

# Can Scintigraphy Explain Prolonged Postoperative Neck Pain?

## *Sintigrafi Uzamış Postoperatif Boyun Ağrısını Açıklayabilir mi?*

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### ABSTRACT

**AIM:** Anterior cervical fusion procedures are among the most commonly performed spinal operations. Investigators have reported pseudoarthrosis rates ranging from 3 to 36% following anterior cervical fusion operations. The diagnosis of pseudoarthrosis has been based on the triad of pain, radiographic evidence of instability, and loss of correction or fixation. Scintigraphic imaging may be involved in pseudoarthrosis investigation by increase of nuclear agent uptake at the operated level but today it is not used in clinical practice as a routine imaging modality.

**MATERIAL and METHODS:** Nine cases operated for degenerative disc disease on single level but suffering postoperative prolonged neck pain were involved in the study. All cases underwent 99mTc-hydroxymethylene diphosphonate (HMDP) bone SPECT later than postoperative twelfth month.

**RESULTS:** Results showed a correlation between severity of neck pain and fusion status.

**CONCLUSION:** Increased and prolonged uptake of nuclear agent should cause a suspicion on so-called fusion, proven by radiology.

**KEYWORDS:** Cervical fusion, PEEK cage, Pseudoarthrosis, Scintigraphy

### ÖZ

**AMAÇ:** Anterior servikal füzyon girişimleri en sık uygulanan omurga ameliyatlarındandır. Araştırmacılar anterior servikal girişimlerden sonra %3 ile %36 arasında değişen psödoartroz oranları bildirmişlerdir. Psödoartroz tanısı ağrı, radyolojik instabilite tespiti ve korreksiyon ya da fiksasyon kaybı triadına dayanır. Psödoartroz tanısında opere edilen seviyede nükleer ajan tutulumunda artışla sintigrafik görüntülemeden faydalanılabilir ancak bu, günümüzde rutin klinik görüntüleme modaliteleri arasında yer almamaktadır.

**YÖNTEM ve GEREÇLER:** Dejeneratif disk hastalığı nedeniyle opere edilen ve postoperatif uzundönem ağrı yakınması olan 9 hasta çalışmaya dahil edildi. Tüm hastalara postoperatif 12. aydan sonra 99mTc-hidroksimetilen difosfonat (HMDP) kemik SPECT taraması yapıldı.

**BULGULAR:** Sonuçlar boyun ağrısı ile füzyon durumu arasında ilişki olduğunu gösterdi.

**SONUÇ:** Opere edilen bölgede artmış nükleer ajan tutulumu radyolojik olarak kanıtlanmış füzyon için şüphe oluşturmaktadır.

**ANAHTAR SÖZCÜKLER:** Servikal füzyon, PEEK kafes, Psödoartroz, Sintigrafi

### INTRODUCTION

Anterior cervical fusion procedures are among the most commonly performed spinal operations (1, 6, 9, 14, 15, 19, 23-34, 36-38). Many congenital, degenerative, malignant and traumatic causes lead the treatment to spinal fusion. Anterior discectomy and fusion with cages (ACDF-c) are very frequently performed for release of the neural tissue and stabilization of the neck. Any kind of operation has its own expected complications and for spinal fusion procedures, the most mundane one is pseudoarthrosis. Investigators have reported pseudoarthrosis rates ranging from 3 to 36% following anterior cervical fusion operations (3, 16, 17, 25).

Traditionally, the diagnosis of pseudoarthrosis has been based on the triad of pain, radiographic evidence of instability, and loss of correction or fixation. Although exploration and intraoperative conviction is the gold standard to establish a diagnosis most reliable imaging modality for spinal pseudoarthrosis is controversial. Commonly used modalities are lateral flexion-extension radiographs and computed tomography (CT). The most widely accepted criteria for pseudoarthrosis were defined by Vavruch et al. (34).

Scintigraphic imaging may also be involved in pseudoarthrosis investigation. Pathological increase of nuclear agent uptake

at the operated site would give rise to the thought of fusion failure. Much as some previous limited studies questioned the diagnostic value of scintigraphy, today it is not used in clinical practice as a routine imaging modality (11, 21).

