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ASSESSMENT OF CHANCE FRACTURE ON COMPUTED TOMOGRAPHY SCAN IN A TERTIARY TRAUMA CARE CENTER OF NEPAL

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ABSTRACT

Introduction:
Chance fracture is a horizontal fracture of the vertebra, extending from the posterior element to the vertebral body. It is caused due to a flexion-distraction injury and is potentially unstable. This study aimed to evaluate the demography and computed tomography scan findings in a Chance fracture of the spine.

Method:
A retrospective study was conducted at the National Trauma Center, National Academy of Medical Sciences, for one year duration. Demographic data, mechanism of injury, and the computed tomographic findings of Chance fractures were recorded.

Result:
Computed tomography scans of 41 patients with Chance fracture were identified. Fall injury (76%) was the most common cause of Chance fracture, followed by road traffic accidents. This fracture was most prevalent in the thoracolumbar junction TLJ (D10-L2), with L1 being the most affected vertebra (36.5%). Among posterior elements, facet distraction (84%) was the most common finding present, followed by lamina fracture (83%) and pedicle fracture (68%). Regarding vertebral body fracture, involvement of both superior and inferior endplates was more common than isolated involvement of either one of them. Computed tomography revealed that a burst component was a common finding (68%) in Chance fracture.

Conclusion:
Chance fracture was commonly caused by fall injury in our context which is higher in incidence than previously reported. More than half of patients with Chance fracture also had Burst-type components that could influence surgical management. Computed tomography scans are a useful imaging modality for the assessment of Chance fracture and burst components.

Keywords: *Chance fracture; Vertebral body; Computed Tomography*

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INTRODUCTION

Chance fracture is named so after G.Q. Chance, who first described the fracture.[1] It is a flexion-distraction injury of the spine with flexion injury of the vertebral body and distraction injury of the posterior elements.[2] The fracture line extends horizontally from posterior to anterior through the spinous process and or lamina, pedicle to a vertebral body.[3] It is a potentially unstable fracture as it involves all three columns of vertebrae.[4]

This type of fracture was first identified in victims of motor vehicular accidents, where the victim was restrained with seat belts. This type of injury is thus also called the seat belt fracture. However, later on, this type of injury was also found associated with other high-energy trauma like fall injuries and sports injuries.

Chance fracture is often subtle on radiography and is often missed or diagnosed late in blunt trauma cases, potentially increasing morbidity.[5] Burst component is frequently present in the fracture, which can cause neurological deficit due to spinal cord injury. A Computed Tomography (CT) scan is the modality of choice in delineating osseous injury of the vertebral column and retropulsion of the posterior vertebral wall into the spinal canal, which helps to identify patients at risk of acute neurologic compromise.[6] The purpose of this study was to evaluate the demography and CT scan findings in the Chance fracture of the spine.

METHOD

A retrospective study was performed, including all patients diagnosed with a Chance fracture of the spine over one year from December 2019 to December 2020 in the Department of Radiology, National Trauma Center. Images were reviewed by two radiologists with experience of >5years.

CT scan was performed on Siemens Somatom Emotion 16 slice CT scanner using 130 peak kilovoltage (KVp), 182 milliampere second (mAs), and standard image reconstruction. A Volumetric CT scan of the spine was done following which, coronal and sagittal images were reconstructed as serial 1mm thick sections.

The level of injury, fracture pattern of posterior elements and vertebral body, and the presence of burst components were evaluated in the images. The findings in the CT spine were categorized as a Chance fracture when there was a transverse fracture of the vertebra extending from the posterior element to the vertebral body involving all three columns. A burst component was diagnosed when there was a displacement of fractured fragments arising from the posterior margin of the vertebral body into the spinal canal i.e retropulsion.

Data were entered in an Excel sheet and analyzed with Standard Package for the Social Science (SPSS) version 19.

RESULT

Fifty-two patients were identified with Chance fractures from the report database. However, 11 patients were excluded due to inadequate CT images or demographic data. So, 41 patients were included in the study.

