In 1996, the BAK cage was approved by the Food and Drug Administration for general open use. Multicenter studies have shown it to be an effective fusion technique with an acceptable complication profile relative to other available fusion methods. Complications do occur, however. This chapter is directed at techniques for dealing with those complications that are unique to the BAK and to some extent other interbody implants.

COMPLICATIONS OF THE POSTERIOR APPROACH

ANTERIOR IMPLANT MIGRATION AND MALPOSITION
POSTERIOR MALPOSITION
LATERAL MALPOSITION

COMPLICATIONS OF THE ANTERIOR APPROACH
IMPLANT MIGRATION AND ANTERIOR MALIGNATION
POSTERIOR MALPOSITION

The threaded design of the BAK implant results in a diminished chance of migration compared with the traditional types of bone graft used in posterior interbody fusions. When migration does occur, caused by reaming too far to the anterior, misplacement of the implant, improper implant sizing, or an incompetent annulus, the treatment depends on the amount of projection of the implant. Complete extrusion or large displacement (more than 60% of implant length) necessitates cage removal to prevent erosion into retroperitoneal visceral structures. Anatomically, there seem to be greater risks above the L5 level. If the implant is anterior to the posterior intervertebral space removal is more readily accomplished from an anterior approach. If the malpositioned implant is still well within the interspace it can be removed or repositioned posteriorly. This is performed by removal of the cap (if present), posterior chamber bone, and cage, using a flat-head screwdriver. The screwdriver is inserted into the BAK slot, unscrewing to the appropriate position or to removal. The reason for the cage shifting should be corrected either by replacement with a larger implant or by substitution of bone graft for the migrated cage. In our experience, reliance upon only a single central or unilateral cage for lumbar fusions has not been successful.

POSTERIOR MALPOSITION

Posterior migration can be a disastrous complication if severe encroachment on the neural elements
occurs. Small amounts of posterior migration are usually asymptomatic or become so with fusion consolidation. Immobilization in a rigid brace is recommended until the fusion solidifies, if symptoms are tolerable and neural element damage is definitely not ongoing. If symptoms are positional they may resolve if and when the fusion consolidates. Large and symptomatic displacements require revision surgery to remove the displaced cage or reposition it in a more anterior and thus more favorable position. A larger implant may be needed to restore stability in some cases. A general principle that must be followed for good results with all interbody implants or grafts is the attainment of maximum intervertebral distraction to minimize micromotion. As an alternative, one can consider additional posterior fixation such as wiring of the posterior elements or pedicle fixation. If the implants are properly countersunk anterior to the posterior vertebral body border by 4 mm or more, this complication is much less likely to occur.

**Lateral Malposition**

In the small patient with a large disk height the width of the implants needed for good distraction may exceed the interspace width, making it difficult to fit cages side-by-side within the disk space. With the posterior approach, lateral displacement is less likely because the placement trajectory is medialized by the pedicles, but might occur due to lateral implant angulation, resulting in their exit laterally from the disk space. In most cases this is not a problem. As long as the cage is mostly within the disk space and the extraforaminal root from the level above is unimpinged there will be no symptoms, especially once the fusion has solidified.

**COMPLICATIONS OF THE ANTERIOR APPROACH**

**Implant Migration and Anterior Malposition**

For various reasons, such as inadequate distraction, toggling of the reamer during reaming, cross-threading of the cage into the tapped bony pilot hole, shallow initial seating of the implant, or an unusually unstable motion segment, anterior extrusion may occur, either partially (Fig. 45-1) or totally (Fig. 45-2). If protrusion is large, erosion into the great vessels (espe-
Revision Spine Surgery

Figure 45-3
Computed tomography scan revealing posteriorly malpositioned cage and reaming debris pushed into spinal canal.

