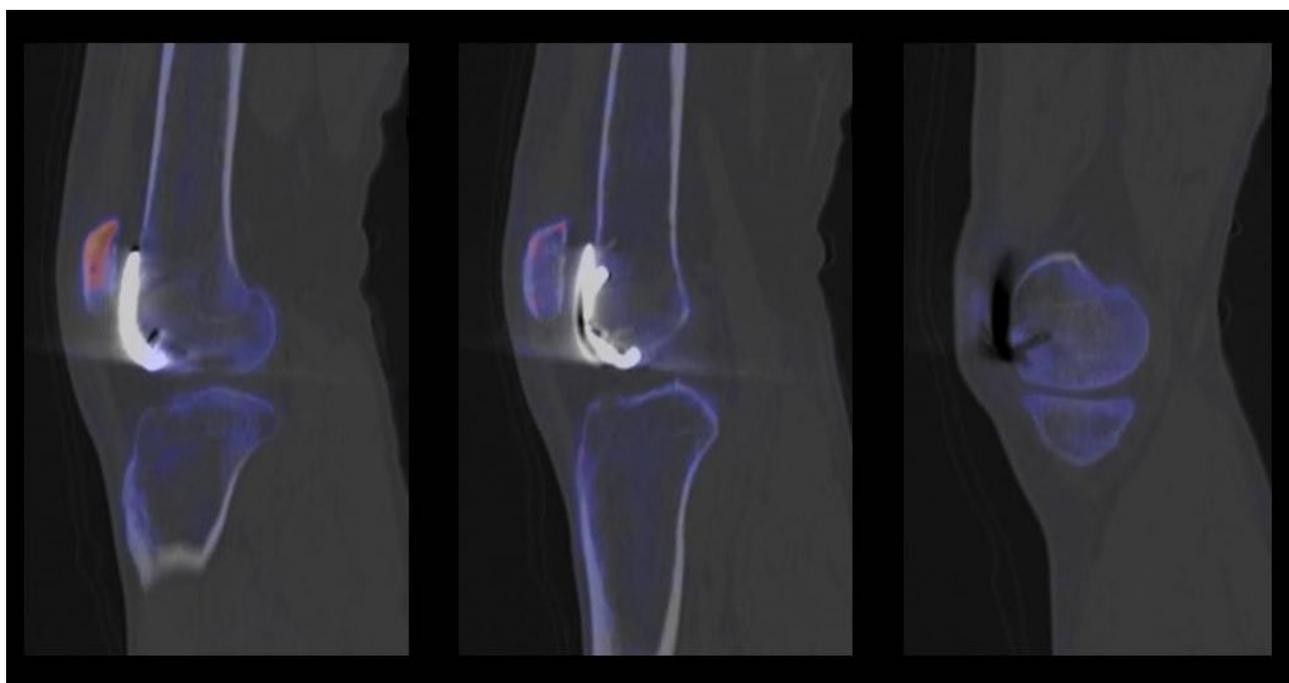
- 5** Enlarged axial-fused SPECT/CT slices through the knee joint at multiple levels through the patella show focal hypermetabolism in the lateral part of patella predominantly involving the anterior and middle part of the entire patellar thickness. The patellar-articular surface appears irregular with mild sclerosis reflecting patellar resurfacing but without significant articular surface hypermetabolism. This suggests that the hypermetabolism is predominantly due to patellar overload stress mostly in the lateral aspect without significant friction at the articular surface.