Age and Sex distribution

There were 27 males and 14 females in the ratio of 1.9:1. (Figure 1)

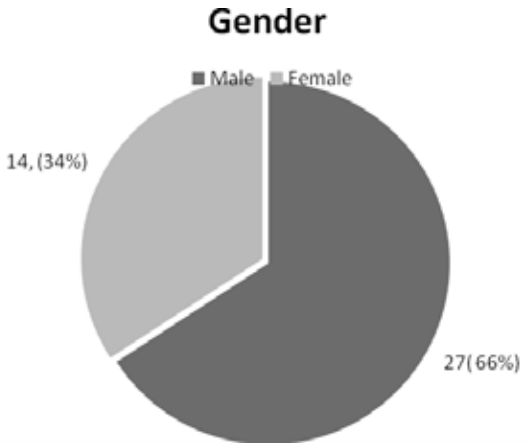

Figure 1: Gender Distribution

The age of the patients ranged from 16 years to 67 years with a mean age of 37± 13.75 years. Most cases of injuries were in the 31-40 years age group accounting for 11 cases (6 males and 5 females), followed by 21-30 year age group with 9 cases (7 males and 2 females). (Figure 2)

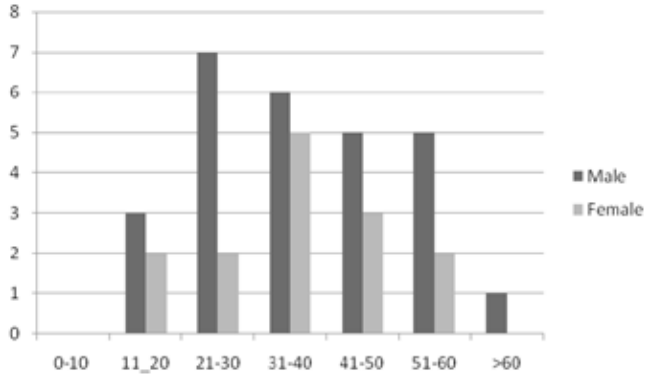

Figure 2: Age and Sex distribution

Mode of injury

Fall was the most common mode of injury accounting for 75.6% of cases (31 patients) followed by road traffic accidents (19.6%). One patient was struck by a falling object and one had incurred the injury during a landslide (Table 1).

Table 1: Mode of injury

Mode of Injury	Number of Patients	Percentage
Fall	31	75.6
Road traffic accident	8	19.6
Struck by falling object on the back	1	2.4
Landslide	1	2.4
Total	41	100

Distribution of Chance fracture

The anatomical distribution of the Chance fracture level is shown in Table 2. Chance fracture affected C4 to L3 vertebrae. Twenty-nine of 41 Chance fractures (70.7 %) occurred in the thoracolumbar junction from D10 to L2. Lumbar vertebrae were most frequently involved with 21 cases; followed by 19 fractures in the dorsal spine while only 2 cases were observed in the cervical spine (at C4 and C7). The L1 vertebra was the most common site with 15 cases (36.5%).

Table 2: Vertebral distribution

Vertebral Level	No of Patients
C4	1
C7	1
D5	2
D6	2
D7	2
D8	2
D9	1
D10	2
D11	4
D12	4
L1	15
L2	4
L3	1
Total	41

Typical Features of the Chance Fracture in Computed Tomography

Posterior element injury:

The most common findings were distraction of the facet, seen in 35 cases (85.3%), and fracture of the lamina, seen in 34 cases (82.9%) (Table 3). Facet distraction was well appreciated in the reformatted sagittal images whereas lamina fractures were well recognized in the axial images.

In 28 cases (68.3%) there was the involvement of pedicles, with loss of definition, and was well appreciated in the axial image. Fracture of the spinous process was seen in 24 cases (58.5%), whereas transverse process fractures were seen in 29 cases (70.7 %).

Table 3: Posterior elements fracture

Posterior elements (n=41)	Number of cases	Percentages
Facet Distraction	35	85.3
Lamina Fracture	34	82.9
Transverse Process fracture	29	70.7
Pedicle Fracture	28	68.3
Spinous process fracture	24	58.5

Vertebral body injury:

Regarding the involvement of parts of the vertebral body, only the superior endplate of the vertebra was involved in 17 cases, and in 3 cases, only the inferior vertebral plate was involved. Both end plates were involved in 21 cases. (Table 4)

Table 4: Vertebral Body Injury

End plates involvement	No of cases	Percentage
Fracture extending to superior endplate only	17	41
Fracture extending to inferior endplate only	3	7
Fracture extending to both end plates	21	51
Total	41	100

The Retropulsed Fragment-Burst component

Burst component of vertebral body fracture (with retropulsion of the vertebral fracture in the spinal canal) was seen in 28 cases (68.2%).