The question 'Should we be sceptical about an unproven pseudoarthrosis?' was raised during the follow-up of our ACDF-c cases. During postoperative period some of the cases complained neck pain despite the resolution of radiculopathy. These cases suffered mild to moderate neck pain, but radiologically no evident cause could be shown. Study group of the present study consisted of these cases with prolonged postoperative neck pain without radiological pseudoarthrosis. The question mentioned above leads to the aim of this study: To investigate an unproven pseudoarthrosis at the so-called fused levels by means of nuclear medicine i.e. pathological nuclear agent uptake. As a classical fact, even completely healed and fused bone fractures may show increased nuclear agent uptake, up to 1.6 times, when compared with healthy subjects. Studies with detailed counts of regions of interest (ROI) windows showed that a peak of uptake occurs within a month and these values reach a plateau within two months that may persist for long years (21).

Our cases underwent scintigraphic evaluation to question the technetium-99m (Tc) uptake at the operation site rated with the uptake at unoperated spinal axis. The pain status was evaluated with Visual Analog Scale (VAS). Radiological, clinical and scintigraphic results were interpreted.

#### MATERIAL and METHODS

**Patients:** Inclusion criteria were quite specific to maintain the homogeneity and to avoid interferences. Middle-aged, non-smoking 10 patients (6 men and 4 women), operated between 2000 and 2005 due to degenerative disc disease, and suffering long term postoperative neck pain were asked to volunteer for this study. None of the cases asked to volunteer for the study refused to be enrolled.

Cases with myelopathy were excluded considering the risk of diffuse spinal degeneration. Concomitant systemic, chronic or degenerative diseases, psychiatric disturbance, drug

abuse, and previous spine surgery were also limitations of the study. Cases enrolled in the study after informed consents were obtained. They were all operated for degenerative disc disease on single level. Postoperative radiographical investigations, evaluated by the same blinded radiologist, have shown fusion in different grades in all cases (Table I). At postoperative twelfth month all cases were suffering neck pain without radiculopathy.

The ethical committee of our institution approved the study.

**Surgical technique:** Through an anatomical dissection with standard right-sided approach, anterior longitudinal ligament was incised. Intervertebral discs was completely removed, nerve roots and spinal cord were decompressed. Afterwards PEEK cages (AC-PEEK, Tasarimmed™, Istanbul, Turkey) packed with demineralized bone matrix (CemO-01P, Berkeley Advanced Biomaterials™, Berkeley, CA) were gently placed into the distracted intervertebral disc space. No anterior cervical plating was used.

All cases used Philadelphia type collar for six weeks postoperatively. Later on, 'at home recovery program' including neck muscles strengthening exercises were started. Standard follow-up evaluation included complete neurological examination, neck pain evaluation (VAS), cervical anteroposterior and lateral flexion-extension radiographs and cervical magnetic resonance (MR) imaging. MR imaging was performed in all cases with postoperative pain to exclude recurrent disc problems or other neck pain causes not related with the operation.

The radiological images were evaluated using the classification of anterior fusion proposed by Vavruch et al (34). In this classification Type 1A is defined as bridging bone anterior and through the disc space; 1B as bridging bone anterior but not through the disc space; 2A as bridging bone not anterior but through the disc space; and 2B as no bridging bone at all. The radiological outcomes were classified as 'non-fusion' when 2B healing was observed, and as 'fusion' when 1A, 1B or 2A healing was observed at the levels subjected to surgery.

**Table I:** Details of Cases

Case no	Age, sex	UIR	VAS (neck pain)	Fusion status (Vavruch grade)
1	37, M	1,55	32	1B
2	36, M	1,75	39	2A
3	42, F	1,61	39	1B
4	39, M	1,82	49	2A
5	35, F	1,41	21	1A
6	37, M	1,79	50	2A
7	44, F	1,91	44	2A
8	34, F	1,79	40	2A
9	40, M	1,65	32	1B

**VAS:** Visual analog scale, **UIR:** Uptake increase ratio.

All cases underwent 99mTc-hydroxymethylene diphosphate (HMDP) bone SPECT later than postoperative twelfth month. Nuclear agent uptake was counted with ROI (region of interest) windows (10,5mm x 10,5mm) placed on operated level and on unoperated spinal axis. Counting results were rated and recorded as 'uptake increase ratio' (UIR). A control group was not planned in this study not to risk any individual with radiation. But regarding the previous literature concerning scintigraphic evaluation of bony fusion, UIR value of 1.6 was accepted as the reference point (5, 7, 8, 10-12, 18, 20-22, 32, 34). UIR higher than 1,6 was accepted as micropseudoarthrosis (i.e. pseudoarthrosis that could not be proven by radiology).

