Clay Shoveler's Fracture: A Pain in the Neck

Marc Boutros, Maria R. Karam, Maria El Asmar, Emmanuelle Wakim, Labib Chebli,
Pierre Maurice Doumit Bader Tarabay and Sami Roukoz

Department of Orthopedic Surgery, Faculty of Medicine, Saint Joseph University of Beirut, Beirut, Lebanon

Abstract:

Clay shoveler's fracture is a stable spinous process fracture commonly occurring at the seventh cervical vertebrae. The name originated in Australia during the 1930s, after many reports of similar injuries among clay workers who suffered fractures due to a sudden flexion force on their neck and back muscles, hence the name "clay shoveler's fracture." This fracture may occur as a consequence of a direct blow/trauma, a contraction of the shoulder muscles, and sudden extreme movements of the neck influenced by additional factors presented throughout the article. Clay shoveler's fracture mechanisms vary among different age groups; Schmitt's disease is the juvenile version. Although this fracture was initially associated with clay shoveling, it occurs in modern-day sports and activities such as paddling, weightlifting, volleyball, Wii gaming, and many more.

A rare occurrence, clay shoveler's fracture is frequently misdiagnosed. Hence, many characteristics were pinpointed to help distinguish it from other differential diagnostics. What does a clay shoveler's fracture patient feel? What are the best tools for the physical exam and imaging? These questions will be answered and developed in this article to reach the right diagnosis and correct treatment for the patient.

Keywords:

Clay shoveler's fracture, spinous process fracture, stress fracture, Spine (cervical, thoracic, lumbar), vertebral column, trauma

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I- Introduction

Clay shoveler's fracture is an isolated spinous process fracture, typically in the cervicodorsal spine, most commonly at C7[1]. Multiple involvements are rare. The first report of "shoveler's fracture" seems to have been made in 1875 by Bourgougnon. Terrier recorded another early example linked to muscular traction in 1879. However, it wasn't until the 1940s that it became a clinically recognized entity in western Australia and referred to as such since then[2]. Mr. Reginald Dalton McKellar Hall, an Australian orthopedic surgeon at the Royal Perth Hospital, was the first to set forth and break down this type of injury in an article published in 1940. He reported 13 "physically below normal standards" males hired to dig swamp ditches in western Australia in 1933. The trenches were up to 15 feet deep, and the laborers tossed the clay high over their heads with long-handled shovels. The clay was sticky and frequently adhered to the shovel head, causing an unanticipated hyperflexion and rotational force to extend into the soft tissues of the laborer's neck. The energy was conveyed via the supraspinous ligaments induced avulsion fractures of the lower cervical spinous process, consequently giving rise to the term "clay shoveler's fracture."

This condition was also described among employees on the Autobahn network in Germany[3].

The fracture is known by different names in different countries: "shoveler's disease," "ditch-digger's disease," "metal-dipper's fracture[4]," "gold-digger's fracture," "snow shoveler's fracture," "root puller's fracture[5]," "Land grader's disease" (in French land workers), "Navvies' disease" (in British canal diggers)[6], "Coal miner's fracture," "break dancer's fracture[7]," and "Schipper's disease" (Schipperkrankheit)[8]. However, shoveling and excessive manual labor[9] were the most common causes of this type of fracture. That's why clay shoveler's fracture has become uncommon since the advent of industrialization, the introduction of earth-moving machinery, and reduced weight-bearing work;