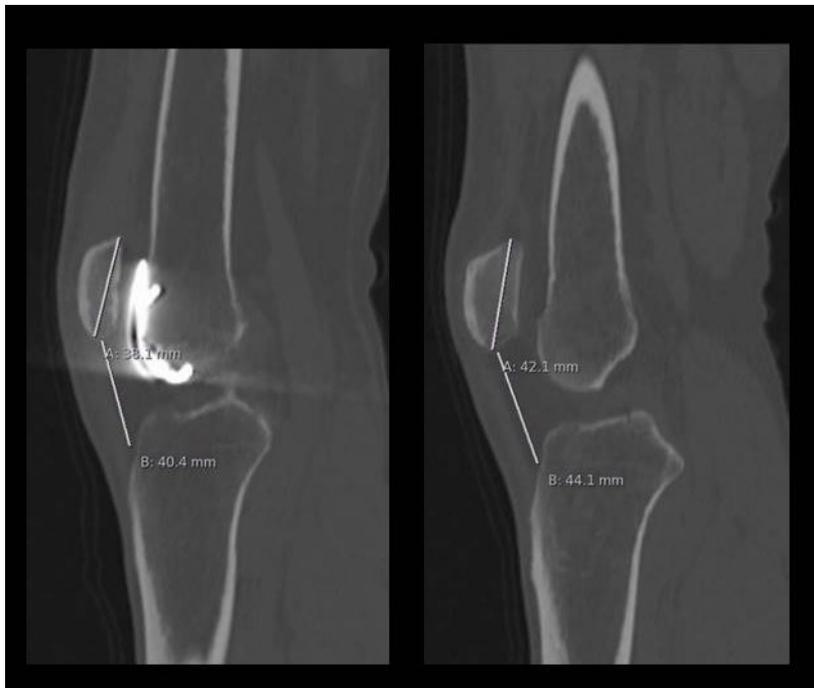
- 6** Coronal CT slices from anterior to posterior aspect of the knee joint shows mild bony sclerosis in the lateral part of the patella (orange arrow). The CT delineates drill holes in the patellar cortex related to previous resurfacing of the patellar articular surface and there is no indication of patellar fracture. Additionally, prosthetic margins are well approximated to the adjacent femoral bone. Medial and lateral femoral condyles and both tibial condyle and tibial tubercles do not show significant irregularity of articular surface. The joint spaces appear normal.



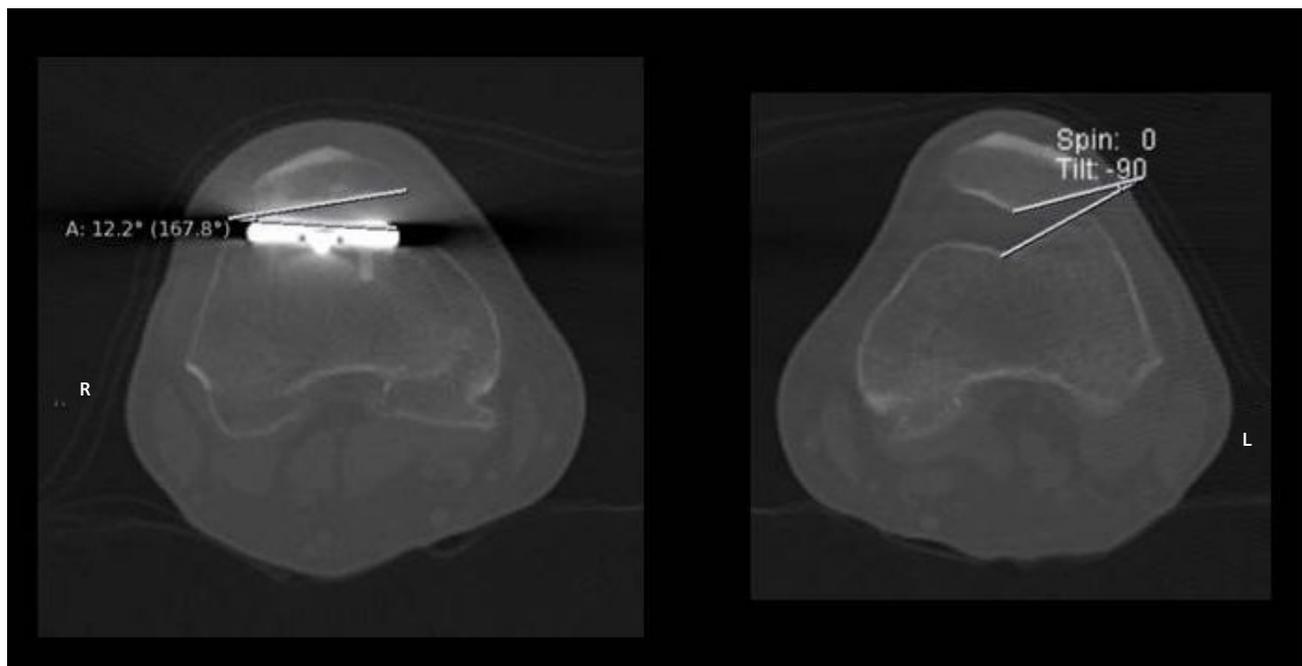
- 7** Coronal-fused SPECT/CT slices through the knee joint from anterior to posterior show focal hypermetabolism in the lateral aspect of right patella corresponding to CT findings of mild patellar sclerosis. There is no hypermetabolism seen in the periprosthetic bone and tibio-femoral condylar and joint space and prosthetic loosening or displacement is not visualized.