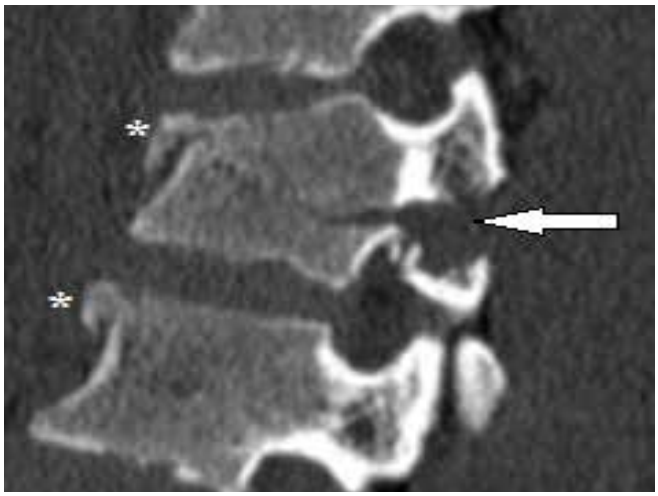

Figure 3: A Chance fracture in an 18-year-old female after a fall from height. Sagittal CT reformation depicts horizontal fracture of L1 through the left pedicle and into the vertebral body (arrow). Note: fracture of the anterosuperior corner (*) of vertebral bodies of L1 and L2

DISCUSSION

British radiologist G.Q Chance, in 1948, described three cases of lumbar spine fracture where horizontal splitting was seen through the spinous process, posterior neural arch, and the posterior part of the vertebral body that exited through the upper endplate anterior to the spinal canal and neural foramen.[1] He described the fracture as a flexion injury. Seventeen years later, Howland et al, presented a similar case report of a splitting apart transverse fracture of lumbar vertebrae and its association with the seat belt. [7]Chance fractures have often been referred to as 'Seat belt' fractures.[8] It is a relatively common type of injury seen in automobile accidents where the victim is restrained with a seat belt.

The chance fracture occurs more frequently in males. This study found males were affected twice as much as females. This preponderance of males agrees with existing literature suggesting a higher rate (up to 77%)(Table 5) of Chance fracture in males.[5,9,10] The reason behind high male victims could be attributed to high-speed vehicle driving and involvement in more risky activities by males as compared to females.

Mode of injury

A motor vehicle accident is the most common mechanism of Chance fracture followed by falls and other causes like farming accidents, injury after being struck by a falling object. [5,10] On the contrary, the present study found fall injury to be the most prominent cause of Chance fracture. One of the reasons for this contradiction could be due to the study period. During most of the study period, a nation-wise COVID imposed lock-down stage where cases due to fall injuries outnumbered RTAs.

The other reason could be changing trends of injury patterns, as Durel et al [3] in their study where Chance fractures in thoracolumbar vertebrae were more frequently seen in cases with fall from height. A similar result was also seen in the study conducted by Liu YJ et al [9] where fall was the most common cause of Chance fracture (52%). The increasing availability of CT scans and their wide use in early and detailed evaluation of traumatic spine injury could have helped in increased detection of this type of flexion injury even in cases without a seat belt.

Level of injury:

Thoracolumbar junction is mostly affected during flexion injury of the spine (77%-82%) and the L1 vertebra is the most susceptible one (Table 5). [5,9,10] This study also found L1 as the most commonly affected vertebra as was seen in previous studies.

A Chance fracture in the cervical region is an extremely rare finding. The cervical spine does not have anterior support except for the anterior longitudinal ligament and the flexibility of the cervical spine prevents posterior components to be ruptured. [11] Present study also encountered only two cases of cervical Chance fracture at C4 and C7. Both were young adult (23-28years) males with fall injuries.

Table 5: Comparison of Gender, Mechanism and vertebral involvement in different studies

	Liu YJ et al [9]	Bernstein MP et al [5]	Grossbach AJ et al [10]	Present study
Gender %				
Male	74	72	77	66
Female	26	28	23	34
Mode of Injury:				
RTA%	39	72	71	19.6
Fall %	52	17	23	75.6
Others %	8	11	6	4.8
Involvement of TLJ %	82	78	76	70.7
Most commonly involved vertebra(L1)	41	38.2	39	36.5

Vertebral injury:

1. Vertebral body involvement :

With Chance fracture, there is frequent involvement of the endplates.[5,12] In this study endplate (either one or both) involvement was seen in all cases of Chance fractures. In more than half of the cases, there is fracture extension to both endplates; while isolated involvement if occurred it was more common in superior endplate than inferior one (17 cases vs. 3 cases). However, previous studies showed more inferior endplate involvement compared to the superior endplate involvement.[5] This contrary finding could be due to the difference in the mechanism of Chance fracture, as motor vehicle accident was the common cause in the study conducted by Bernstein while fall injury was the most common mechanism in our study. Rupture of posterior vertebral margin with retropulsion also called "burst component" is a common finding in Chance fracture. Burst component is seen in almost half of the Chance fracture cases.[5] This study detected an even higher rate of Burst components (more than 65%). The increased association of burst component and Chance fracture show that both injuries have a similar mechanism of injury in common i.e high-velocity trauma and sudden flexion of the spine. Hence when Chance fracture is detected then the burst component should be closely looked for and vice versa. The diagnosis of the burst component is extremely essential as retropulsed fractured fragments can cause spinal cord injury or progression and hence early decompression may be essential.

2. Posterior element involvement: The most commonly affected posterior element in a Chance fracture is the pedicle. [5,13] The progressive loss of definition of a pedicle in images can be observed in up to 76% of cases. [5] In the present study pedicle fracture was seen in a similar percentage of cases (68%). However amongst posterior elements; distraction of facet was the commonest findings followed by fracture of the lamina. Transverse process fracture was more common than pedicle fracture and spinous process fracture. The distraction of facet and fracture of the lamina with an extension of the horizontal fracture line to the vertebral body were the two most frequently observed signs in Chance fracture.

