

Pedicle subtraction osteotomy for sagittal imbalance

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Introduction

A 51-year-old man, welder, still working, became progressively disabled due to intractable back pain and transient radicular pain with claudication. He had no previous surgery history and had in the past frequently treated lumbalgia by rest and painkillers.

Case description

The patient is pain-free at night but endures increasing pain during daily activities and work. He cannot stand straight and is permanently bent forward. He has transient radicular claudication; neurologic exam is normal at rest. MRI shows multiple degenerative discs in the lumbar spine without canal stenosis or hernia. Facet arthrosis is present but posterior muscles are still good. Full standing films show a straight spine on AP view and a significant lumbar kyphosis with global imbalance on lateral view. The C7 plumb line falls in front of the femoral heads and the pelvic parameters show a pelvic incidence of 75° and a pelvic tilt (PT) of 33°, which is too high for an incidence of 75°. This

is the characteristic of a compensation phenomenon. It is possible to see that femoral shafts are not vertical and the clinical exam shows that the knees are flexed. The conclusion is that this patient has a global imbalance, compensated by pelvic retroversion and knee flexion. Back muscles are constantly struggling to restore a better sagittal alignment but this is ineffective and increases back pain by muscle fatigue. A correction is requested.

Surgical procedure

An analysis of the sagittal imbalance is performed on the full standing X-rays. There is no angular kyphosis but only harmonious curves. The thoracic kyphosis is 30° and the lumbar lordosis is only 40°. To evaluate the amount of correction needed, the FBI, full balance integrated technique was used.

- the C7 translation angle measured from L4 is: 15°
- the femur shaft angulation with vertical is: 10°
- the pelvic tilt is 33° so the PT compensation angle is: 10°
- the total amount of correction required to restore a good balance is: 35°.

The thoracic kyphosis is normally (being) less than 35° (and stiff on flexion/extension films). Knowing this, the correction will be performed in the lumbar area only where the loss of lordosis is located. To restore a good lumbar lordosis a posterior subtraction osteotomy at L4 is planned with a strong sacral fixation and a construct from T12 to

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S2. The surgery is performed under MEP and SSEP neuro control. An O-arm with navigation is used to secure the screw placement and control the osteotomy.

The approach is posterior, from T12 to sacrum, with pedicular screws at all levels except L4. A complete lamino-arthrectomy is performed at L4 including superior lamina of L5 and inferior lamina of L3. L4 and L5 nerve roots are released bilaterally. The eggshell technique is used to perform the osteotomy with a superior base triangular lateral removal of the L4 vertebra wall. The posterior wall is then removed. The operating table is flexed to allow a progressive and harmonious correction of the deformity with permanent L4 and L5 nerve root control visually and with the evoked potential. A C-arm check and CT analysis of the correction is performed with the O-arm. Lordosis is measured according to the preop planning. If more lordosis is requested, one or two levels of Smith-Petersen (also called Chevron osteotomy) are added at the levels above the osteotomy level. Posterolateral graft is done by using all the bone chips. The dura is protected by a collagen membrane to decrease adherences. Wound is closed with drainage.

Postoperative information

Patient stays in ICU for one or two days mainly for pain management. Patient stands up and is mobilized on the 3rd day and wears a soft brace to protect his lumbar spine. Rehabilitation starts immediately with walking. Full standing X-rays are made to control the appropriate correction of the balance. Return home or rehabilitation center at 10 days postop.

Discussion and conclusion

Harmonious kyphosis (i.e. not posttraumatic or tumoral angular kyphosis) mainly occurs in the lumbar area [1] due to the ageing process [2]. Iatrogenic kyphosis in relation with arthrodesis without respect of balance parameters is one of the most common reasons for sagittal imbalance [2]. Back pain is often combined with radicular pain in such degenerative spines. The clinical examination must be global including the lower limb and the sagittal balance. Analysis using full standing X-rays is mandatory [3, 4]. Thoracic kyphosis and lumbar lordosis have to be measured. If thoracic kyphosis is less than 35° there is no need

for long fixation (except sometimes for dramatic osteoporosis or Parkinson disease patient where the indication should be discussed). The osteotomy correction must be performed at the level L4, which is the location of the apex of the lumbar lordosis in the normal asymptomatic population [5]. The amount of correction requested is evaluated with the FBI technique. The surgical technique must be adapted to the amount of correction: PSO average correction is 30°, Smith-Petersen/Chevron: 8–10° per level [6]. Strong sacral or sacroiliac fixation is requested with good posterolateral grafting [7, 8]. Cage at the level L5/S1 and L4/L5 is often requested if the disc is high to avoid loss of correction. This surgery is extensive and the complication rate, mainly infection, and transient radicular pain are frequent. The patient's expectation is important in such situations but the risk should be well evaluated and the patient fully aware of this. Sometimes a compromise has to be found between the ideal correction and what the patient is able to support. Compensated balance is sometimes the compromise in elderly patient.

Conflict of interest None.

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