Corresponding author: Marc Boutros, marc.boutros@net.usj.edu.lb
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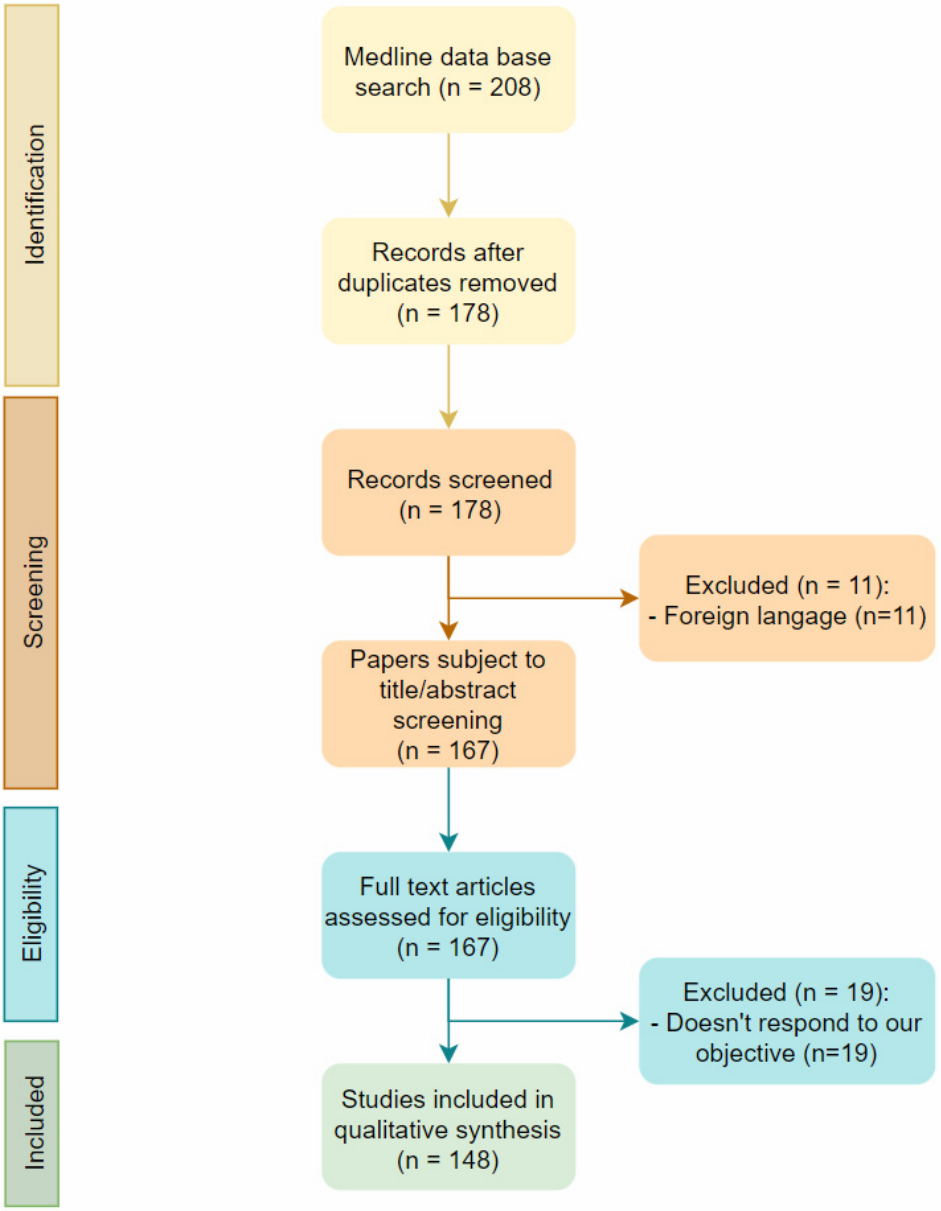

Figure 1. Visual representation of qualitative synthesis of evidence from the literature.

hence, it may be overlooked[5]. Importantly, several recent case reports have highlighted the same avulsion fractures in the context of traffic accidents and sports requiring rotational motions of the upper spine.

From an orthopedic standpoint, this fracture is considered mechanically stable and may not cause any neurologic damage as the posterior ligament complex is unaffected[10]. Nonetheless, failing to identify and adequately treat this injury might result in pain and weakness associated with fracture non-union.

While most clay shoveler's fractures occur suddenly, some patients report a protracted period of dull discomfort preceding the fracture. As a result, clay shoveler's fractures might be acute or acute-on-chronic.

II- Methods

This review offers a thorough examination of the clay shoveler's fracture. A comprehensive search of relevant literature was carried out using the PubMed and SCOPUS databases until January 15th, 2023. The titles and abstracts of the articles found were evaluated for relevance, and after a full analysis, 50 papers meeting the review's objectives were included. Only peer-reviewed articles written in English were considered. The PRISMA flow diagram, illustrated in Fig. 1, delineates the stages of the qualitative synthesis of evidence derived from the literature upon which this review article is founded. This diagram provides a visual representation of the systematic approach adopted by the authors in identifying, selecting, and evaluating the relevant literature for inclusion in the review. By adhering to the rigorous standards set out in the PRISMA guidelines, the authors ensured

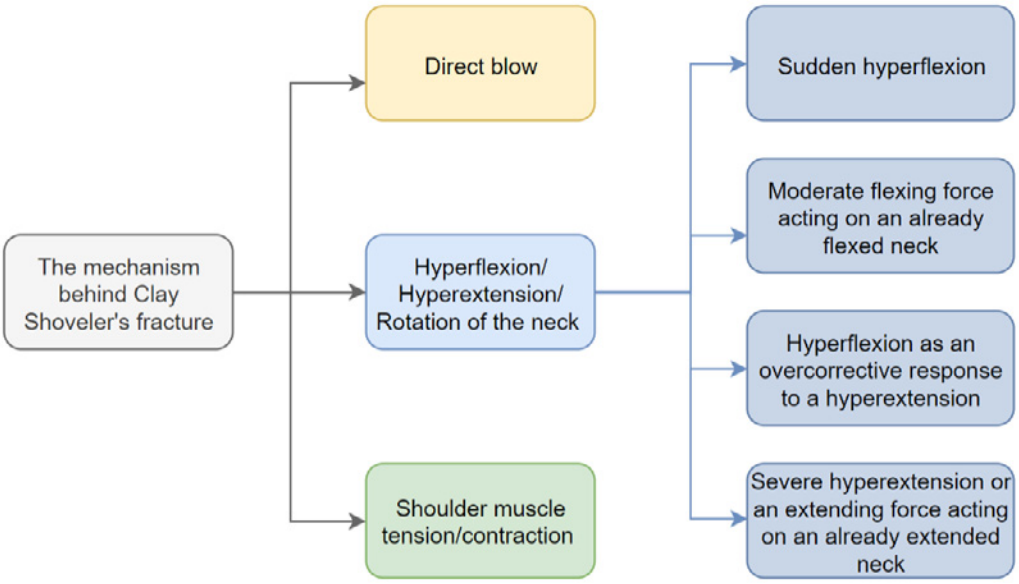

Figure 2. PRISMA flow diagram of the mechanism behind clay shoveler's fracture.

a high level of transparency and accountability in their methodology, thus enhancing their findings' credibility and reliability.

