

Initial Experience of Titanium-Coated PEEK Cage Capstone PTC for MIS-PLIF

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At the 20th Annual Meeting of the Japanese Society of Minimally Invasive Spine Surgery, held in Sapporo from July 27 to 28, 2017, Hisashi Koga, MD., Ph.D., Deputy Director of Iwai Orthopaedic Medical Hospital gave an academic presentation related to Shimadzu's SONIALVISION series R/F system titled "Initial Experience of Titanium-Coated PEEK Cage Capstone PTC for MIS-PLIF." An overview of that presentation is described in this article.

1. Objectives

Polyetheretherketone (PEEK) cages have recently become popular for interbody fusion surgery due to having a similar stiffness to bone. Titanium cages have a long history of use in this area due to the high biocompatibility of titanium and titanium cages do not produce inferior results to PEEK cages from the standpoint of bone union rates. Titanium-coated PEEK cages that utilize the advantages of both materials recently became available to use in Japan, and we decided to investigate the utility of titanium-coated PEEK cages at our hospital.



Fig.1 Titanium-Coated PEEK Cage Capstone PTC (Pure Titanium Coating) (Medtronic)

The cage we used is shown in **Fig. 1**. This cage is characterized by rough and porous surfaces of sprayed titanium particles. The physical properties of this cage compared to a cage with no titanium coating are a 2.7-fold increase in friction during a slide

test and 5.5-fold increase in surface area. Animal testing has also shown less aberrant fibrous tissue and markedly greater biomechanical strength after 6 weeks and 24 weeks with titanium-coated cages.

2. Methods

Titanium-coated PEEK cages were used for 37 interbody fusions of 31 patients between July 2016 and March 2017. This number was reduced to 15 patients with a single interbody fusion and at least 5 months of follow-up. In addition to radiography and CT, the degree of bone union was determined by the anteroflexion-retroflexion tomosynthesis lateral images for assessment of trabeculae formation, instability and screw loosening. Shimadzu's SONIALVISION series R/F system was used for tomosynthesis imaging, and T-smart was used for image reconstruction to reduce metal artifacts. The X-ray conditions of tomosynthesis and image reconstruction parameters of T-smart are shown below.

- Tube voltage: 80 to 100 kV, Tube current: 320 to 500 mA, msec.: 7.1 to 20 msec.
- Slice thickness: approx. 3 mm, Slice pitch: 1.5 mm, Number of slices: 80 to 100

The principle of tomosynthesis is described in **Fig. 2**. The entrance surface dose of tomosynthesis is around twice that of radiography (Diagnostic Reference Level)^{1), 2)} and 1/12 to 1/13 effective dose of conventional CT³⁾. However, the effective dose is considered to be around 1/7.5 times that of "low dose CT using partial iterative reconstruction," a technique that is recently becoming more common⁴⁾. Furthermore, medical reimbursement for tomosynthesis under the medical insurance system in Japan are less than 1/3 that of 16-row CT (**Table 1**). The cases included in this study are listed in **Table 2**. The mean age of cases was 71.6 years and the male-

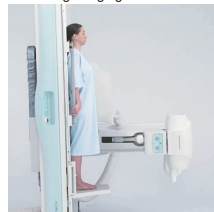
What Is Tomosynthesis?

Tomosynthesis is a new type of **digital tomographic radiography** that combines CT image reconstruction with the latest image processing technology.

Tomosynthesis of the lumbar spine



Standing Imaging Also Possible

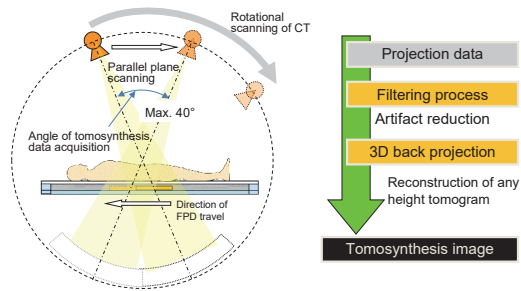


Important

In conventional linear tomography, a single image is obtained in a single scan, but with tomosynthesis multiple tomograms parallel to the patient table are obtained in a single scan. Imaging time is 2.5 or 5 seconds.

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Principles of Tomosynthesis



Important

Based on the reconstruction technique of cone beam CT, tomosynthesis reconstructs tomograms using filtered back projection or iterative reconstruction.

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Fig.2 Principles of Tomosynthesis

Table 1 Medical Reimbursement Points for CT and Tomography in Japan (Revised in FY2016)

	Taking CT images	Interpretation of CT images	Digital Image Management	Total
CT: ≥64 row	1000	450	120	1570
CT: ≥16, <64 row	900	450	120	1470
CT: ≥4, <16 row	750	450	120	1320
CT: <4 row	560	450	120	1130

	Taking special radiography	Interpretation of special radiography	Digital Image Management	Total
Tomography in special radiography (tomosynthesis)	270	96	58	424

(Note) Unit price for 1 point is ¥10

to-female ratio was 7:8. The most common pathology was degenerative spondylolisthesis associated with spinal canal stenosis in 8 cases. The most common location was the L4/5 segment in 9 cases, the cage size was 22 × 7 to 10 mm, and the percutaneous pedicle screw (PPS) diameter was 6.5 to 7.5 mm.