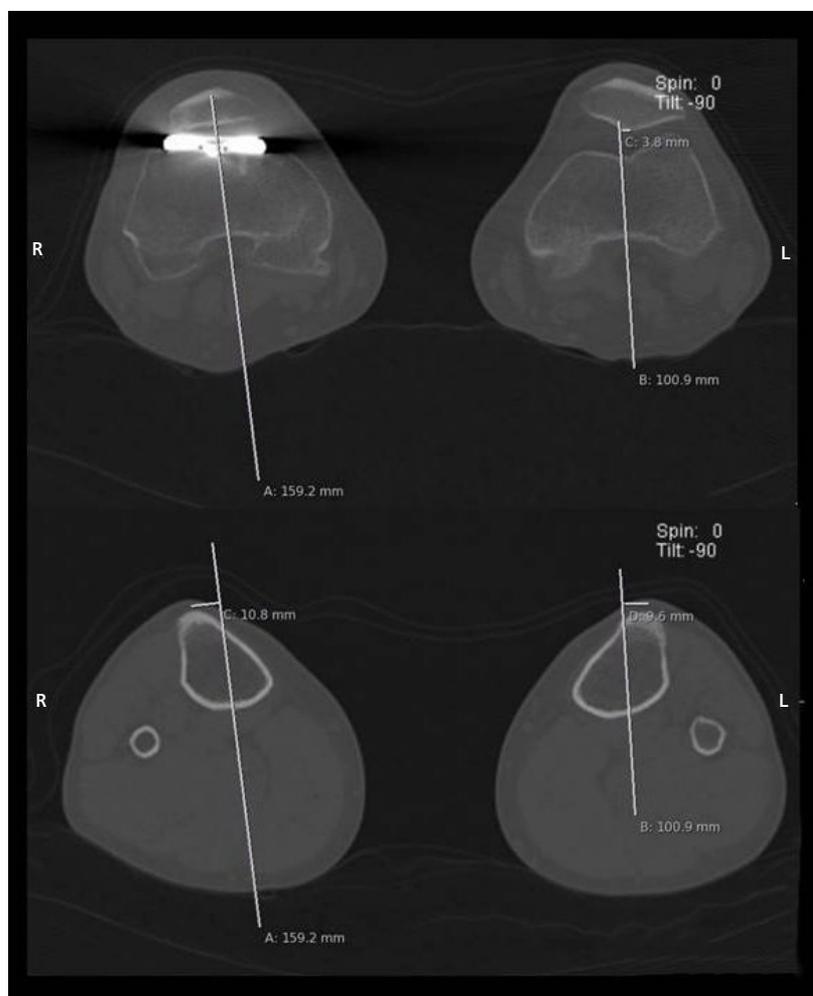
- 8** Sagittal-fused SPECT/CT slices through the right knee joint from lateral to medial show hypermetabolism in the patella in the upper lateral part. Sclerosis in the patellar articular surface is visualized. Patello-femoral arthroplasty prosthesis attached to the anterior aspect of lower femur in the trochlear groove and inter-condylar space show no evidence of displacement or loosening. No other periprosthetic, condylar, or articular hypermetabolism is visualized. Femoral and tibial condylar margins and joint spaces are unremarkable.



