ORIGINAL ARTICLE

Traumatic isolated spinous process fractures

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ABSTRACT

BACKGROUND: Isolated traumatic spinous process fractures account for a small proportion of diagnosed spinal fractures. Among spinal fractures, the cervical vertebra is the most common site of involvement, often referred to as a Clay-Shoveler's fracture. This study included patients with isolated spinous process fractures through radiologic examinations over the past five years. The study aimed to investigate the cause of trauma, the presence of spinal ligament injury, and the relationship between these fractures with age and sex.

METHODS: Magnetic resonance imaging (MRI) and computed tomography (CT) scans of the spine, performed for any reason over the past five years at the hospital where the study was conducted, were retrospectively reviewed and re-evaluated. Patients whose examinations were unrelated to trauma, those with imaging artifacts that interfered with evaluation, and those who had undergone spinal vertebral surgery were excluded. The etiology of fractures was classified using the International Classification of Diseases (ICD) diagnoses. Data on age, sex, cause of trauma, and spinal ligament injury were recorded.

RESULTS: A total of 44 patients (36 men and eight women) were included in the study, with a mean age of 43.1 years. Among them, 25 patients were admitted due to traffic accidents and 18 due to falls. Spinous process fractures were observed in 18, 17, and three patients in the cervical, thoracic, and lumbar regions, respectively. Multiple spinous process fractures were found in 15 patients, while six patients had fractures in both the cervical and thoracic regions (Clay-Shoveler's fracture). In 12 patients, spinal MRI with Short-TI Inversion Recovery (STIR) sequences was performed in addition to CT imaging. All patients with Clay-Shoveler's fracture fractures underwent both CT and MRI examinations. In all cases where MRI was performed, interspinous ligament damage was detected. However, no intracanal involvement or comorbid pathology was observed.

CONCLUSION: Notably, multiple fractures may occur, particularly at the cervicothoracic junction. Although spinous process fractures associated with trauma are rarely isolated, they are usually managed with medical treatment. Therefore, the vertebrae below the initially detected fracture site should also be evaluated. Additionally, imaging studies such as MRI with STIR sequences should be performed to assess ligament damage and the neural canal, in addition to tests for evaluating bony structures.

Keywords: Vertebrae; spinous process; fracture; trauma; multiple; Clay-Shoveler's fractures.

INTRODUCTION

Spinous process fractures are currently recognized as part of spinal trauma resulting from high-energy trauma. Isolated spinous process fractures (ISPFs) are extremely rare. Although ISPFs can occur in all three spinal regions, Clay-Shoveler's fractures—stress-type avulsion fractures of the lower cervical or upper thoracic spinous processes—are the most common. Clay-shoveler's fractures (CSF) most frequently involve the spinous processes of the C7 and T1 vertebrae. According to previous studies, the mechanism of CSF involves repetitive and forceful pulling of the upper back muscles, leading to fatigue fractures of the spinous processes. ISPFs were historically considered occupational injuries in workers who lifted heavy loads with shovels. However, they are now more commonly observed in individuals engaged in sports such as weightlifting and golf, as well as in cases of high-energy trauma. In this study, post-traumatic ISPFs are discussed in light of previous research findings.[1-6]

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MATERIALS AND METHODS

This study was conducted retrospectively. Approval was obtained from the Gaziosmanpaşa Training and Research Hospital Ethics Committee (Approval Number: 169, Date:12.27.2023). The study was carried out in accordance with the Declaration of Helsinki. Spinal vertebrae magnetic resonance imaging (MRI) and computed tomography (CT) examinations performed for any reason at the hospital where the study was conducted were retrospectively reviewed and re-evaluated. Spine CT scans were performed using a 128-slice CT scanner (Optima CT660, GE, USA). MRI scans were conducted using a 1.5 Tesla MRI system (Signa HDxt, GE, USA) with a whole-body coil. Sagittal T1-W Fast Spin Echo (FSE) (425/7 repetition time/echo time, 320 x 256 matrix, 300 mm field of view, and 4 mm section thickness, NEX 3), T2-W Short-TI Inversion Recovery (STIR) (7000/100 repetition time/echo time, 256 x 256 matrix, 300 mm field of view, and 4 mm section thickness, NEX 2), T2-W Fast Recovery Fast Spin Echo (frFSE), and axial T2-W frFSE (3357/120 repetition time/echo time, 320 x 256 matrix, 300 mm field of view, and 4 mm section thickness, NEX 3) were used for cervical MRI imaging. All examinations were performed by a single radiologist with 16 years of experience in musculoskeletal radiology.