Posterior Malposition

Posterior displacement of implants may result in neural element entrapment not only from the implant itself but also from reaming debris that is driven ahead of the implant during insertion (Fig. 45-3). To avoid this problem, reaming and implantation should always stop several millimeters short of the posterior vertebral body border. The C-arm or x-ray must be exactly perpendicular to the patient in assessing implant depth to avoid parallax error, which may result in the actual implant depth being more posterior than is apparent from the image. If persistent neurological symptoms develop, the spinal canal will have to be decompressed. Because soft tissue, free bone, or cartilage fragments may be part of the entrapment problem, decompression is best approached from a laminotomy. The cage can also be repositioned more anteriorly from this approach by screwing it anteriorly via the transverse slot inside the cage using a flat-head screwdriver after removing the posterior chamber bone graft.

Cephalad-Caudal Malposition

The implants should engage both the upper and lower decorticated endplates. If they are too far cephalad or caudal, thus engaging only one endplate, the fusion does not solidify at the unengaged endplate (Fig. 45-5). However, even if one cage is not engaged, the other may solidify because the unengaged cage still provides a stabilizing effect. Symptomatic treat-
ment is the bottom line in these instances, since some patients are improved enough to be satisfied even in the event of nonunion. Pulsed electromagnetic field stimulators are not likely to have an effect if the end-plate is unengaged by the cage. If revision of the fusion is required this can be handled as discussed in the section on pseudarthrosis.

**WOUND INFECTION**

BAK implant infections are unusual. Based on our experience with other spinal implants we would recommend the following: if recognized in the first postoperative week deep wound infections can often be eradicated with culture-specific antibiotics administered for 6 weeks. Definitive wound cultures are most helpful for appropriate antibiotic selection. Abscess formation requires incision and drainage and probably implant removal with wound closure over tube irrigation or delayed primary closure.

Later-appearing deep infections probably can't be eradicated without removal of the implants. In some cases infections can be indolent and difficult to detect. A history of chills, new-onset night sweats, general fatigue, low-grade intermittent fever, and increased back pain in the postoperative patient should be considered infectious in origin until proven otherwise. Laboratory tests may be unremarkable and the wound cultures may be the only way to establish the diagnosis.

**PSEUDARTHROSION**

In our experience the most common problem with the BAK implant is failure to fuse. In patients with residual mechanical pain and static-position intolerance, fusion site motion should be ruled out. Any amount of motion may be responsible for symptoms. Flexion and extension plain x-rays will usually demonstrate motion (Fig. 45-6), but in questionable cases carefully taken lateral midline single plane sagittal tomography in side-lying flexion and extension can help delineate subtle pseudarthrosis. A full year should be allowed for fusion consolidation unless patient suffering mandates earlier intervention. In those who are somewhat improved from their preoperative state indefinite observation may be appropriate, de-
Figure 45-6
Flexion (A) and extension (B) x-rays demonstrating motion at both fusion levels.

Figure 45-7
Anteroposterior (A) and lateral (B) x-rays of patients from Figure 45-6 following pedicular instrumentation.
pending on symptom severity. External electromagnetic bone stimulators may also be considered. Patients should be screened for osteoporosis and undergo a metabolic workup to determine appropriate treatment. Reversal of the metabolic bone disease state may result in fusion consolidation.

Revision options include posterolateral fusion (with or without instrumentation) and revision of the interbody fusion. The latter approach may be more difficult due to postoperative scarring. In addition, viability of the fusion bed is compromised by the previous fusion attempt. In our own series, revision fusions without internal fixation in the same bone graft bed are successful only in 37% of patients, compared with a 66% success rate in a previously surgically unviolated fusion bed.³ Posterolateral fusion is recommended. The fusion consolidation rate in circumferential fusions with pedicle fixation is over 95% in our experience (Fig. 45-7). One has to weigh the disadvantages of pedicle fixation, which also relates to the individual surgeon’s experience and skills in choosing the revision technique.

**LAPAROSCOPIC APPROACH**

Clinical trials on the laparoscopic delivery of BAK fusion cages began in September of 1993 and are still ongoing at the time of this writing.⁸ The more elaborate approach entails the same possible orthopedic complications as the anterior open approach.²,⁴

**REFERENCES**