Abstract
A 65-year-old female continued to experience chronic neck pain six years after an anterior cervical discectomy and fusion. New symptoms, including radiculopathy and myelopathy, developed within the four months leading up to her presentation. Magnetic resonance imaging revealed multilevel cervical spondylosis. Also, a computed tomography scan demonstrated a pseudarthrosis at C6/7. The patient underwent surgery and was treated with a PEMF bone growth stimulator postoperatively. On a one year follow-up, the patient had full strength with no Hoffman’s sign bilaterally, and gait was normal. The arm pain was resolved though she noted some neck stiffness.

Introduction
Chronic pain long after fusion surgery is an indicator that a nonunion might exist. Pseudarthrosis or nonunion occurs when a fracture fails to unite leading to a “false joint.” Research shows that high risk patients who undergo multilevel fusion surgery have a greater chance of developing this unfavorable outcome. Smoking is among the risk factors, found to be statistically significant, that lead to pseudarthrosis. It is hypothesized that smoking affects the blood gas level within the body which then interferes with the bone’s biomechanical properties.1,2

Another variable that influences patient surgery outcomes is the number of fusion levels. Shen et al., found that the number of levels corresponded with the risk of nonunion in augmented anterior cervical fusions. The study showed that the greater the fusion level, the greater the chance for pseudarthrosis to develop.3 Smoking, multilevel fusion, and other risk factors negatively impact a patient’s chance for union.4

This case report discusses a comprehensive approach to improving the probability of a solid cervical fusion, including the adjunct use of a bone growth stimulator, for a high risk patient who had previously experienced a failed fusion.

Case Presentation
Patient Profile
A very pleasant 65-year-old female had an anterior cervical discectomy and fusion performed at the C6/7 level six years prior to her presentation. The patient was 5’3” (160 cm) tall and weighed 194 pounds (88 kg). Past medical history was notable for hypertension, asthma, and hypercholesterolemia. She smoked a half pack of cigarettes per day for the past 26 years. She continued gainful employment as a laborer on an assembly line.

Since the initial surgery, the patient experienced chronic neck pain. Over the past four months she developed a number of new symptoms. Pain graded as 10/10 in severity on a visual analog scale radiated down her left shoulder and into the biceps muscle. Looking down exacerbated the left upper extremity pain. She also noted loss of coordination, numbness, and weakness in her hands bilaterally. The patient stated that she was dropping objects. Finally, she noted gait instability with a feeling of unsteadiness when upright on her feet. Conservative treatments consisted of nonsteroidal anti-inflammatory medications.
The patient had full and symmetric strength in her upper extremities with the exception of her left biceps and extensor carpi radialis, which were both graded at 4/5. Sensation was grossly intact to light touch and pinprick bilaterally. Her reflexes were brisk, graded at 3/4 bilaterally for biceps and brachioradialis. She also had a prominent Hoffman’s sign bilaterally and two beats of ankle clonus on the left. When ambulating the patient had a waddling gait. A Spurling maneuver to the left reproduced her shoulder and biceps pain.

**Diagnostic Data**

Magnetic resonance imaging (Figure 1) demonstrated multilevel cervical spondylosis. At the C5/6 level a posterior osteophyte effaced the spinal cord, and uncovertebral arthropathy resulted in severe left C5/6 neuroforaminal stenosis. Computed tomography (Figure 2) demonstrated a pseudarthrosis at C6/7. Dynamic radiographs (Figure 3) showed approximately 3mm of subluxation at C3/4 and C4/5.

**Patient Outcome**

Postoperatively, the patient had a left C5 palsy, which resolved within six months. On examination during follow-up one year after surgery, the patient had full strength with no Hoffman’s sign bilaterally and gait was normal. Her arm pain had also resolved, although she noted considerable neck stiffness. A lateral radiograph one year after surgery demonstrated solid arthrodesis from C3 to C7 (Figure 4).

**Discussion**

In this case, the patient presented with symptoms and signs of both myelopathy and cervical radiculopathy. The weakness, numbness, and loss of coordination in her hands, along with gait instability, are all symptoms worrisome for myelopathy. Although the degree of central canal stenosis is not severe on the sagittal MRI (Figure 1A), the bilateral Hoffman’s sign and ankle clonus also strongly suggested the patient
was myelopathic. The distribution of pain and weakness in the left arm were both consistent with a left C6 radiculopathy, which corresponded well with the C5/6 neuroforaminal stenosis noted on the MRI scan (Figure 1B).

Since the patient was apparently both myelopathic and had radicular weakness, surgery was strongly indicated. Clearly, the C5/6 level had to be addressed to decompress the central canal and left neuroforamen. However, due to the pseudarthrosis at C6/7 and the mobile subluxation at C3/4 and C4/5, it was decided that all four levels from C3/4 to C6/7 had to be included in the construct to avoid ending a construct adjacent to a level of instability.

Unfortunately, the patient had multiple risk factors for developing a pseudarthrosis in the patient. Most concerning, though, was the presence of a pseudarthrosis from a previous single level anterior cervical discectomy and fusion, which is a surgery with an arthrodesis rate of over 95%. Knowing that constructs involving more levels tend to have a higher pseudarthrosis rate, a four-level fusion surgery in this patient had a very high chance of developing a pseudarthrosis.

A multimodality approach was applied to this patient to minimize the risk of a pseudarthrosis developing. First, the patient was placed on smoking cessation and weight loss programs preoperatively to address the smoking and obesity. Second, an anterior and posterior surgery was performed including anterior cervical discectomies and placement of interbody grafts, along with posterior stabilization with lateral mass (C3-5) and pedicle screws (C7). Bone morphogenic protein was not used because it can significantly increase neck swelling.
and dysphagia in anterior cervical discectomy and fusion cases. Third, a PEMF bone growth stimulator was used for several months after the surgery. Using this combined strategy, the patient underwent the four-level fusion surgery and developed a solid arthrodesis at all four levels within a year (Figure 4).

**Conclusion**

There is a substantial amount of literature which shows the efficacy of PEMF bone growth stimulators. The studies show that patients, in particular, with high risk factors such as obesity, smoking, diabetes, and multilevel fusions are key candidates to use the device as an adjunct to fusion surgery. The prescription of the Cervical-Stim® bone growth stimulator was a necessary measure in this case since the patient had a high chance of nonunion. She had various risk factors going into the multilevel fusion: obesity, smoking, advanced age, and a failed single-level fusion. With a combined strategy incorporating proper surgical technique and bone growth stimulation, a solid arthrodesis formed at all four levels within a year.

**Fig. 4:** Follow-up lateral cervical radiograph 1 year after surgery demonstrating arthrodesis from C3 to C7.

**References**