Patients with examinations unrelated to trauma, those with artifacts interfering with evaluation, and those who had undergone spinal vertebral surgery were excluded from the study. The etiology of fractures was classified using the International Classification of Diseases (ICD) diagnoses. Age, sex, cause of trauma, and spinal ligament injury were recorded for patients with post-traumatic ISPF.

Statistical Analyses

In this descriptive study, data were presented as mean, standard deviation, median (min-max), frequency, and percentage.

RESULTS

A total of 44 patients were included in the study, comprising 36 men (81.81%) and eight women (18.18%). The patients' ages ranged from 14 to 80 years, with a mean age of 43.1 years. Among the patients, 25 were admitted due to traffic accidents and 19 due to falls. Spinous process fractures were observed in 18, 17, and three patients in the cervical, thoracic, and lumbar regions, respectively. Additionally, 15 patients had multiple spinous process fractures, and six patients with multi-level fractures had combined fractures in the cervical and thoracic regions (CSF) (Fig. 1). In 16 patients, spinal MRI with Short-TI Inversion Recovery (STIR) sequence was performed in addition to computed tomography (Fig. 2). In eight patients, no edema was observed in STIR sequences at the current fracture levels, indicating old fractures. All patients

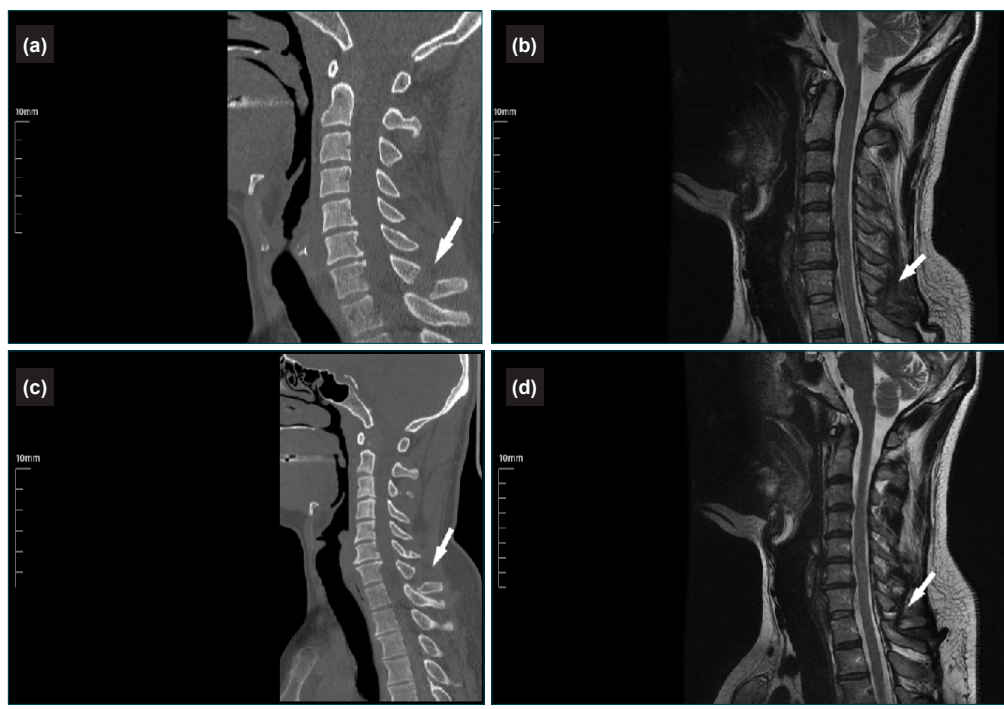

Figure 1. (a) Midsagittal computed tomography (CT) scan showing an oblique fracture and significant displacement of the spinous processes of the C7 and T1 vertebrae. **(b)** Sagittal T2-weighted image magnetic resonance imaging (MRI) scan showing a fluid collection at the tip of the C7 spinous process with associated bone marrow edema. **(c)** Midsagittal CT scan obtained three years after a motorcycle accident showing nonunion of the displaced spinous process. **(d)** Sagittal T2-weighted image MRI scan demonstrating complete resolution of the fluid collection and bone marrow edema.

