# Useful Fusion Image Measure of CT and MRI For Detail Assessment in Low Pain (LBP)

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## Article Info

## Abstract

Authors and collaborators have presented several reports using computerized technique with Synapse Vincent. The case is 78-year-old male with low back pain (LBP) and lumbar disc herniation of L4/L5. By the reconstruction of CT and MRI images, detail relationship between vertebrae and lumbar nerve can be observed. The moderate stenosis of lumbar nerve was found in sagittal and coronal views of medical image fusion. Using the reconstruction technique, transverse image of intravertebral disc at L4/L5 showed moderate lumbar spinal canal stenosis. Thus, diagnostic fusion method for reconstruction of CT/MRI images will be beneficial and useful for future clinical practice.

**Keywords:** Synapse vincent; Lumbar disc herniation; Lumbar spinal canal stenosis; Medical image fusion; Reconstruction of CT

## Introduction

Among health problems, many patients complain of low back pain (LBP) [1]. It is important to evaluate the pathology of lumbar disc herniation and lumbar spinal canal stenosis, and to evaluate the morphology of lumbar nerve roots beyond their malformation and course [2]. It is also indispensable when making a diagnosis, deciding on a treatment plan, and increasing the safety of surgical techniques [3]. In order to accurately evaluate, it has conventionally been necessary to construct a 3D image of the lumbar nerve extracted from a 2D image.

Concerning the medical image fusion, the purpose would be the improvement of the accuracy of clinical diagnosis. The obtained fusion image can be produced by holding the precise details and essential characteristics of the original images. A certain method of weight-optimised anisotropic diffusion filtering (WOADF) has been possible for combination of CT and MRI images [4]. Authors and co-researchers have presented several reports about the reconstruction of CT and MRI using computerized technique [5]. We recently came across an important case that can be applied the fusion technique, and present the clinical progress in this article.

## Case Presentation

### Medical History

The patient is a 78-year-old male, and he did not have previous remarkable diseases or medical problems. In May 2023, he visited our hospital because family noticed his slower speech and behavior. He was diagnosed as the early stage of mild cognitive impairment (MCI), but it did not interfere with his ordinary daily life. Since July 2023, he had complained of low back pain (LBP) and mild numbness from his lower back to both legs, and then radiological evaluation was conducted by lumbar CT and MRI.

### Several Examinations

Physical examinations in August 2023 were as follows: Consciousness, vitals and usual speech showed unremarkable. For physical exam, the head, face, neck, lung, heart and abdomen did not have abnormalities. His physique showed height 157 cm, weight 49 kg, and calculated BMI was 19.9 kg/m². His body weight has been almost the same for 5 years.

The biochemical exams revealed the following results. The were AST 26 U/L, ALT 8 U/L, GGT 28 U/L, uric acid 7.0 mg/dL, BUN 10 mg/dL, Cre 0.79 mg/dL, HDL 42 mg/dL, LDL 59 mg/dL, TG 60 mg/dL, glucose 72 mg/dl, HbA1c 4.9%, WBC 5500/μL, RBC 3.77 x 10⁶ /μL, Hb 11.5 g/dL, Ht 37.0 %, MCV 98.1 fL (80-98), MCH 30.5 pg (27-33), MCHC 31.1 g/dL (31-36), Plt 20.9 x 10⁴ /μL.

 As other physiological exams, chest ray showed no remarkable

changes, and electrocardiogram (ECG) was ordinary sinus rhythm and unremarkable ST-T changes.

## Results

### Thoracolumbar CT Findings

There were no significant changes in the internal organs of the thorax and abdomen. However, it showed spondylolisthesis at L4/5, and a protruding soft tissue shadow behind the intervertebral discs. The radiological finding was lumbar spinal canal stenosis at L4/L5.

