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CASE REPORT

Repeated posterior dislocation of total hip arthroplasty after spinal corrective long fusion with pelvic fixation

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Abstract
Purpose Several reports have indicated that anterior dislocation of total hip arthroplasty (THA) can be caused by spinal degenerative changes with excessive pelvic retroversion. However, no reports have indicated that posterior dislocation can be caused by fixed pelvic anteversion after corrective spine surgery. We describe a rare case experiencing repeated posterior THA dislocation that occurred at 5 months after corrective spinal long fusion with pelvic fixation.
Methods A 64-year-old woman had undergone bilateral THA at 13 years before presenting to our institution. She had been diagnosed with kyphoscoliosis and underwent three subsequent spinal surgeries after the THA. We finally performed spinal corrective long fusion from T5 to ilium with pelvic fixation (with iliac screws). Five months later, she experienced severe hip pain when she tried to stand up from the toilet, and was unable to move, due to posterior THA dislocation. Therefore, we performed closed reduction under sedation, and her left hip was easily reduced. After the reduction, she started to walk with a hip abduction brace. However, she had experienced 5 subsequent dislocations.
Results Based on our findings and previous reports, we have hypothesized that posterior dislocation could be occurred after spinal corrective long fusion with pelvic fixation due to three mechanisms: (1) a change in the THA cup alignment before and after spinal corrective long fusion surgery, (2) decreased and fixed pelvic posterior tilt in the sitting position, or (3) the trunk's forward tilting during standing-up motion after spinopelvic fixation.
Conclusions Spinal long fusion with pelvic fixation could be a risk factor for posterior THA dislocation.

Keywords Spinal corrective long fusion · Total hip arthroplasty · Dislocation

Introduction

Dislocation is one of the most important complications after total hip arthroplasty (THA). The orientation of the acetabular cup during THA is important for preventing postoperative dislocation [1–5]. However, pelvic tilt directly affects cup orientation, and poor cup orientation can cause subsequent dislocation. Pelvic tilt varies according to posture, age, and other factors and posterior pelvic tilt typically increases with age [6–8]. This progression is usually gradual, due to the loss of lumber lordosis, weakness of the back muscles, flexion contracture of the knee, and other factors [8–10]. Progressive posterior pelvic tilt may cause anterior instability and dislocation of the THA [11]. However, there are no reports that posterior THA dislocation can be caused by fixed pelvic anteversion after spinal corrective long fusion with pelvic fixation. In this report, we report a rare case of repeated posterior THA dislocations that occurred at 5 months after spinal corrective long fusion with pelvic fixation (with iliac screws).

Case report

A 64-year-old woman was presented to our outpatient clinic for her acute left hip pain. She had no history of hip disease during her childhood, although she had undergone bilateral

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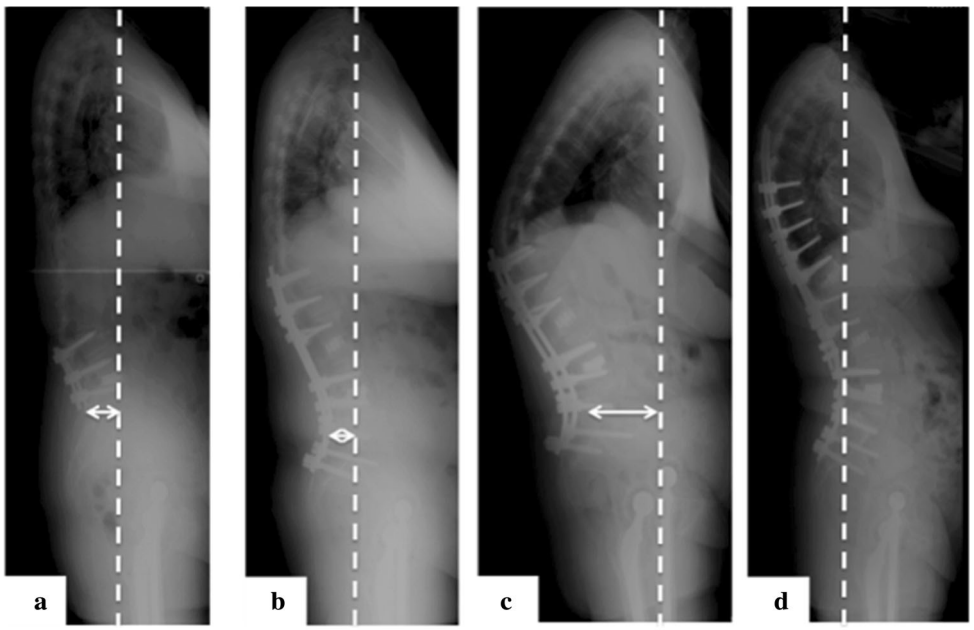
THA via the posterior-lateral approach for secondary hip osteoarthritis due to acetabular dysplasia 13 years before her presentation. Eleven years after the THA, she had severe low back pain and was diagnosed with degenerative kyphoscoliosis of the spine. She underwent spinal fusion from L3 to L5 (Fig. 1a) at another institution. However, her lower back pain was not improved, and she visited our hospital. At that point, we diagnosed her back pain due to lumber kyphosis and spinopelvic malalignment and performed spinal corrective fusion from T12 to the ilium as the second operative treatment (Fig. 1b). However, proximal junctional kyphosis subsequently occurred and her back pain got worse (Fig. 1c). Therefore, we extended proximal spinal fusion end from T12 to T5 as the third operative treatment, this turned out the final spinal fusion ranged from T5 to pelvis (Fig. 1d). Unfortunately, the patient subsequently reported that she experienced severe hip pain when she tried to stand up from the toilet (at 5 months after the third spinal operation). She could not move by herself, and was subsequently transported to our hospital.