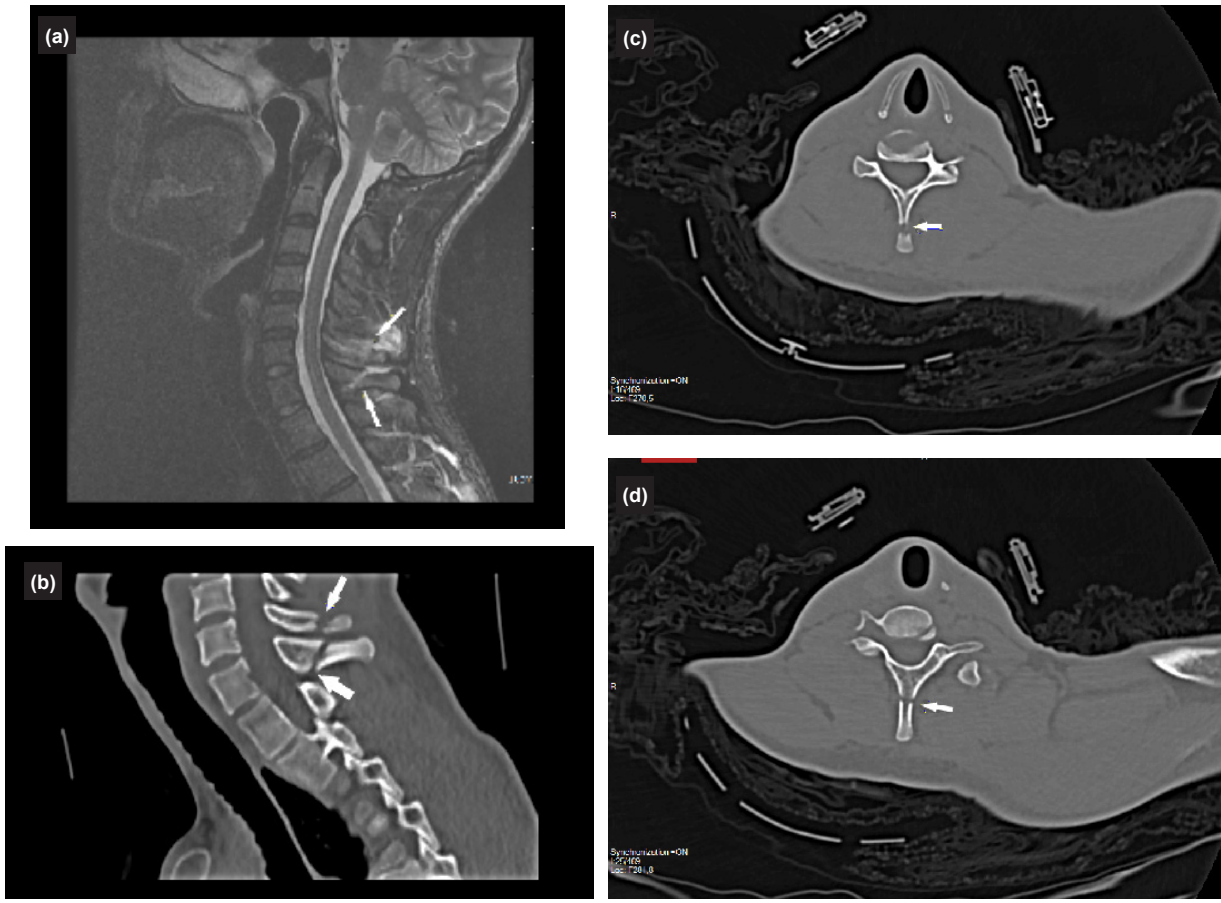

Figure 2. (a) Midsagittal Short-TI Inversion Recovery (STIR) magnetic resonance imaging (MRI) scan showing an oblique fracture of the spinous processes of the C5 and C6 vertebrae with associated bone marrow edema, along with edema in the interspinous ligament and adjacent soft tissue. The vertebral bodies and other posterior elements appear normal. **(b)** Midsagittal cervicothoracic computed tomography scan showing an oblique fracture of the spinous processes of the C5 and C6 vertebrae. **(c)** Axial CT scan showing a spinous process fracture of the C5 vertebra. **(d)** Axial CT scan showing a spinous process fracture of the C6 vertebra.

with Clay-Shoveler's fractures underwent both CT and MRI examinations. In all patients who underwent MRI, interspinous ligament damage was detected. However, no intracanal involvement or comorbid pathology was identified.

DISCUSSION

Spinous process fractures were first described in individuals whose occupations required heavy manual lifting. Today, most spinous process fractures are associated with sports injuries and high-energy trauma. Although case reports and reviews of ISPFs exist in the current literature, the present study includes a series of 44 patients.

Mechanically, ISPFs occur due to stress forces exerted by muscles during excessive flexion and rotation of the spine. This force is transmitted to the spinous processes through the supraspinous ligaments, leading to avulsion fractures.[1-4] Previous studies have reported that impaction fractures occur due to direct impact or hyperextension of the spinous processes, most commonly resulting from motor vehicle accidents.[5-7] In the present series, 25 patients were diagnosed with ISPF due to traffic accidents, while 19 cases resulted from falls. Therefore, all cases in this study resulted from high-energy trauma. Anatomically, the ligament that attaches to all spinous processes of the spine, the ligamentum nuchae, extends from the external occipital protuberance to the C7 spinous process and serves as the origin of the upper part of the trapezius muscle. Beyond this point, the ligamentum nuchae continues as the supraspinous ligament. The vector of pulling forces exerted by these muscles is transmitted perpendicularly to the axis of the spinous processes. This mechanical stress increases the risk of fracture and causes the distal portion of the fracture to be displaced caudally in the direction of traction, and to a lesser extent, laterally.