Statistical analyzes were performed with SPSS (Statistical Package for Social Sciences) for Windows 15.0. T Test was used to investigate the significance between UIRs ( $p < 0.05$ ).

### RESULTS

During the investigations one of the cases was found to have lung cancer so he was ruled out. Study group included 9 cases (5 men and 4 women). Mean age was 38,2 years (range; 34-44).

Of all 9 cases one case (case #5) showed type 1A fusion. Her VAS score -21- and UIR -1.41- were the lowest among all cases. Since type 1A fusion is the strongest type as defined by Vavruch et al. probable mobility and the pain related with this mobility was lowest (Figure 1A,B).

Three cases showed type 1B fusion. This means only anterior bridging was present between the vertebral bodies at the operated level. Their VAS score ranged between 32 and 39. This spectrum was higher than the VAS score of only 1A case

in the study group. Their UIRs ranged between 1.55-1.65 and this spectrum was also higher than the same case with 1A fusion (Figure 2A,B).

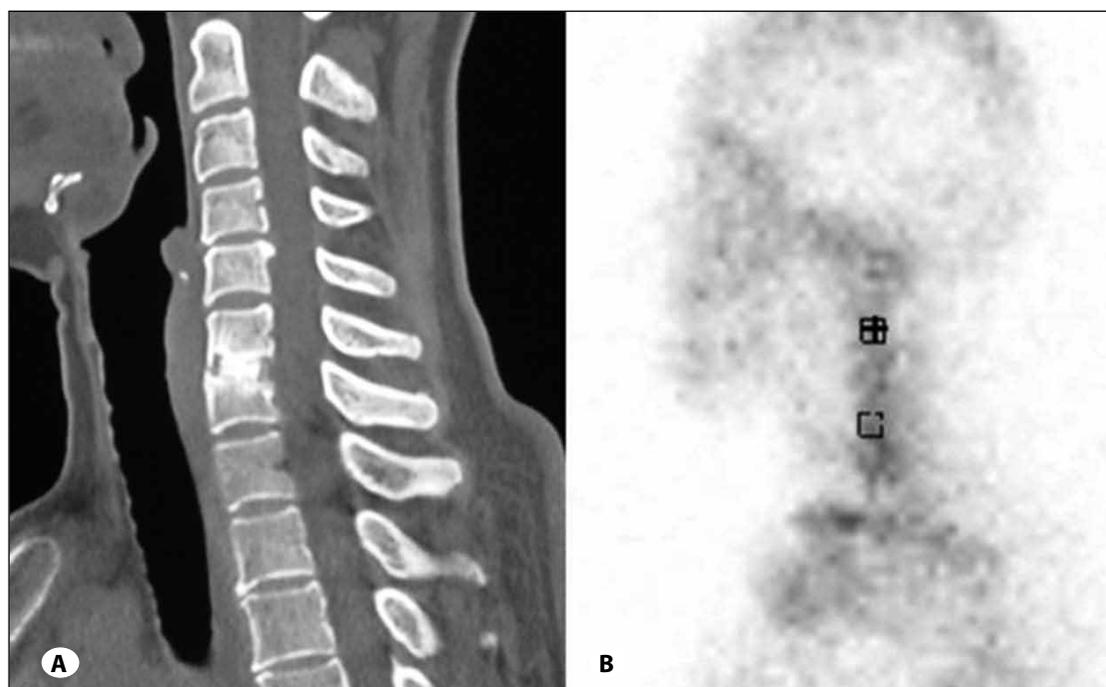
Five cases showed type 2A fusion with VAS scores between 39 and 50, and UIRs between 1.75-1.91. These cases had the highest scores of UIR and VAS. Details of cases are given in Table I (Figure 3A,B).

Statistical analyzes elicited that the difference between 1B group and the reference point of UIR (1,6) was insignificant ( $p: 0.919$ ), and the difference between 2A group and the reference was significant ( $p: 0.001$ ).