III- Physiopathology

The fracture may include a single or several spinous processes and generally occurs at the narrowest region of the spinous process, which is also the weakest part[11].

It occurs in declining order of frequency at the C7, C6, or T1 levels for various reasons:

-Their longer spinous process, compared to neighboring levels, allows for a greater bending moment to be applied.

-The spinous process at the apex of kyphosis (at the junction of the lower cervical and upper thoracic spine) is particularly thin compared to neighboring levels, making it less resistant to applied pressures and more prone to fatigue failure.

-Their position is almost horizontal, and muscle stresses are directed perpendicular to the axis of the processes, increasing the likelihood of fatigue fracture.

-Compared to the upper and middle cervical vertebrae, the trapezius, splenius capitis, rhomboideus minor, and serratus-posterior (superior) muscles are more densely and intimately attached to the C7 spinous process[12]. Additionally, Johnson G et al. reported that the trapezius muscle generates greater force at C7 than the upper or middle cervical vertebrae, which likely contributes to the higher incidence of fractures at the C7 spinous process[13].

-Anatomical anomalies in the attachment of nuchal muscles at the cervicothoracic junction, along with individual differences in the length of the C6 spinous process, also play a role. For instance, a longer C6 spinous process results in a denser attachment of the nuchal ligament to its tip, potentially leading to fractures at this level under certain conditions[14,15].

In addition, the fracture can have two different onsets: an acute (drastic symptom onset) type, mainly in individuals who initiate a new activity or movement pattern, and an acute-on-chronic type, especially in high-intensity athletes, following a prodromal neck/upper back discomfort[10,16]. The latter is called "overuse injuries;" in fact, stress fractures that account for 10% of all sports-related injuries are caused by repetitive loading and overuse[17].

The vertebral bones, trabecular-rich bones compromised by low bone mineral density, are considered particularly vulnerable to overuse stress fractures[18,19]. Therefore, even slight breaks or microtears in this area may worsen due to great shear and repetitive stress caused by contraction of the large, attached muscle, i.e., the trapezius and rhomboid muscles, leading to a complete fracture with time.

Biomechanically, clay shoveler's fracture is mechanically stable and may not cause neurologic damage as the posterior ligament complex is unaffected. However, applying posterior stress on the spinous processes could result in serious laminal fractures and spinal cord damage[10]. There are three types of mechanism of injury, aggravated by many factors, as shown in Fig. 2:

1- Direct blow/trauma

First, spinous process fractures can occur due to a direct blow to the spinous process[6,10,20,21]. The force associated with these injuries may be exacerbated by flexion forces[22]. This mechanism is common in high-contact sports, including basketball, football, weightlifting, wrestling, and many more[23,24].

2- Shoulder muscle tension/contraction

Second, spinous process fractures can occur as a consequence of repetitive high traction forces generated by contracting the paraspinal muscles as well as the muscles attached from the shoulder girdle (predominately from the trapezius, rhomboid minor, and serratus-posterior) to the rela-

tively long, slender and horizontal spinous processes of the lower cervical and upper thoracic spine[6]. These muscles can exert a significant amount of pull and consequently give rise to a vigorous deceleration force transmitted through the supraspinous and nuchal ligaments, exerting repetitive shear on the narrow spinous processes[25]. This event especially occurs with a flexed position of the neck and shoulders or with an asymmetrical heavy-load lifting (causing a whip-like pull from the upper back muscles). Such forces applied for prolonged periods can lead to the overuse or avulsion of the spinous process. Consequently, even a minor break in these regions may worsen due to shear pressures from the muscle engagement mentioned above.

Furthermore, histological examinations of the removed distal fragment revealed bone remodeling anomalies caused by severe repeated stress[26].

Volleyball is a vivid example. As reported by Hetsroni et al., the deceleration of neck motion is likely to induce traction on these soft-tissue attachment sites following the pull of the trapezius, rhomboid, and ligamentum nuchae muscles[27].

Weightlifting is another example. The trapezius, rhomboideus minor, and serratus-posterior (superior) muscles are in an ideal position to avulse the spinous process through active or reflexive strenuous muscle contracture when they work together to draw the scapula toward the spine and lift the ribs (to complete the head lift or replace the barbell on the squat rack at the end of the squat). Given the anatomy and biomechanics of these specific motions, it is simple to understand how this injury may occur in weightlifting, particularly squat or deadlifting if done improperly[28].