### Lumbar Spine MRI Findings

Anterior slippage is found in the L4 vertebral body. Endplate degeneration accompanied by inflammation and edema is observed at the Th12/L1 and L4/L5 levels. From L3/L4 to L5/S1 levels, there are osteophytes, bulging and protruding intervertebral discs, thickening of the ligamentum flavum, and hyperplasia of the facet joints. At the L4/L5 level, there was a right paramedian disc protrusion and cranial deviation. At the L3/L4 level, a right lateral disc protrusion was observed, with HIZ within the protruding disc and edematous changes in the right paravertebral soft tissue. These findings revealed mild narrowing of the bilateral lateral recesses at the L3/L4 level and severe compression of the dural sac predominant on the right side at the L4/L5 level. The intervertebral foramen is narrowed on the right side of L4/L5.

Diagnosis included i) degenerative disk disease, disk extrusion and spondylolisthesis with lumbar spinal stenosis, ii) endplate degeneration, and iii) right paraspinal soft tissue abnormality.

### Combining Method of CT and MRI Data

The lumbar nerve was extracted in three dimensions (3S) using Synapse Vincent. A three-dimensional image of the lumbar vertebrae was created from a CT image. By combining the above two, an image having the advantages of each was obtained. A fusion image was created from both 3D images using a general-purpose application. With the above method, the detailed positional relationship between bones and nerves can be grasped three-dimensionally.

### Combined Detail Fusion Image of CT And MRI

Current case had received abdominal CT and MRI exams. This case has intervertebral hernia at L4/L5 (Figure 1). Posterior protrusion of the intervertebral disc at L4/L5 is observed in sagittal MRI and coronal CT views. For developed images, detail changes can be found in sagittal MRI and reconstruction of CT exams (Figure 2). By reconstruction of vertebral CT at L3/L4 and L4/L5, sagittal and transverse images showed detail situation of intervertebral disc and lumbar canal stenosis (Figure 3). Fusion images were reconstructed from CT and MRI data for detail relationship between lumbar vertebrae and lumbar nerve (Figure 4).
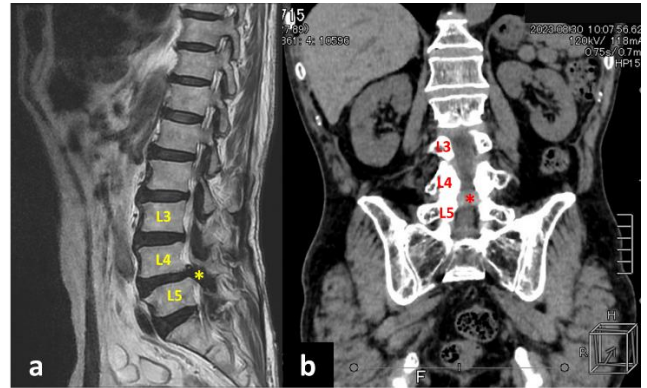


*Figure 1: Images of lumbar portion*
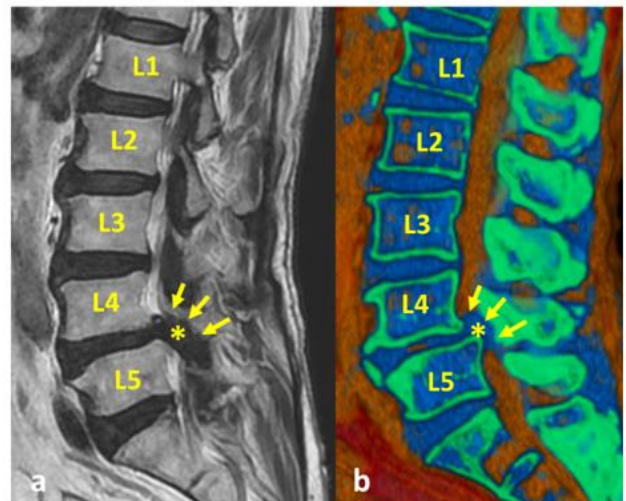*a: MRI image (sagittal view)*
*b: CT image (coronal view)*