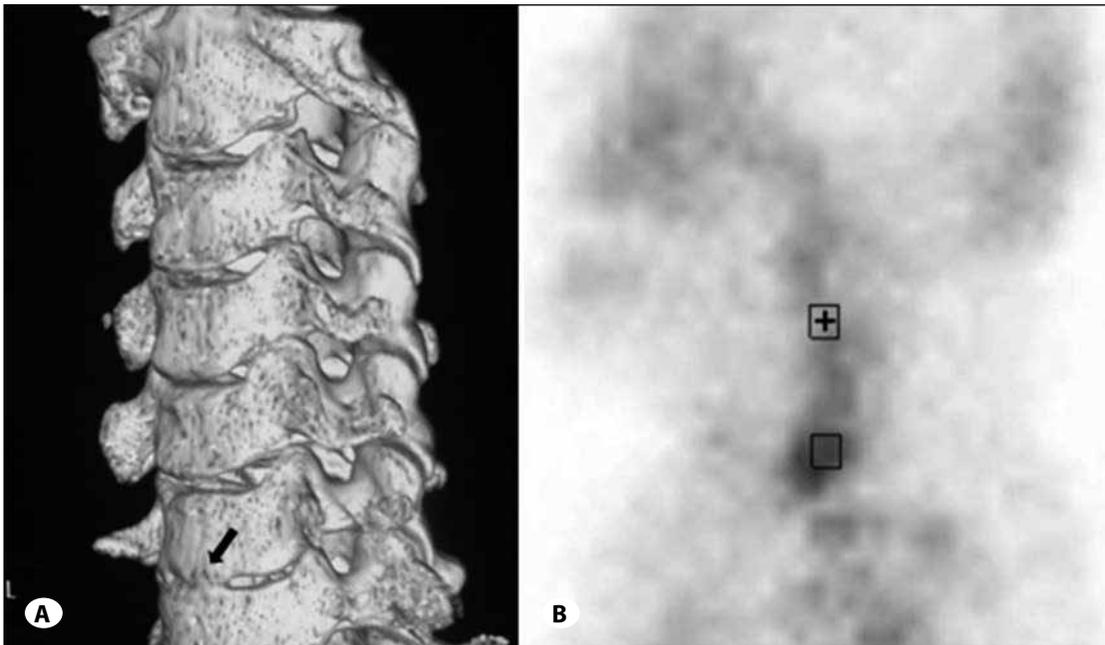
### DISCUSSION

Anterior cervical discectomy and fusion is an efficacious procedure used to treat a variety of cervical spinal disorders, including spondylosis, myelopathy, herniated discs, trauma, opacified posterior longitudinal ligament, and degenerative disc disease (2, 3). The aim in these operations is to maintain a solid bony fusion at the operated level by creating an environment that encourages bone formation between the vertebrae. The quality of fusion is essential to achieve a satisfactory clinical outcome (11). White and Panjabi reported a spine fusion should progress to the stage of immature osseous union and minimal intervertebral motion by 18 weeks. The complete fusion process may take 18 months (35).

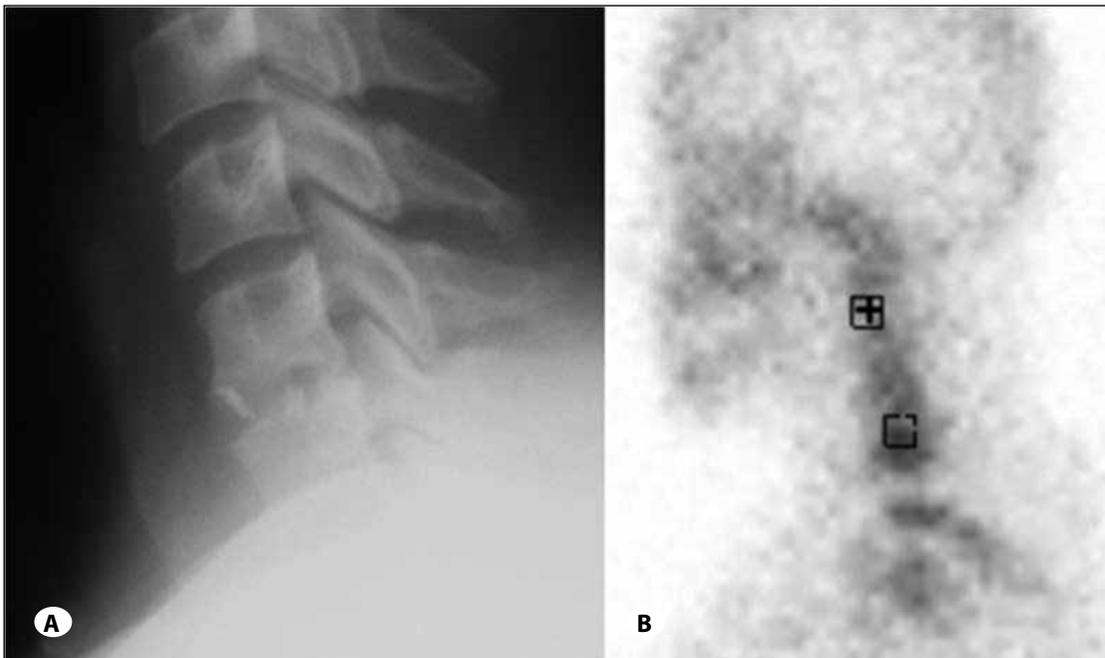
The term 'spinal fusion' remains unclear; if it defines a complete solid fusion with no mobility or minor mobility is negligible. Food and Drug Administration (FDA) currently accepts  $4^\circ$  as the definition of failed fusion in the lumbar spine, although the rationale for this guideline is not well documented (20). Regarding this threshold as pseudoarthrosis limit, in their