Physical examination

Our physical examination revealed that the left hip joint was flexed, adducted, and internally rotated. She had severe left groin pain, therefore, she could not move her left leg by herself. However, her left lower limb exhibited no neurological impairment.

Radiographic evaluation

Hip radiographs revealed posterior dislocation of the left THA (Fig. 2). Standing whole spine X-ray before the THA dislocation had shown the sagittal vertical axis (SVA) showing the global spinal sagittal alignment, which was represented as a horizontal distance between the C7 plumb line and the posterior edge of the S1 end plates, was greatly improved by the spinal corrective long fusion with pelvic fixation (with iliac screws) (Fig. 1). Sacral slope (SS) had changed anteriorly from 1° to 23° before and after the spinal corrective long fusion with iliac screws. However,



	a	b	c	d
TK(T5-T12)	18°	37°	64°	42°
LL(L1-S1)	0°	19°	22°	47°
SS	1°	18°	13°	23°
SVA	78mm	30mm	110mm	0mm

Fig. 1 Standing lateral full-length radiographs reveal the change in the spinal sagittal alignment during the series of the spinal surgeries. The sagittal vertical axis (SVA) is defined as the distance between the C7 plumb line (*white dotted line* the vertical sagittal line that extends from the center of the C7 body) and the postero-superior edge of the sacrum. Thoracic kyphosis (TK) measured from the superior endplate of T5 to the inferior endplate of T12. Lumber lordosis (LL) measured from the superior endplate of L1 to the superior endplate of S1. Sacral slope (SS) measured from the superior plate of S1 and a *horizontal line* (**a**). The SVA after the first operation was 78 mm (**b**). The SVA after the second operation was 30 mm (Fig. 1c). The SVA after proximal junction kyphosis was 110 mm (**c**). The SVA after the third operation was 0 mm (**d**)