9 Sagittal slices through CT of right and left (normal) knee joints for determination of Insall-Salvati (IS) ratio of both knee joints (ratio of patellar tendon length or length of the posterior surface of the tendon from the lower pole of the patella to its insertion on the tibia (TL) to the patellar length or greatest pole-to-pole length of the patella (PL)). Both knees show a normal IS ratio of 1.05.



10 Axial CT slices through the right and left knee joints showing pathological patellar tilt on the right side (prosthesis). The patellar tilt angle is defined as the angle formed by a line drawn parallel to the lateral patellar facet and the posterior condylar line. In presence of prosthesis in the right knee, the angle between a line drawn along with anterior edge of the prosthesis attached to the right femoral trochlear groove and the flattened articular surface of the right patella is the closest approximation of the patellar tilt angle. In this patient the right patellar tilt angle (12%), is abnormally high and suggests significant medial patellar shift, which may explain the overload stress on the right side of the patella. The left knee joint also shows a higher than normal patellar tilt angle.



- 11** Axial CT slices through both knee joints at the level of the trochlear groove of the femur and the tibial tuberosity with lines drawn through the tibial tuberosity (TT) and trochlear groove (TG) perpendicular to and bisecting the line joining posterior edges of both femoral condyles (TT and TG lines). The distance between these lines (TT-TG distance) for both knees is about 1 cm, which is within normal limits and suggests absence of any knee joint instability.

Discussion

Anterior knee pain is one of the most common causes of persistent problems after implantation of a total or partial knee replacement. It can occur in patients with or without patellar resurfacing. As a result of the surgical procedure itself many changes can occur, which may affect the delicate interplay of the components in the patello-femoral joint. These causes include offset errors, oversizing of prosthetic component, rotational errors of femoral or tibial component. Additionally, instability, maltracking, chondrolysis, patella baja, and aseptic loosening can result as well. In these cases, reoperation or revision is often necessary.

Patello-femoral instability is a common cause of post-operative pain and functional limitations in the joint, which may lead to revision surgery. Patello-femoral instability or maltracking is usually diagnosed by conventional X-ray (merchant view), which can demonstrate patella lateralization, tilting of the patella, or a lateral osteophyte. Pain related to patellar overload stress secondary to patellofemoral instability is usually associated with hypermetabolism in the related patellar articular surface, as reflected in this case example.

Conclusion

This case illustrates how bone SPECT/CT can accurately define the cause of post-arthroplasty

pain in presence of inconclusive radiographic and CT findings. CT shows mild sclerosis in the lateral part of right patella and abnormal lateral tilt with a larger gap between the patellar articular surface and the prosthetic anterior surface on the medial aspect with a large patellar tilt angle of 12%. However, in absence of any evidence of fracture, loosening, joint instability, or mal-alignment, CT findings alone do not confirm presence or absence of focal joint stress and its location nor the likely cause. Only with bone SPECT/CT is it possible to accurately define the patellar overload stress with the focal point in the lateral patella, which correlates with the medial patellar shift and large patellar tilt. The SPECT/CT scan also confirmed lack

of any other significant bony stress in the femoral and tibial condylar region or articular or periprosthetic region with normal joint stability and absence of any prosthetic displacement or periprosthetic or patellar fracture. Accurately defining

the patellar overload as the origin of pain with SPECT/CT is key to correct management. Since accurate fusion of the focal hypermetabolism and bony morphology is fundamental to SPECT/CT evaluation, the high resolution SPECT imaging and

high CT quality (with absence of displacement between CT and SPECT acquisition planes) provided by Symbia Intevo was instrumental in proper evaluation of this case. ●

Examination protocol

Scanner: Symbia Intevo 16

SPECT		CT	
Injected dose	600 MBq ^{99m} Tc-MPD	Tube voltage	130 kV
Acquisition	30 frames, 20 seconds per frame with Flash 3D reconstruction	Tube current	25 mAs
		Slice thickness	3 mm

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