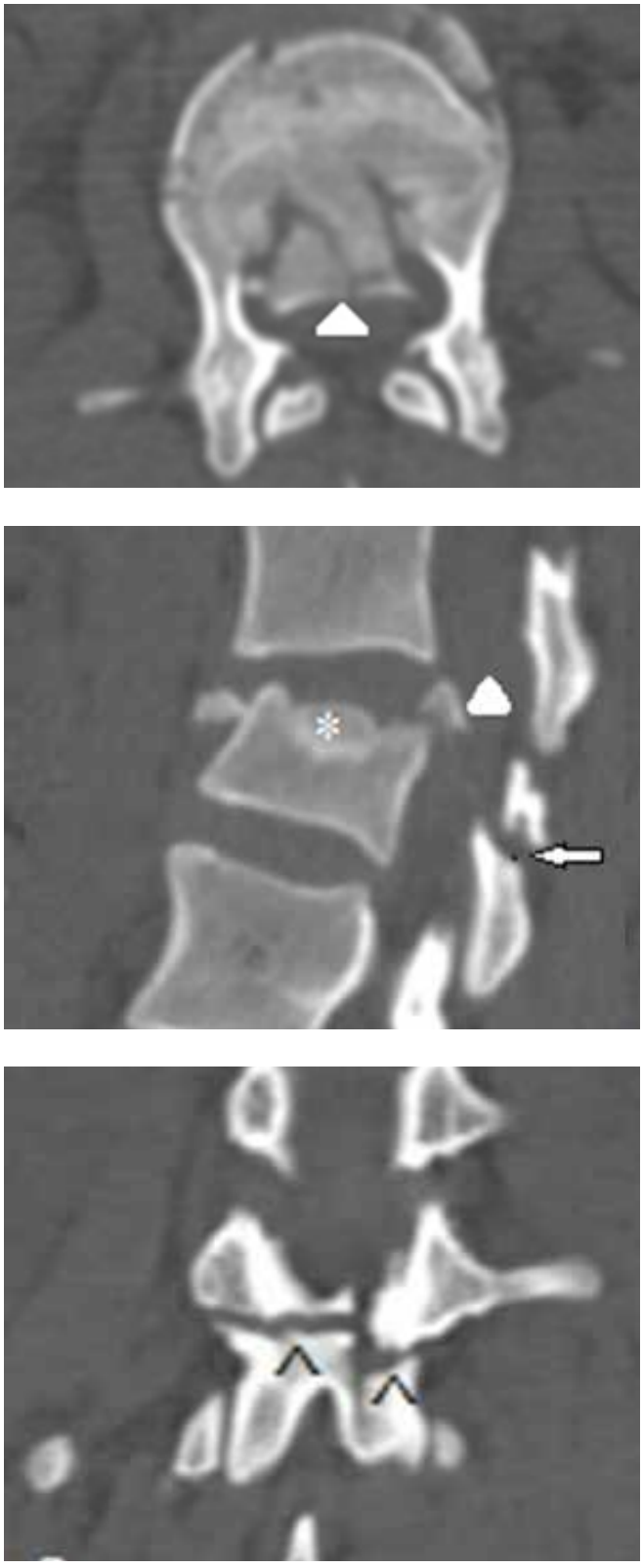

Figure 4: A Chance-burst fracture of L2 in a 20-year-old male with a history of a fall from height. Axial CT section (a) shows burst fracture with retropulsion of posterior vertebral body cortex (triangle). Parasagittal (b) CT reformation confirms Chance-type fracture of L2 with fracture line through facetal pars interarticularis (arrow). Note incomplete burst fractures involving a superior endplate (*) with retropulsion of fractured posterosuperior corner of the vertebral body (triangle). Coronal reformatted image (c) demonstrates the horizontal fracture line across posterior elements(^)along with pars interarticularis and lamina.

LIMITATIONS

The data in the study included cases with traumatic spinal injuries that occurred during the nationwide lockdown imposed due to COVID-19. This may have led to the alteration in the predominant mode of injury. Another limitation is that the study was conducted in a single hospital.

CONCLUSION

Chance fracture has long been termed "seat belt fracture" reflecting the predominant association with seat belt users of road traffic accidents. However, a similar pattern of injury of the spine in our context was commonly caused by fall injury. In high-energy traumatic flexion injury of the spine, there is a high chance of both Chance and burst fractures. More than half of patients with a Chance fracture can have Burst-type components that, when present may warrant prompt surgical intervention to avoid further neurological injuries and their progression. CT is an useful imaging modality for the assessment of Chance fracture and burst components.

CONFLICT OF INTEREST

None

SOURCES OF FUNDING

None

REFERENCES

1. Chance GQ. Note on a type of flexion fracture of the spine. *Br J Radiol*. 1948;21(249):452-3. https://doi.org/10.1259/0007-1285-21-249-452

2. Davis JM, Beall DP, Lastine C, Sweet C, Wolff J, Wu D. Chance fracture of the upper thoracic

spine. *Am J Roentgenol*. 2004;183(5):1475-8. https://doi.org/10.2214/ajr.183.5.1831475

3. Durel R, Rudman E, Milburn J. Clinical images-a quarterly column: Chance fracture of the lumbar spine. *Ochsner J*. 2014;14(1):9-11.

4. Gotfryd AO, Franzin FJ, Hartl R. Thoracolumbar Chance fracture during a professional female soccer game: case report. Einstein (Sao Paulo). 2016;14(1):67-70. https://doi.org/10.1590/S1679-45082016RC3432

5. Bernstein MP, Mirvis SE, Shanmuganathan K. Chance-type fractures of the thoracolumbar spine: imaging analysis in 53 patients. *Am J Roentgenol*. 2006;187(4):859-68. https://doi.org/10.2214/AJR.05.0145

6. Riazi A, Vahdati SS, Tajlil A. Unstable less common Chance fracture. *Turkish J Emerg Med*. 2014;14(1):1. https://doi.org/10.5505/1304.7361.2014.10327

7. Howland WJ, Curry JL, Buffington CB. Fulcrum fractures of the lumbar spine: Transverse fracture induced by an improperly placed seat belt. *JAMA*. 1965;193(3):240-1. https://doi.org/10.1001/jama.1965.03090030062025

8. Kingsbury-Smith R. Chance and his fracture. *Trauma*. 2008;10(1):13-5. https://doi.org/10.1177/1460408607088631

9. Liu YJ, Chang MC, Wang ST, Yu WK, Liu CL, Chen TH. Flexion-distraction injury of the thoracolumbar spine. *Injury*. 2003 Dec 1;34(12):920-3. https://doi.org/10.1016/S0020-1383(02)00396-0

10. Grossbach AJ, Dahdaleh NS, Abel TJ, Woods GD, Dlouhy BJ, Hitchon PW. Flexion-distraction injuries of the thoracolumbar spine: open fusion versus percutaneous pedicle screw fixation. *Neurosurg Focus*. 2013;35(2):E2. https://doi.org/10.3171/2013.6.FOCUS13176

11. Eghbal K, Abdollahpour HR, Ghaffarpasand F. Traumatic Chance fracture of cervical spine: A rare fracture type and surgical management. *Asian J Neurosurg*. 2018;13(3):906.

12. Koay J, Davis DD, Hogg JP. Chance Fractures. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2021.

13. Karargyris O, Morassi LG, Zafeiris C, Evangelopoulos DS, Pneumaticos SG. The unusual Chance fracture: case report & literature review. *Open Orthop J*. 2013;7:301. https://doi.org/10.2174/1874325001307010301