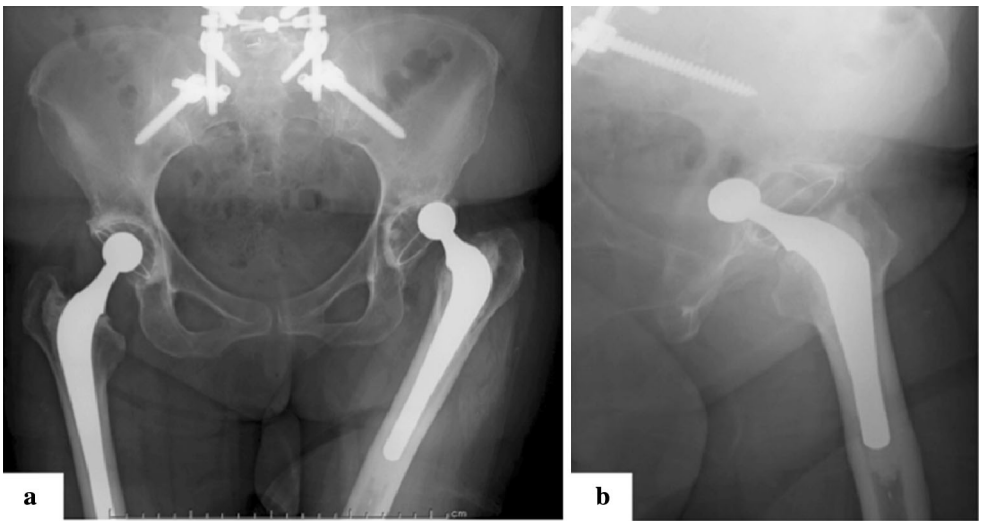


Fig. 2 Plain hip X-rays reveal posterior dislocation of the left total hip arthroplasty. **a** Antero-posterior radiograph. **b** Lauenstein position

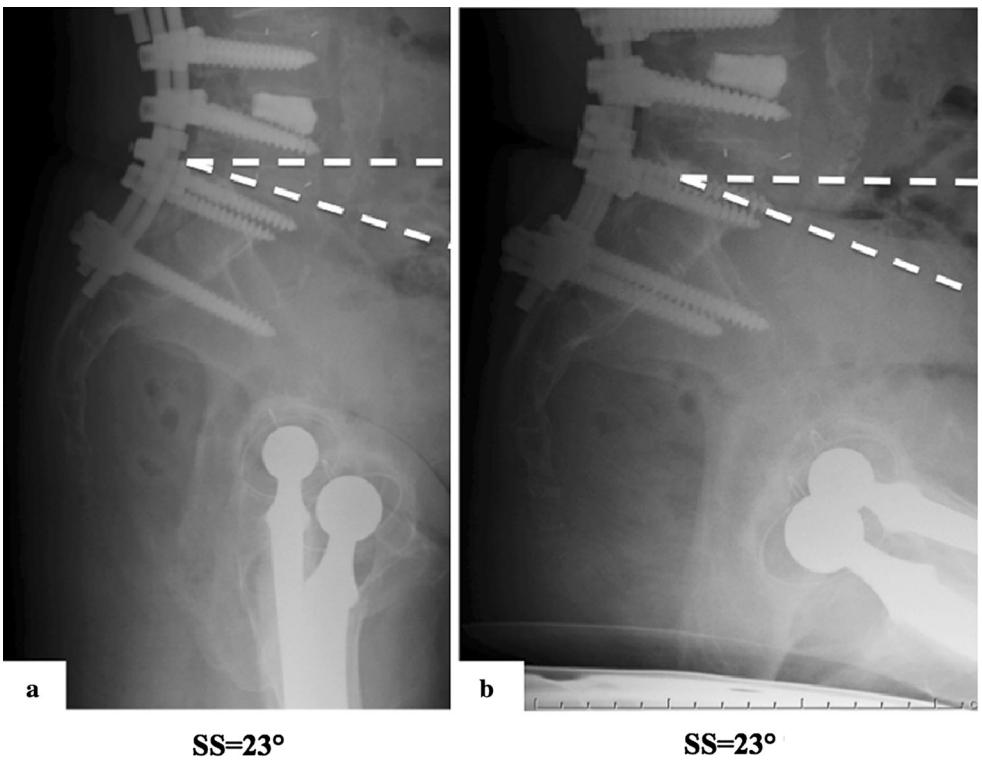


Fig. 3 Lateral radiographs of the pelvis after the spinal long fusion with pelvic fixation (with iliac screws) while the patient was standing (**a**) and sitting (**b**). Pelvic position is not changed, and remained anteverted from the standing position to sitting position

there were no motion of the pelvis between standing and sitting positions (Fig. 3), although the pelvis usually is retroverted in sitting position. We then performed computed tomography to examine the THA implant's orientation. The stem's anatomic anteversion was 13.7°. In addition, the cup's radiographic anteversion had been reduced from 30.2° to 14.2° after the spinal corrective long fusion with iliac screws. Based on these findings, we determined that the combined anteversion was reduced from 39.8° to 24.1° (Table 1), and we speculated that this could be the reason of THA dislocation.