3- Hyperflexion/hyperextension/rotation

Third, isolated spinous process fractures can also be caused by abrupt hyperflexion, extension, or neck rotation. Many mechanisms are possible:

- An abrupt hyperflexion of the neck, as seen in a traffic accident (e.g., a fast-moving car striking a stationary object), can lead to a quick deceleration[29]. In this scenario, a sudden force transmission through the interspinous, nuchal, and supraspinous ligaments could lead to an avulsion of the spinous processes. The ligamentum nuchae, extensively developed in the cervical spine, creates an intermuscular septum connected to the extremities of the cervical spinous processes and the external occipital protuberance[27], and contributes significantly to increased stress along the spinous processes. Additionally, this ligament acts as a strong tendon to control head balance. Its attachments to the spinous processes are subject to fraying and tearing (it has a substantive attachment to the C7 spinous process)[30].

- A hyperflexion can arise as an overcorrective reaction to a whiplash-induced neck hyperextension. This might happen to a passenger in a car quickly propelled by a rear-end impact from a fast-moving vehicle[29].

- A mild flexing force may also fracture the spinous processes and tear the supraspinous and interspinous ligaments when applied to an already flexed neck. The intervertebral discs and all the other bony and ligamentous components are intact, thus protecting the spinal cord and preserving stability[31].

- An extreme hyperextension or an extending force acting on an already extended neck can lead to the posterior vertebral arches being approximated and crushed. Furthermore, the bases of the spinous processes may also be fractured in this case[7].

An unconditioned worker shoveling clay is the classic example. When the clay is wet, it sticks to the shovel and does not release when thrown, causing a forced hyperextension load to the neck, which crowds the lower cervical posterior spinous process, leading to fracture.

This mechanism has been replicated in cadavers by abruptly hyper-flexing and hyperextending the neck. A supine cadaver's neck is hyperextended by pulling hard on the loose end of a trouser belt fastened around its protruding head. Similarly, a hyperflexion could be induced on a corpse in a prone position. The consequential fractures were similar to those that occur in the living[29].

4- Additional factors

Moreover, some factors may lay the ground for this type of fracture:

- Previous work history: Venable et al. found that in a group of new employees with no previous metal dipping experience, the sedentary workers are almost twice as likely to suffer spinous process fracture as the heavy workers. Thus, fracture of the spinous process is the repercussion of recurrent and immoderate action of attached musculature on an unprepared and/or a physiologically unconditioned bone[32]. The biggest danger is for the new untrained workers performing rapidly weighted activities with extended arms extended[1].

- Low density and osteoporosis, whether primary or secondary, increases the risk of bone fracture. As an example, Sorell et al. reported a case of clay shoveler's fracture in a female suffering from "female athlete triad," a condition in which a combination of amenorrhea, osteoporosis, and an eating disorder could occur simultaneously[16].

IV- Equivalent in Children / in Adolescents: Schmitt's Disease

Cervical spine injuries have different mechanisms, depending on the patient's age[33]. The size difference is the most evident distinction between children's and adults' spines; children aren't just little grownups. When compared to spinal injuries in adults, children's incidences, distributions, physiologic characteristics, biomechanics, fracture patterns, and their mechanisms are very different. These disparities are mostly caused by the physiological architecture of the growing vertebral bodies, elastic soft tissues, and weaker cervical musculature supporting a disproportionately large head[20].

Schmitt's sickness is the name given to a variation seen in teenagers and appears to be a juvenile version of clay shoveler's fracture. It is a traumatic apophyseal separation or osteochondritis and involves the secondary center of ossification for the spinous process[23,29,34]. The most frequent causes of cervical spine injuries in children under the age of eight are falls and motor vehicle collisions, as expected, with sports-related injuries becoming more common in late childhood and adolescence. The mechanisms of injury are nearly evenly distributed among motor vehicle collisions, falls, and sports-related injuries in people 8 years of age and above (each account for 23%-26% of all cases)[33].

V- Etiology in the Modern Era

Historically, clay shoveler's fracture was primarily caused by shoveling clay. However, this type of fracture is now seen more frequently in these contexts with the advent of modern-day sports such as paddling, weightlifting, volleyball, Wii gaming, and many others. Modern etiologies are summarized in Table 1.

VI- Multiple Levels

Multilevel fractures of the spinous process are incredibly rare in literature. Cases of multiple-level involvement of clay shoveler's fracture found in the literature are summarized in Table 2. Normally, only one level is involved, although case reports with up to 12 different levels of involvement have been published[35].

VII- Differential Diagnoses

Clay shoveler's fracture is commonly misdiagnosed, leading to various erroneous evaluations. Nuchal bone formation, ununited secondary ossification center of the spinous tip, "Spinolaminar breach" (SLB), and whiplash accident… are all ailments that can be confused with clay shoveler's fracture[6,23,30,36].

Other uncommon conditions encompass omovertebral bones, muscle sprains or spasms of the upper back muscles, congenital bent spinous, pathological fracture, and spina bifida occulta[6]:

- Ossification may occur, particularly in patients over 40 years old, in parts of the ligamentum nuchae, called "nuchal bone formation." Despite being clinically asymptomatic, its elongated shape and posterior position on radiographs, with the spinous remaining unblemished, help distinguish it from clay shoveler's fracture[23] (Fig. 3a).