**Figure 1:** 1A fusion, **A)** Anterior bridging and bone formation through the disc space, **B)** ROI windows on the operated (lower) and unoperated (upper) cervical axis.



**Fig. 2:** 1B fusion, **A)** Anterior bridging on 3-D CT image (black arrow), **B)** ROI windows on cervical axis.



**Figure 3:** 2A fusion, **A)** Bone formation through the disc space without anterior bridging, **B)** Lower ROI window shows significantly increased uptake.

retrospective clinical study with 200 anterior cervical fusion cases Hipp et al. reported 6% pseudoarthrosis, one year after surgery, even with the use of anterior plate and screw system. In the same study, the apparent pseudoarthrosis rate was 44% when the intervertebral motion threshold was 1° (20). This means despite the strongest instruments 44% of the anterior cervical fusion cases will have minor movement.

Pseudoarthrosis may be the most common complication associated with spinal fusion procedures. The diagnosis of pseudoarthrosis is not always straightforward, and the optimum imaging modality in the absence of frank

instability remains controversial. Traditionally, the diagnosis of pseudoarthrosis has been based on the clinical triad of pain, radiographic evidence of instability, and loss of correction or fixation (4, 13). However, intraoperative exploration of fusion which is most accurate is the gold standard technique to detect a pseudoarthrosis.

In their prospective study Buchowski et al. tried to assess the reliability of plain radiographs, CT, and MRI to detect a pseudoarthrosis after ACDF compared with intraoperative exploration. They found that a combination of all three imaging methods correlates most closely with intraoperative

findings (5). In the same study, they reported when only a single imaging modality is employed, CT scans most closely agree with intraoperative findings and also even with all three diagnostic methods, it is possible to misdiagnose a pseudoarthrosis (5).

The point that generated this study was doubt about the radiological evaluation of cervical fusion. Many operated cases suffering prolonged postoperative neck pain showed radiologically evident fusion in different grades. But the important clue, 'the worse the fusion, the worse the neck pain', consequently brought up the need of scintigraphic evaluation.

In the present study radiologically proven fusion, regarding the criteria of Vavruch et al., was re-evaluated with <sup>99m</sup>Tc-HMDP scintigraphy.

For pseudoarthrosis diagnosis UIR of 1,6 was accepted as the cut point in this study. Iseda et al. showed <sup>99m</sup>Tc-HMDP uptake ratio peaked 1 month after surgery and decreased rapidly to a plateau within 2 months. Thereafter an uptake ratio of 1,6 remained. Previous studies about scintigraphic evaluation of bone healing of radius and femur fractures has showed relevant uptake ratios (21). UIR higher than 1,6 could be related with mobility concerning the associating neck pain.

The correlation between VAS scores and the fusion status suggested that the minimal mobility of the operated and so-called fused levels may proceed healing, namely bone regeneration or increased uptake at these levels may predict a second surgery for advanced stabilization.

All cases in this study were offered a second surgery with anterior platinum, for the relief of neck pain. But regarding the complications and the mildness of their pain, none of them has accepted.

### CONCLUSION

The criteria offered by Vavruch et al. may be much optimistic for cervical fusion status. Increased and prolonged uptake of nuclear agent should cause a suspicion on so-called fusion, proven by radiology. These cases may need stabilization of the cervical spine (i.e. plates).

The present study may be assumed to be a pilot study with a limited group of cases. Further multicenter studies with larger groups, supported by different imaging modalities will definitely have sound conclusions.

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