Closed reduction was not easy when she was awake, but easily performed under sedation. We have confirmed under fluoroscope that her left hip was successfully reduced. During this manipulation, we found that her soft tissue tension was not loose, although her left THA had posterior

Table 1 The changes in total hip arthroplasty implant alignment during standing before and after long spinal corrective fusion with pelvic fixation for adult spinal deformity in the present case

	Preoperative		After long spinal corrective fusion with pelvic fixation	
	Right	Left	Right	Left
Cup anteversion (radiographic) (°)	28.9	30.2	12.7	14.5
Cup inclination (radiographic) (°)	47.8	50.5	41.6	43.5
Stem anteversion (°)	31.4	13.7	31.4	13.7
Combined anteversion (°)	50.9	39.8	34.7	24.1

instability at 90° of flexion and 30° of internal rotation. Therefore, we diagnosed the reason of THA dislocation was due to anterior impingement of the femoral implant. After the reduction, she started to walk with a hip abduction brace. Although she has experienced 5 subsequent dislocations, and we explained the continuous risks of subsequent THA dislocations, she did not expect revision THA surgery. After these events, she had continued the use of the abduction brace and experienced no further THA dislocations during the follow-up period.

Discussion

Interrelationships between the spine and hip have been defined as hip-spine syndrome. In recent studies, sagittal spinal alignment in patients with severe hip osteoarthritis and gluteus medius weakness in patients with low back pain has been reported [13, 14]. Some studies reported that THA cup orientation relates to pelvic morphology and tilt, and to the global sagittal balance of the pelvic spinal unit [15, 16]. The influence of pelvic antero-posterior tilt on THA cup orientation has been reported by Lembeck et al. [17], who found that each degree of pelvic tilt requires a cup orientation correction of 0.7°. The changes in cup orientation may cause THA dislocation, and follow-up monitoring of pelvic tilt is important after THA. Taki et al. [18] have investigated the change in sagittal plane pelvic tilt among 86 patients 2–4 years after THA. They reported that the average posterior pelvic tilt was 5.1° 2 years after the surgery, and 6.5° 4 years after the THA. The pelvis generally tilts posteriorly after THA, and previous studies have confirmed that excessive posterior pelvic tilt can cause anterior THA instability. However, in the present case, the pelvis cannot normally progress anterior tilt since her spinal long corrective fusion with pelvic fixation makes it fixed her pelvis position. In this case, there are three possible explanations why posterior dislocation was occurred after spinal corrective long fusion with pelvic fixation: (1) a change in the THA cup's alignment before and after spinal corrective long fusion surgery with pelvic fixation, (2) decreased pelvic posterior tilt and fixed anteverted pelvis in the sitting position, or (3) the body trunk got rigid after the long corrective spinopelvic fixation and directly forced the THA impinged at anterior cup edge when the patient stands (Fig. 5).

A change in the THA cup's alignment before and after spinal deformity surgery

Aging and degenerative changes often result in loss of lumbar lordosis and posterior pelvic tilt. Lafage et al. [19] have reported that pelvic tilt is correlated with the health related quality of life score. Therefore, the goal of surgical treatment for adult spinal deformities is through the correction of posterior pelvic tilt and achieve to the proper global spinopelvic alignment for ergonomic standing position. Thus, spine surgery for adult spinal deformities tilts and fixes the pelvis anteriorly, this may decrease the THA cup's anteversion, therefore, increases the risk of posterior dislocation. Buckland et al. [20] investigated 33 patients (41hips) that underwent surgical spinal realignment for adult spinal deformity after THA. Their acetabular anteversion significantly reduced after spinal surgery by mean change of −4.96° (range −22.32°to +2.36°).

In the present case, the cup's radiographic anteversion in the dislocation side had been reduced from 30.2° to 14.5°, and the combined anteversion had been reduced from 39.8° to 24.1° after the spinal surgery. Widmer et al. [12] have reported that the ideal combined anteversion is 37.7°. Therefore, spinal surgery in the present case reduced the combined anteversion, compared to the ideal value, and increased the chance of anterior impingement and posterior dislocation.