- Many characteristics can help distinguish "Ununited secondary ossification centers" from clay shoveler's fracture. The fragment margins are smooth and sclerotic, and the fragments are typically smaller. Moreover, the avulsed segment has less and sometimes no downward displacement. Finally, the distal ununited segment can have a concave margin, continuous with the convex surface of the spinous process[23] (Fig. 3b).

- SLB is coined to describe the discontinuity of the spinolaminar junction, resulting from an expansion of a spinous process base's fracture into the lamina. Distinguishing this atypical fracture type is fateful as it can involve fractures of anterior structures and conceivably unstable fractures. As a rule of thumb, a typical "clay shoveler's fracture" appears on lateral radiographs as a vertical or oblique radiolucent line that runs perpendicular to the spinous process, with a slight downward displacement and no disruption of the spinolaminar line, and on AP radiographs as a "double shadow" sign (Fig. 3c). In contrast, atypical spinous process fractures with SLB are radically different in morphology. On lateral radiographs, the fracture line runs close to the junction between the spinous process and the laminae, horizontally to the spinous process axis. It also broadens anteriorly into the lamina and toward the facet joints, interrupting the spinolaminar junction (Fig. 3d). No downward displacement appears, resulting in a negative double-shadow sign on AP radiographs[23,36].

- In the whiplash accident, a sudden pull by the ligamentum nuchae, interspinous, and supraspinous ligaments on the spinous processes to which they are attached can result in an avulsion type of fracture. In contrast, a shoveler's fracture occurs when a sudden pull is transmitted from the shoulder girdle to the bony thorax via the trapezius, rhomboid, and other thoracoscapular muscles attached to the spinous processes. Although the avulsion fracture produced by this mechanism is similar to that of the whiplash type, the traumatic force and its transmitted direction are different.

-A third type of injury, usually caused by a fall, can cause compression fracture of vertebral bodies and injury of intervertebral disks. Fractures of the spinous processes can occur simultaneously if the injury is severe enough[30].

VIII- Diagnosis

Although frequently overlooked due to their rareness, clay shoveler's fractures have typical features that should alert an attending physician during diagnosis, including occupational history and clinical and radiological findings[32].

a- History and symptoms

In clay shoveler's fractures, patients report hearing an interscapular crack followed by drastic pain mostly in the posterior thoracic spine region between the shoulders' blades (knife-sharp) at the level of the fracture. The ache may worsen with pulling, lifting, or even while forward stretching their arms, but it will eventually go away within a few days or weeks[4,26]. Moreover, activities stressing the upper back muscles could increase the pain.

Although there are usually no neurological impairments - because the underlying spinal cord is highly protected by the spinous processes - laminal depression fractures could nonetheless happen in the case of direct trauma and result in neurological deficiency[10]. The pain may occasionally move

Table 1. Various Etiologies of Clay Shoveler's Fracture in the Modern Era.

Source	Sport	Age, y/sex	Level of involvement	Mode of injury	Diagnosis	Treatment	Outcome
18	Paddling	51/M	T1	Overuse, shoulder muscle tension	CT scan	Complete rest with analgesics	Full recovery after 12 weeks
34	Indoor rock climbing	14/M	T1	Overuse, shoulder muscle tension	Radiographs normal, diagnosed on MRI	Conservatively with anti-inflammatory drugs and rest	Full recovery after 16 weeks
6	Horse riding	33/M	C7–T1	Overuse, hyperflexion hyperextension rotation	AP and lateral radiographs, confirmed with CT scan	Conservatively with oral analgesics and rest	Full recovery after 16 weeks
26	Volleyball	18/M	C7–T1	Overuse, shoulder muscle tension	Diagnosed on radiographs and bone scintigraphy. Diagnosis confirmed on MRI	Conservatively with anti-inflammatory drugs, rest, and physical therapy, electrotherapy and thermotherapy	Complete recovery after 6 weeks
22	Basketball	16/M	L3	NA	Plain radiographs normal (Increased uptake in SPECT) Confirmed with CT scan	Anti-inflammatory drugs and physical therapy failed. Excision of the L3 spinous process	Pain-free by 6 weeks; recovery after 52 weeks
21	Weightlifting	34/M	C7	Overuse, severe hyperextension	Diagnosed on radiographs	Aspirin, localized heat, mild muscle relaxants (at night)	Full recovery after 12 weeks
37	Weightlifting	21/M	C6	Overuse, severe hyperextension	Diagnosed on radiographs	Symptomatic management	Full recovery after 6 weeks
13	Golf	40/M	T1–T2	NA	Radiographs normal, diagnosed on CT scan and MRI	Muscle relaxant and analgesics, and cervical immobilization with collar	Full recovery after 40 weeks
20	Football	17/M	C7	Overuse, sudden hyperflexion (tackling)	Radiograph	Somi brace for 6 weeks and soft collar for 2 weeks	Full recovery after 12 weeks
20	Football	17/M	C7	Overuse, sudden hyperflexion (tackling)	Radiograph	Somi brace to immobilize the neck for 6 weeks	Full recovery at 6 weeks
36	Golf	45/F	C6–C7	Overuse, shoulder muscle tension	Diagnosed with radiograph, confirmed with MRI	Analgesics and cervical immobilization with collar	Pain gradually improved
43	Wii™ game	38/M	C7	Overuse, shoulder muscle tension contraction	Radiograph	3 weeks immobilization in a soft collar unsuccessful. Excision of the C7 spinous process	NA
12	Weightlifting (Running)	18 /F	T1	Overuse, shoulder muscle tension	Diagnosed with radiograph, confirmed with CT scan	Rest, a soft cervical collar, and oral analgesics	Pain gradually subsided
44	Virtual reality	31/M	C7	Overuse, shoulder muscle tension contraction	Diagnosed with radiograph, confirmed with CT scan	Conservatively with pain therapy for 4 weeks and immobilization with a semi-rigid collar for 6 weeks	No pain at 4 weeks; complete recovery at 12 weeks