*Figure 2: Lumbar herniation image.*
*a: MRI image with disc herniation*
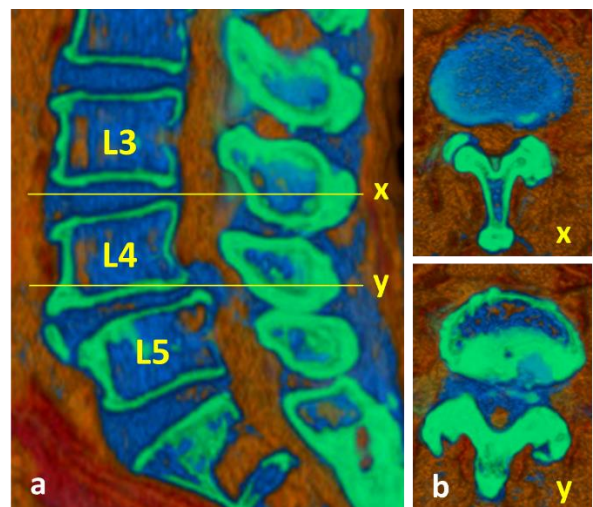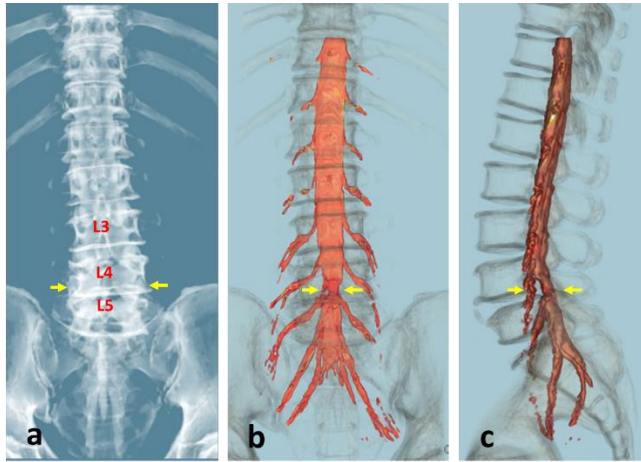*b: reconstruction image of CT*



*Figure 3: Reconstruction image of CT.*
*a: sagittal view,*
*b: transvers view*

***Figure 4:** Fusion image of CT and MRI in lumbar vertebrae and lumbar nerve.*
*a: narrowing image of intervertebral disc at L4/ L5*
*b: fusion image showed the stenosis of lumbar nerve (coronal view)*
*c: fusion image showed the stenosis of lumbar nerve (sagittal view)*

## Discussion

In this case, fusion imaging clearly revealed the location of the lumbar nerve within the spine, its relationship to its surroundings, and the pressure marks on the nerve due to bone compression. Thus, 3D fusion image technology has been shown to be useful for clinical diagnosis and treatment [6].

Similar research using fusion image method was found. It was for cervical radiculopathy with combined images of cervical nerve and cervical bone [7]. Novel measure included the combination of 3-D MR and 3-D CT, which can show the compression of responsibility point of the cervical nerve root. Thus, cases with cervical radiculopathy may show such herniated disc and also preforaminal bony spur.

For the detail diagnosis of carotid endarterectomy (CEA), 3-dimensional CT angiography (3D-CTA) and digital subtraction angiography (DSA) have been used for preoperative evaluation. Using Synapse Vincent (Fuji film, Tokyo), fusion image of CT 3-D-MRA and carotid plaque imaging has been successfully emerged [8]. In order to manage the risk of cerebral vascular accident (CVA) by carotid artery stenosis, the novel measure has been reported [8]. It is the fusing measure of three images by SYNAPSE VINCENT, which includes including cervical CT, 3D time-of-flight (TOF)-MRA, and plaque MRI to replace 3D-CTA [9].

Certain limitation exists in this report. This is only one case with lumbar problems, in which fusion image of CT and MRI was clinically useful. Various changes in the technique have been found so far, where close attention will be required to catch up with the development for this field in the future.

 In summary, elderly male had medical problems of LBP and detail radiological assessment was possible by the fusion image method of CT and MRI. Current article will become helpful data for future radiological and medical research development.

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