[3,4,8,9] Due to this anatomical feature, spinous process fractures can occur at any level of the spine, though they are most commonly observed in the lower cervical and upper thoracic vertebrae. The spinous processes of C7 and T1 are the most frequently affected in CSFs.[3,5,6,10] Unilateral forceful traction, particularly from the trapezius and rhomboid minor muscles, may cause

fractures of the C7 or T1 spinous processes.[5] The increased susceptibility of the C7 and T1 spinous processes to fracture is attributed to their relatively longer and thinner structure, making them less resistant to trauma or tensile forces.[5,8] In the present series, C7 fractures were observed in 13 patients, while T1 fractures were identified in 12 patients. C7 fractures were present in six patients, T1 fractures in two patients, and combined C7 and T1 fractures (Clay-Shoveler's fracture) in six patients. The findings of our study align with previous reports.

Although multiple spinous process fractures have been infrequently reported in prior studies, they are generally estimated to occur in approximately one out of eight cases.[5] We believe that the mechanism of multi-level fractures is similar to that of previously described ISPFs. However, previous studies have suggested that nonunion of the fractured bone ends may affect the biomechanical stability of the surrounding muscles and ligaments. This increases movement-related stress and the resulting shear force. Repetitive shear force, particularly during intense physical activity, is associated with an increased risk of additional fractures in adjacent vertebral spinous processes.[3] This explains the mechanism of CSFs previously described in heavy laborers. In the present series, 6 out of 15 multiple spinous process fractures involved both the cervical and thoracic regions and were classified as CSFs. Additionally, nine patients had similar fractures in the cervical and thoracic regions. The key difference between this study and previous literature is that the present cases consisted of high-energy trauma-related fractures, whereas most prior studies were limited to case reports.