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; SPECT, single photon emission computed tomography; NA, not available

down to the arms and up to the head and even radiate to the scapulae, and the patients can notice a click on movement[4,29]. Patients could also complain of mild, persistent pain for days or weeks before the actual fracture[6].

b- Physical exam

During a physical exam, the doctor clamps the patient's shoulders by raising them, flexing the head, and exaggerating the kyphotic curve[32]. This examination could reveal pain

Table 2. Cases of Multiple-Level Involvement of Clay Shoveler's Fracture Found in the Literature.

Source	Sport / incident	Age, y/Sex	Level of involvement	Mode of injury	Diagnosis	Treatment	Outcome
45	Road traffic accident	40/NA	T2–T8	Traumatic	Diagnosed on CT	Conservative, analgesic therapy, immobilization for 6 weeks	Good
13	Golf player	40/M	T1–T2	Overuse	Radiograph normal, diagnosed on CT	Conservative, immobilization for 8 weeks	Good at 10 months (symptoms free)
36	Golf player	45/F	C6–C7	Overuse	Dynamic cervical radiograph and MRI	Conservative, cervical collar for 6 weeks	Improved
38	Road traffic accident	58/M	T5–T10	Traumatic	Radiograph normal, diagnosed on CT	Conservative, 3 months hyperextension brace	Pseudoarthrosis of all the 6 spinous processes at 12 months, clinically asymptomatic
46	Road traffic accident	32/M	C6–C7	Traumatic	Dynamic cervical radiograph and MRI	Conservative, cervical collar for 4 weeks	Good
47	Road traffic accident	NA	C6–T4	Traumatic	Normal radiograph; diagnosed on CT and MRI	Conservative, hard cervical collar for 4 weeks and restricted physical activity	Good
33	Osteoporosis	39/M	C7–T1	Overuse	Diagnosed on radiograph and CT scan	Conservative, 6 weeks collar, alendronate, and long-term rest	Good at 24 months
31	Motorcycle accident	34/M	C4–T8	Traumatic	Radiograph, CT scan and MRI	Conservative, 4 weeks cervical collar and thoraco–lumbar brace with analgesics and muscle relaxant	Gradually improved
48	Road traffic accident	29/F	C6–T9	Traumatic	CT scan	Conservative, 6 weeks brace	Good
49	Automobile accident	60/F	T4–T9	Traumatic	Radiographs and CT scans	Immobilization for 6 weeks, with analgesics and muscle relaxants	Good
50	7m fall injury	47/M	T6–L5	Traumatic	Normal radiograph; diagnosed on CT and MRI	Conservatively by thoracolumbosacral orthosis (TLSO) for 4 weeks	Improved

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; NA, not available

of the upper back muscles aggravated during neck flexion[4,37], a reduction in the ROM of the cervical spine and head in several cases as a consequence of the pain[16,32], crackling sounds and sometimes mobility of the fragment[14,33,39], changing intensity of muscle spasms[32], exquisite tenderness to palpation around the spinous processes of the upper thoracic and lower cervical spine[4,16,29,32,38-40]. Some studies reported swelling and ecchymosis over the tender point[41]. Moreover, as previously mentioned, normal neurological function is expected on physical exam due to the spinous processes' anatomy protecting the spinal cord[4,6,10,16,29,37,38,40,42].

c- Diagnostic imaging

X-rays and computed tomographic scans are the gold standards of investigation for diagnosing clay shoveler's fractures[42].

The standard method for diagnosing clay shoveler's fracture is plain radiography[17]. X-Ray examination of the cervical spine, in most cases, confirms the early diagnosis of spinous process fractures. These fractures appear on lateral radiographs as an oblique radiolucent line midway between the spinous process extremity and its junction with the laminae, associated with posterior or postero-inferior displacement of the spinous process tip. On anteroposterior roentgenograms, the clay shoveler's fracture appears as a so-called "double-shadow" or "double-spinous process" (as if one vertebra has two spinous processes). The downward movement of the avulsed shred 5,6,11,23,30,32,43 brings this on. The AP radiographs also help in diagnosing associated fractures in the spine[43].