Decreased pelvic posterior tilt in the sitting position in the present case

Previous studies have indicated that the pelvis tilts posteriorly during the transition from the standing to the sitting

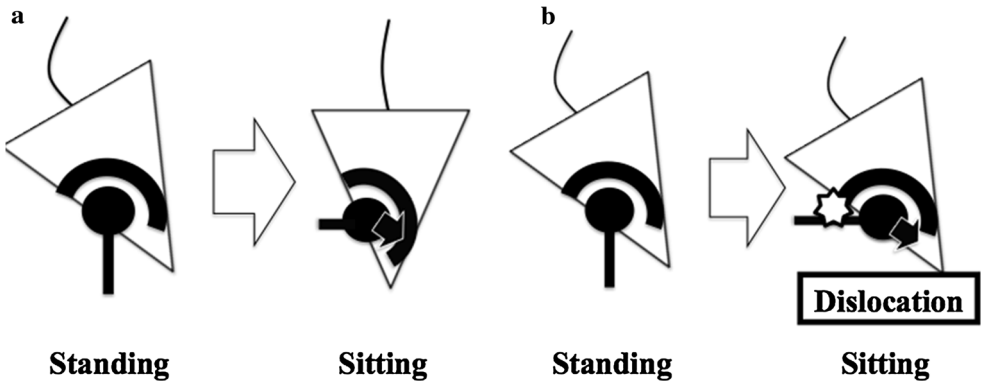


Fig. 4 In the healthy person, pelvis shifts to retroversion in sitting position (**a**). On the other hand, in the patients with spinal fusion with pelvic fixation, pelvis cannot shift to retroversion and stays anteverted. In this case, we have speculated that neck impingement occurs at the anterior edge of the cup, then femoral head is dislocated posteriorly (**b**)

positions [21]. In addition, Endo et al. [8] have investigated the relationship between sagittal lumber and pelvic alignment in the standing and sitting positions among 50 healthy adults. Their findings indicate that the average variation in SS was 18.7° posteriorly during the transition from standing to sitting. Furthermore, Lazennec et al. [22] investigated 328 patients who had undergone THA, and found that the average variation in SS between standing and sitting was 14.5° posteriorly. Therefore, if the bilateral hip joints are flexed during sitting, the risk of impingement between the anterior edge of the cup and the femoral stem might be increased. In this situation, the posterior pelvic tilt by sitting increases cup anteversion and prevents impingement and following posterior dislocation. On the other hand, Ochi et al. [23] investigated the sagittal spino-pelvic alignment among 74 patients who underwent primary THA. They found that the change in pelvic tilt from standing to sitting is strongly related to the mobility of the lumber spine in patients with hip disease.

In the present case, there was no difference in the pelvic tilt between the standing and sitting positions, as there were no lumber spine and pelvic mobility in the sagittal plane due to the spinal corrective long fusion with pelvic fixation. Therefore, the patient could not prevent anterior impingement via posterior pelvic tilt and experienced the THA dislocations (Fig. 4).

The trunk's forward bending motion after spinopelvic fusion

The patient did not experience THA dislocation after the second spinal surgery (from T12 to the ilium). However, the THA posterior dislocation occurred after the third operation (spinal corrective long fusion from T5 to the ilium), and she also lost body trunk flexibility due to the spino-pelvic long fusion. The standing motion in healthy individuals requires the body's center of mass to be moved forward, and this is achieved via increased thoracic kyphosis and decreased lumbar lordosis and pelvic tilt. However, patients who have undergone spinopelvic long fusion did not have adequate flexibility in their thoracic and lumber spine. Therefore, to move their center of gravity, it is necessary for these patients to bend their trunk forward and deeply flex their hip joint directly (Fig. 5). These motions increase the risk of anterior impingement of the femoral neck at the anterior edge of the cup, then the following posterior THA dislocation can be occur.

Our patient experienced repeated posterior THA dislocations after spinal corrective long fusion with pelvic fixation. This suggested that this spinal procedure is a risk factor for posterior THA dislocation. Therefore, both hip and spine surgeons should recognize this risk of posterior THA dislocation and explain this to the patient preoperatively. Phan et al. [24] recommended dividing patients into four categories based on the flexibility and sagittal balance of the spine preoperatively and acetabular component should be placed using this information as a guide. They recommended increase acetabular component anteversion for patients with rigid spino—pelvic junctions. When planning THA first for patients who will require the future spino-pelvic long fusion, THA surgeons should increase the cup anteversion slightly to prevent anterior impingement or use other acetabular implant which has high resistance posterior THA dislocation such as dual-mobility cup [25]. When planning spino-pelvic long fusion for patients with pre-existing THA, spine surgeon must plan how much is the appropriate correction under the consideration of THA implant alignment. There are some reports that THA did not influence pelvic position and sagittal alignment [26], but corrective spinal surgery can affect the pelvic and spinal sagittal alignment. In the case who have both pathologies in hip and spine, we recommend the spinal corrective surgery first since the cup placement can be easily set up without the consideration.