ISPFs are generally considered stable, regardless of whether they are single or multiple; however, they are often associated with significant pain.[11] Previous studies have reported that surgical excision of the fractured bone fragment or stabilization procedures are not necessary. In this case series, no surgical interventions were performed for ISPFs. Instead, medical management with painkillers and muscle relaxants at different doses was sufficient for system control. The primary components of treatment include movement restriction and the use of braces such as a cervical collar, thoracolumbar sacral orthosis (TLSO), TLSO hyperextension brace (Jewett), or TLSO with cervical extension. The purpose of these braces is to accelerate healing by limiting movement in the fractured segment and preventing bone fragments from rubbing against each other or from irritating edematous tissue, which could otherwise cause pain.[3,5,7,9]

CONCLUSION

With advances in imaging techniques, spinal radiographs are widely used, particularly in trauma cases. In high-energy trauma, a suspected spinous process fracture should be considered in patients presenting with midline tenderness. Even if direct radiographs appear negative, these patients should undergo CT and STIR sequence MRI scans to ensure accurate diagnosis.

Ethics Committee Approval: This study was approved by the Gaziosmanpaşa Training and Research Hospital Ethics Committee Ethics Committee (Date: 12.07.2023, Decision No: 169).

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Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Travmatik izole spinöz proses kırıkları

AMAÇ: Saptanan omurga kırıkları içinde izole travmatik spinöz proces kırıkları küçük bir yere sahiptir. Tüm spinal bölgeler içinde servikal omur daha sık görülür ve Clay-Shoveler's kırıkları olarak adlandırılır. Bu çalışmada son 5 yıl içerisinde spinal travma sonrası radyolojik tetkiklerinde spinöz proces kırığı raporlanan hastalar içinden sadece izole spinöz proces kırığı olanlar ayrılmıştır. Bu hastaların yaş, cinsiyet ve travma sebebi, spinal ligaman hasarı yönünden araştırılması amaçlandı.

GEREÇ VE YÖNTEM: Hastanemizde son 5 yıl içerisinde herhangi bir neden ile yapılan spinal vertebra MR ve BT incelemeleri retrospektif olarak tarandı ve tekrar değerlendirildi. Travma nedeniyle yapılmayan tetkikler ve değerlendirmeyi engelleyecek artefaktı olan tetkikler, ile spinal vertebra ameliyatı geçirmiş olan hastalar çalışma dışı bırakıldı. Etyoloji ICD tanıları ile tarandı. Hastalar yaş, cinsiyet ve travma sebebi, spinal ligaman hasarı kayıt edildi.

BULGULAR: 36 erkek, 8 kadın toplam 44 hasta araştırmaya dahil edildi. Ortalama yaş 43,1 idi. 25 hasta trafik kazası, 18 hasta düşme nedeniyle değerlendirilmişti. Spinöz proces kırıkları sırası ile servikal bölgede 18, torakal bölgede 17, lomber bölgede 3, 15 hastada multipl spinöz proces kırığı izlenmekle birlikte servikal + torakal bölgede (Clay-Sholever's kırığı) 6 hastada saptandı. 12 hastada tomografi tetkikine ek olarak STİR kesitli spinal MR yapılmıştı. Clay-Shover's kırığı olan tüm hastalarda BT + MR tetkiki yapılmıştı. MR tetkiki yapılan tüm hastalarda interspinöz ligaman hasarı izlendi Bunula birlikte kanal içi patoloji veya ek bir patoloji izlenmedi.

SONUÇ: Travmaya bağlı spinöz proces kırıkları tek başına az görülmesine ve genellikle medikal tedavi ile takip edilmesine rağmen, özellikle servikotorakal birleşkede çoklu sayıda olabileceği unutulmamalıdır. Bu nedenle ilk tespit edilen bölgenin altındaki omurlarda değerlendirilmeli ve kemik yapıyı değerlendiren tetkiklere ek olarak STIR sekansı da içeren MRI gibi ligaman hasarı ve nöral kanalı değerlendiren tetkiklerde yapılmalıdır.

Anahtar sözcükler: Vertebra; spinöz proçes; kırık; travma; çok sayıda Clay-Shoveler's kırıkları.

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