Moreover, radiographs provide enough evidence to determine whether the fracture is recent or old. In recent fractures, the line on lateral radiographs has been poorly defined

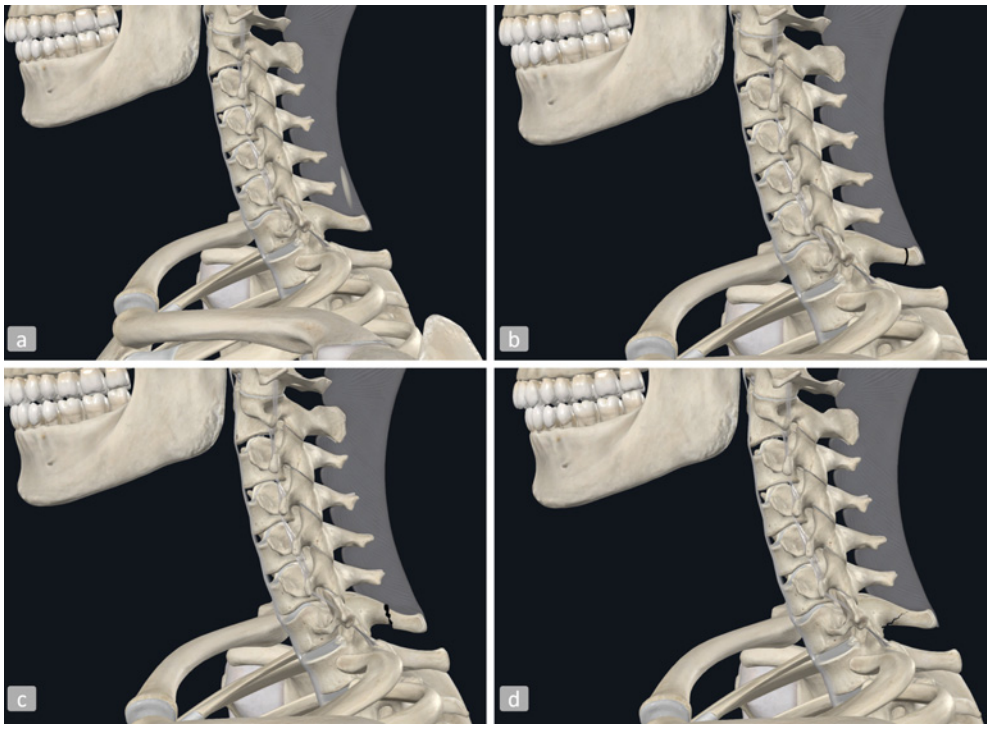

Figure 3. Differential diagnostics of clay shoveler's fracture: a) Nuchal bone formation b) Ununited secondary ossification center of the spinous tip c) Typical Clay Shoveler's Fracture with spinolaminar line intact d) Atypical spinous process fracture with spinolaminar breach (SLB).

and rough, with serrated margins. In contrast, the line is well-defined in old or healed fractures with visible continuous cortex. Moreover, callus (fractures without displacement) are absent in recent fractures but can be present in old ones[30].

However, in several cases, clay shoveler's fractures are overlooked in roentgenology as lateral radiographs may encounter struggles to visualize the lower cervical spine or identify the condition due to the overlapping of thick, soft tissues with bones and muscles from the shoulder, mainly in obese or muscular patients and individuals with muscular spasm, acute pain, short neck. Consequently, by banishing the neighboring soft tissues, CT examination provides a useful efficient technique to improve detecting of spine fractures and resulting injuries, better assessing suspected anomalies in plain radiographs. It yields a clear evaluation of the lower cervical-upper thoracic spine.

Along with CT scans, other particularly specific and highly sensitive imaging techniques grant better definitive diagnoses of minor stress fractures, including clay shoveler's fractures, such as MRI, single photon emission computed tomography, Multidetector computed tomography (MDCT), and Technetium 99 bone scans. However, without clinical evidence, radiographic evaluation is not requisite.

IX- Possible Treatments

The treatment of a clay shoveler's fracture is simple.

The most common case for clay shoveler's fractures is an isolated spinous process fracture that is stable during flexion/extension radiographs. After imaging confirmation of this stable fracture, a conservative treatment is applied[23]. NSAIDs, pain medication, bed rest, and anesthetic blocks are used in the conservative treatment[9]. Avoiding any occupational or sports activities suspected to have caused this fracture is also recommended. This conservative treatment with analgesics, muscle relaxant medication and/or a thoracolumbar brace lasts roughly 6 weeks with a generally satisfying clinical outcome[42].

A persistent pain or unstable fracture during flexion/extension radiographs may require a cervical orthosis, a spinal traction, or a hard collar to immobilize the neck for a few weeks, with rehabilitative exercises if needed[30].

Furthermore, persistent pain after nonunion or an unstable fracture extending to the spinolaminar region, the pedicle or the pillar, possibly leading to persistent pain even after immobilization of the neck, will require operative treatment involving the removal of the residual fragment to treat the fracture[29].

Usually, the non-union is caused by the continuous traction of the trapezius and rhomboid muscles during the spinous process[24]. If necessary, surgery can be performed under general anesthesia via a midline incision over the affected area down to the spinous process. The supraspinous ligament is opened, revealing an easily identified and definable ununited ossicle, which can be removed without taking down the interspinous ligament. The residual end of the spinous process will be smoothed down with a rongeur followed by standard closure[44].