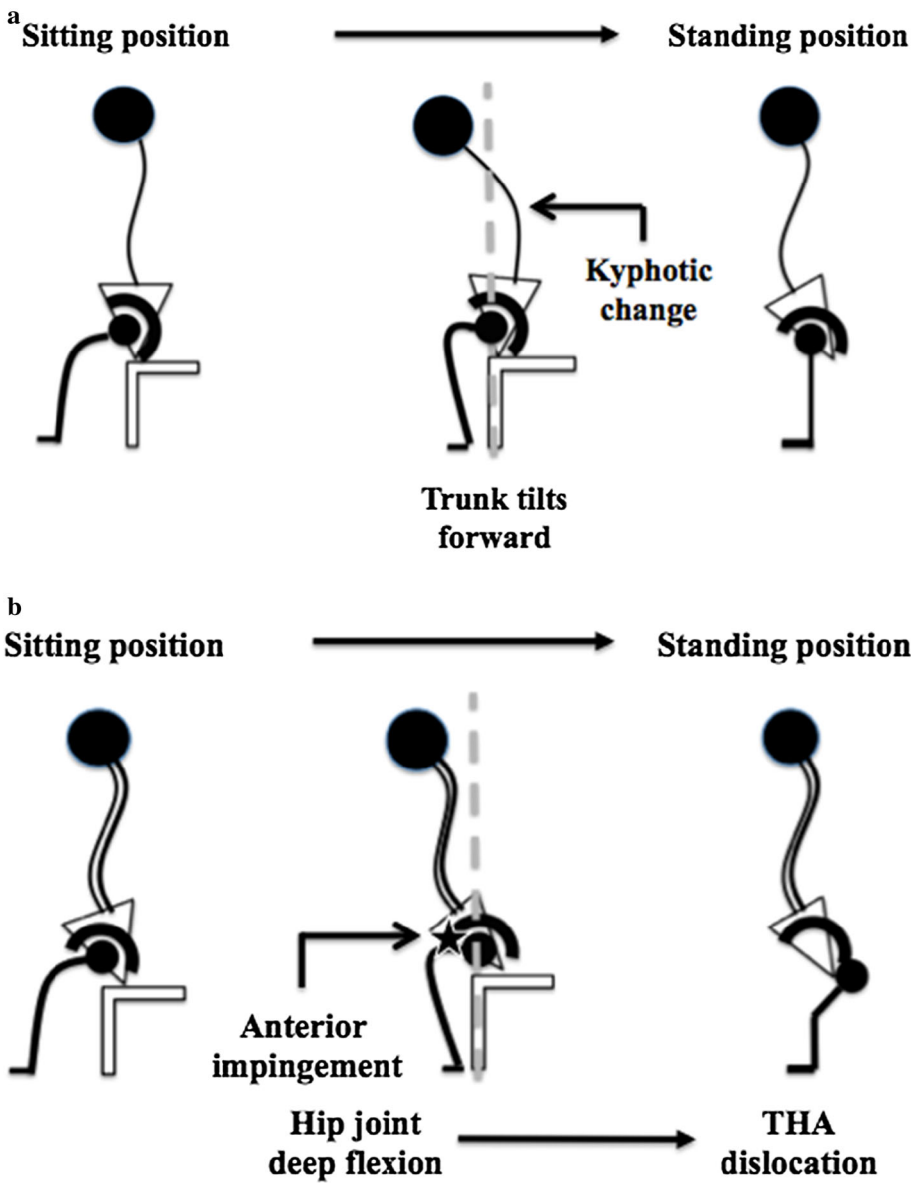


Fig. 5 When a healthy individual stands up from the chair, the trunk leans forward and the spine flexes into kyphosis. According to this motion, pelvis usually is retroverted (**a**). However, in the patients with long spinal fusion with pelvic fixation, the pelvis stays anteverted, the hip joint requires deep flexion. When the femoral neck hits the anterior edge of the cup (impingement), the femoral head could be dislocated posteriorly (**b**)

Conclusion

We reported a rare case experiencing repeated posterior THA dislocation after spinal corrective long fusion with pelvic fixation. This spinal procedure is a risk factor for posterior THA dislocation.

Compliance with ethical standards

Conflict of interest None of the authors has any potential conflict of interest.

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