3. Results

The mean follow-up period was 8.7 months (5 to 12 months), mean surgery time was 93 minutes

(55 to 141 minutes) and mean intraoperative blood loss was 20 mL (5 to 80 mL). There were 1 case of instability and 1 case of screw loosening found by the anteroflexion-retroflexion tomosynthesis lateral images, respectively. No problems such as cage dislodgement or clear pseudoarthrosis (interbody range of motion of $\geq 3^\circ$ by functional radiography) occurred.

In Case No. 6 (**Fig. 3**) of degenerative spondylolisthesis 10 months after L4/5-PLIF surgery (76-year-old woman), the anteroflexion-retroflexion tomosynthesis lateral images showed no instability of the cage or fixed vertebrae and no loosening, and this case was judged in the process of bone union.

In Case No. 1 (**Fig. 4**) of degenerative spondylolisthesis 12 months after L4/5-PLIF surgery (79-year-old woman), frontal tomosynthesis images confirmed loosening around the left-side screw in L4. Vacuum clefts were also observed in retroflexion tomosynthesis lateral images (**Fig. 4a, 4b**), and instability was confirmed by comparison with anteroflexion lateral images. Based on these findings, this case was evaluated as nonunion at that time.

Table.2 List of MIS-PLIF Cases

Case No.	Approach side	Vertebral Level	PPS	Size of Capstone PTC	Diagnosis	Follow-up (months)	Loosening	Fusion
1	L	L4/5	Voyager 6.5mm	22X10mm X 2	Degenerative spondylolisthesis	12	Lt L4 PPS	(-)
2	R	L5/S1	Voyager 7.5mm	22X7mm, 22X8mm	Spondylolytic spondylolisthesis	11	(-)	(+)
3	L	L2/3	Voyager 7.5mm	22X8mm X 2	Degenerative scoliosis	11	(-)	(+)
4	R	L3/4	Voyager 6.5mm	22X9mm X 2	OLF	10	(-)	(+)
5	L	L5/S1	Voyager 6.5mm	22X10mm X 2	L5/S1 foraminal encroachment	10	(-)	(+)
6	L	L4/5	ViperX-tab 7mm	22X7mm, 22X8mm	Degenerative spondylolisthesis	10	(-)	(+)
7	L	L4/5	Voyager 7.5mm	22X9mm, 22X10mm	Degenerative spondylolisthesis	9	(-)	(+)
8	R	L3/4	Voyager 7.5mm	22X9mm, 22X10mm	Adjacent segment disease	9	(-)	(+)
9	L	L4/5	ES2 7.5mm	22X8mm, 22X9mm	Degenerative spondylolisthesis	9	(-)	(+)
10	L	L4/5	ViperX-tab 7mm	22X7mm, 22X8mm	Lateral recess stenosis	8	(-)	(+)
11	L	L4/5	Voyager 7.5mm	22X10mm X 2	Degenerative spondylolisthesis	8	(-)	(+)
12	R	L5/S1	Voyager 7.5mm	22X9mm, 22X10mm	Degenerative spondylolisthesis	7	(-)	(+)
13	R	L4/5	Voyager 7.5mm	22X8mm X 2	Degenerative scoliosis	6	(-)	(+)
14	L	L4/5	Voyager 7.5mm	22X7mm, 22X8mm	Degenerative spondylolisthesis	6	(-)	(+)
15	L	L4/5	ViperX-tab 6.5mm	22X10mm X 2	Degenerative spondylolisthesis	5	(-)	(+)