Other modalities, such as ultrasound or microcurrent, may

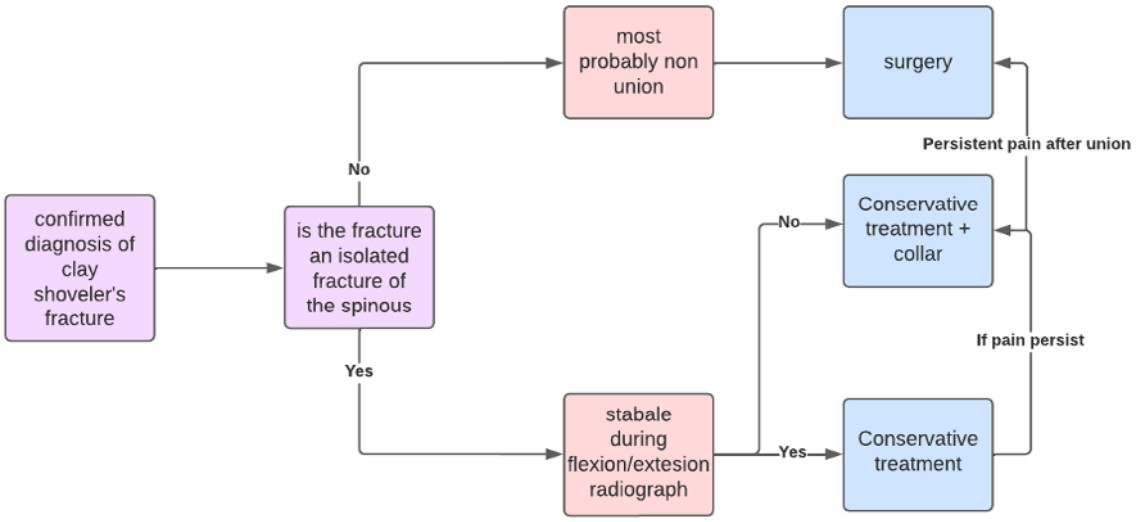

Figure 4. PRISMA flow diagram of the management of clay shoveler's fracture.

be applied to damaged soft tissues[23].

Management of clay shoveler's fracture can be summarized in Fig. 4.

X- Prognostic

Most clay shoveler's fractures tend to heal without residual sequelae regarding neck function or pain. It is important to note that due to the constant muscular pull in this region, non-union of the avulsed fragment is common without any symptoms whatsoever[23]. Nonetheless, in some cases, this injury could result in chronic pain and weakness, so it is important to diagnose and treat properly[45].

Simple cervical spinous process fracture without a posterior ligamentous complex (PLC) injury does not usually affect the overall stability of the cervical spine. According to Wu et al., simple cervical spinous process fracture had little effect on the stability of the cervical spine, with no significant reduction in cervical range of motion under all working conditions.

A cervical spinous process fracture and a PLC injury are more likely to cause cervical instability. Hence, surgical intervention will be required in this case[46].

XI- Preventions

Throughout the 20th century, efforts directed at preventing this injury were established among the workers after the increase in clay shoveler's fracture cases:

- A time layoff separates the onset of interscapular pain and the actual avulsion of the fragment. Therefore, when a metal dipper presents himself with interscapular pain, he should be laid off from metal dipping even though initial x-rays may be negative. Additionally, employees are encouraged to report any symptoms immediately.

- Recommendations have also been made to lengthen the training and breaking-in period. The work situation is such that each employee has a quota of metal to dip. New employees are especially encouraged to "stretch" their quota of metal dipping over a full eight hours rather than at the beginning of a shift[32].

Efforts directed at preventing this injury should be highlighted and prioritized before treatment[30]. Even if clay shoveler's fracture is not specific to any sport, it should be considered when the symptoms and mechanism of the injury are present[22].

XII- Conclusion

Since the 1930s, when McKellar Hall initially characterized the clay shoveler's fracture, the patient demographic, mechanism of injury, and diagnostic tests have changed, but the management has remained the same. This cervicodorsal spine fracture is due to modern sports and activities. Although plain radiography is the standard method for diagnosing clay shoveler's fractures, CT scans better assess suspected anomalies in plain radiographs. Despite these differences, the 1930s management strategy is still in place, with the conservative treatment consisting of rest, analgesics, and a cervical collar if necessary. Patients can return to normal activity without notable complaints if diagnosed early and treated accordingly. Hence, doctors need to know about this pathology even though it is rare compared to other fractures.

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This collaborative effort ensured a cohesive and comprehensive final product, with each author contributing their unique expertise and insights. The resulting manuscript reflects the authors' dedication to producing high-quality research while ensuring transparency and accuracy in reporting findings.

Patient Involvement Statement: Since this study is a literature review, it did not involve any patients.

Data Sharing Statement: As this paper constitutes a literature review, the authors collected no new data. Instead, they meticulously analyzed previously published studies and synthesized the findings to offer a comprehensive overview of the current state of knowledge on the subject. By drawing upon a vast array of sources, the authors have produced a thorough and insightful examination of the existing literature, highlighting the strengths and limitations of the current research in this field. In this way, the paper contributes to the ongoing discourse on this topic, providing valuable insights for scholars, researchers, and practitioners alike.

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