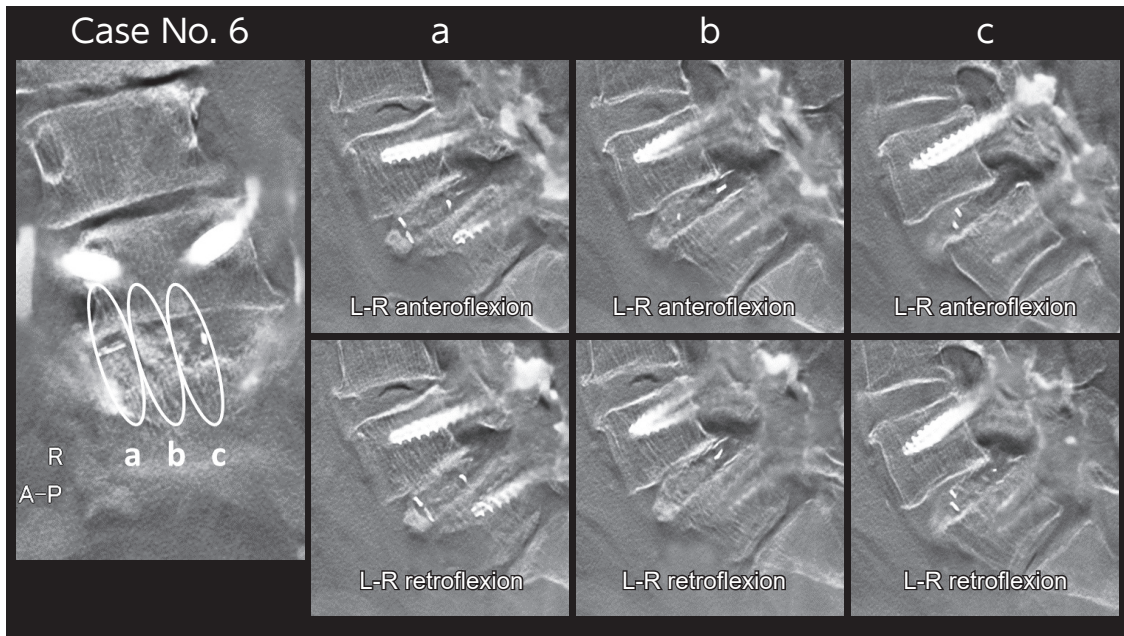


Fig.3 Tomosynthesis Images of Case No. 6
 Degenerative spondylolisthesis 10 months after L4/5-PLIF surgery (76-year-old woman)

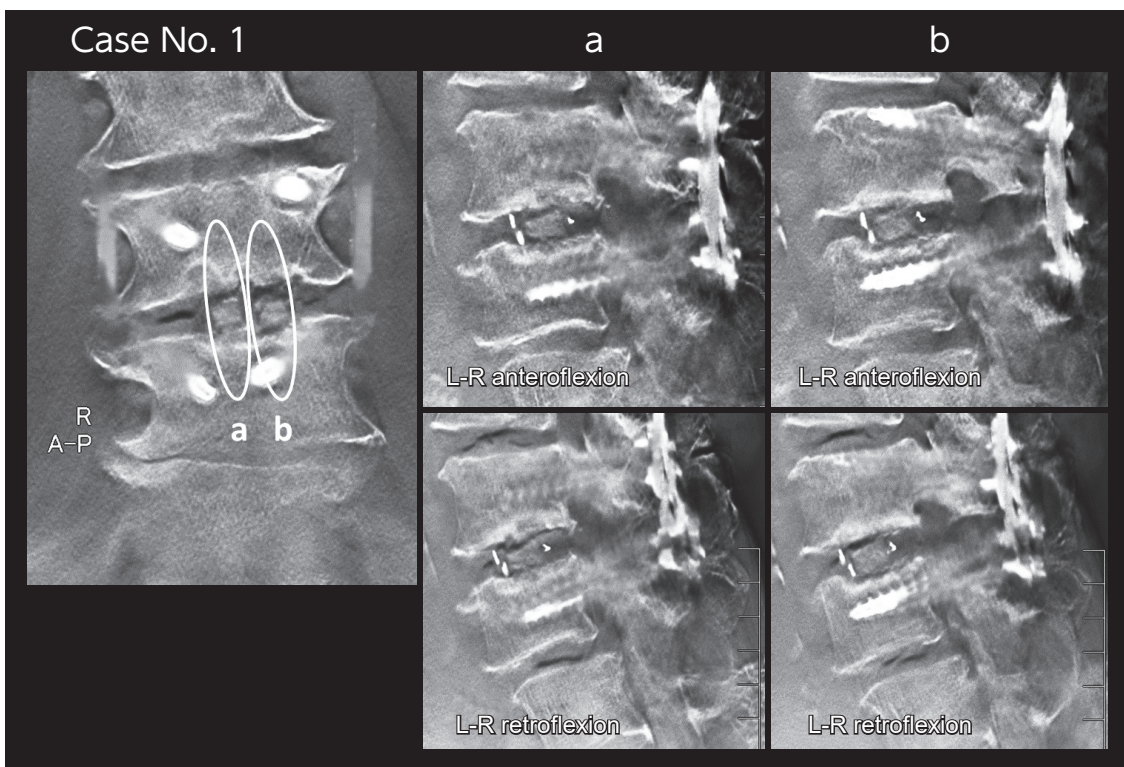


Fig.4 Tomosynthesis Images of Case No. 1
 Degenerative spondylolisthesis 12 months after L4/5-PLIF surgery (79-year-old woman)

4. Discussion

Despite the small number of patients and the short duration of postoperative follow-up, titanium-coated PEEK cages are expected to provide superior results to conventional cages.

References

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