CPK as A detector for Muscle Damage Degree in Both Open Versus Percutaneous Thoraco-Lumbar Spine Fixation

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ABSTRACT

This study was carried-out for study the role of Cpk as a detector for muscle damage degree in both open versus percutaneous thoraco-lumbar spine fixation**. this study was** a prospective case series study performed in the Neurosurgery, by operating on 60 instances hospitalized to Al-Azhar University Hospitals with the diagnosis of thoracolumbar fractures, degenerative lumber instability, lumber canal stenosis. The trial began in May 2021, and the operated patients had a 12-month follow-up.

This study concluded that, the level of CPK is higher in its level in opend group than the percutaneous group, The extent, range, and duration of muscle stripping are all linked with blood creatine phosphokinase activity. Consequently, creatine phosphokinase is a more accurate signal when evaluating muscle damage and judgement on the efficiency of the open or percutaneous operation for preservation of muscle from damage. so, the percutaneous fixation method is preferable and more efficient for preservation of skeletal muscle from damage.

Key words: Cpk - muscle damage - open - thoraco-lumbar spine fixation.

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INTRODUCTION

Greater trauma, significant bleeding, protracted hospital stays, and other problems are all associated with the conventional open fixation **(1).** The future prospects of patients can also be seriously impacted by the ischemic necrosis and the fibrosis of muscles brought on by vast detached and repeated sustained traction of tissues next to the body of the vertebra (fascia muscularis, muscle, and anadesma), which can result in hard stiffness of the back and waist **(1).**

open versus percutaneous thoraco-lumbar spine fixation, The minimally invasive method for treating spinal injuries was developed as far back as the 1980s employing percutaneous pedicle screws osteosynthesis. In recent years, minimally-invasive percutaneous pedicle screw fixation (MIPPSF) has steadily gained popularity in medical applications **(2, 3).**

There are now 3 surgical pathways: the anterior approach, the posterior one, and the combined anterior and posterior method **(4).** MIPPSF has steadily shown its advantages in clinical practise as demands for aesthetics and quality of life have increased **(4).**

CPK as a detector for muscle damage in both open versus percutaneous thoraco-lumbar spine fixation where the trauma-stress reaction the body experiences during surgery may result in organ malfunction and local harm; this is why surgeons strive to minimize the trauma. Nowadays, CPK are the primary markers used to assess trauma stress. **(5).**

The intensity of postoperative pain has been linked to alterations in the paraspinal muscles after spine surgery **(6).** A good criterion for evaluating muscle damage in different spinal surgeries has been deemed the serum creatine phosphokinase (CPK) amount during the early postoperative phase. Serum levels of this enzyme have been observed to strongly associate with the duration and severity of the pressure that retraction exerts on the paraspinal muscles, as well as with the depth and length of the surgical dissecting **(7).**

Additionally, at post-operative 24 and 48 h, the traditional open pedicle screws osteosynthesis group (TOPSO) had greater serum CPK activities than the minimally-invasive percutaneous pedicle screws osteosynthesis group (MIPPSO), indicating that minimally-invasive procedures could lessen the degree of discomfort following the procedure in the back and waist by reducing the trauma to paravertebral musculature which has achieved a perfect clinical impact **(8).**

So, this study aimed to study the role of CPK as a detector for muscle damage degree in both open versus percutaneous thoraco-lumbar spine fixation.

Material and methods

1-Type of the study:

This research was a prospective case series study conducted at Al-Azhar University's Neurosurgery

Department of the Faculty of Medicine, by operating on 60 cases admitted to Al-Azhar University Hospitals. The trial began in May 2021, and the existed patients had a 12-month follow-up.

2-Ethical consideration

The Faculty of Medicine at Al-Azhar University's Institutional Research Board (IRB) received the study protocol for permission. After ensuring privacy, informed written permission was acquired from each participant in the research.

3-Patients

Participants with fractures of thoracolumbar spine, degenerative lumber instabilities, and stenosis of lumber canal who required posterior fixation surgery were included in our research.

The following are some illustrations of study qualification inclusion criteria:

- Age from 18 to 60
- Traumatic lumbar and/or thoracic spine fractures requiring lumber or dorsal instrumentation but without major anterior column harm or neurological deficit for percutaneous pedicle screws fixation.

- The following are the exclusion criteria:

- Decompression of neuronal components is required due to a neurological impairment for percutaneous pedicle screws fixation.
- Segment retro-pulsed that takes up over fifty percent of the spinal canal for percutaneous pedicle screws fixation.
- osteoporosis, untreated coagulopathy at the time of surgery, severe post-traumatic segmental kyphosis that is greater than or equal to 10 degrees, and prior spine surgery at the same level.

4-Surgical procedure

All patients are asked for their informed permission before the surgery. The patient is positioned on a lumbar frame in a prone posture after undergoing general anaesthesia. An instrument called a guidewire localizer is used to determine the right level under lateral fluoroscopic imaging provided by a fluoroscopic C-arm.

-Operative technique for percutaneous pedicle screws fixation

-System tools

tap cannula, Guidewire, dilators, self-drilling cannulated tap, cannulated polyaxial viper screws with extensions, evaluations, rods, and a rod holder were employed with a DepuySpine Viper 2 system.

-Operative procedures:

-A guide wire was positioned at the desired level on the patient's back, orthogonal to the axis of the spine. The guide wire was modified to transect the middle of both pedicles in a cephalad-caudal manner using A-P fluoroscopy. That plane was moved to the patient's back using a surgical marker.

-On the individual, the guide wires were positioned parallel to the spine's axis. The guidewire's location was modified using A-P fluoroscopy to line up with the lateral pedicle walls of the desired level and the surrounding levels.

-At this point, it is also possible to estimate the lateral pedicle walls of neighbouring levels. This plane was then transferred to the patient using a surgical marker.

-For each level, the skin incision should be no less than 1 cm laterally from the point where the two lines converge. To make it easier for the tap cannula to get through, the fascia was punctured after a skin incision using the scalpel's tip. Once a bone structure was sensed, the tap cannula was inserted via the incision of the skin in a little medial trajectory.

-The tap cannula tip was examined and modified under fluoroscopy at the 3 and 9 o'clock positions in the left and right pedicles, respectively. In AP view, pedicles were punctured with the tap cannula across the lateral pedicular margin to the medial pedicle margin. At this point, it was verified from a lateral view that the tip had passed the pedicle-body junction.

-After inserting the 7-mm dilator into the cannula, it was spun while being pressed downward till both components "snapped" and latched together. The distal tip of the connected instrument was progressed along the guide wire till it made contact with the pedicle, which was verified by radiograph.

-Once it had disengaged from the dilator and made contact with the bone, the cannula moved downward. It was positioned after the dilator was withdrawn while the guide wire was kept in the hands. The appropriate-sized cannulated self-drilling tap was inserted into the cannula along with the guidewire.

-The self-drilling tap was progressed over the guide wire within the pedicle by rotating the tap clockwise while regulating the cannula. The depth of the proximal tap and the appropriate length of the screw may be determined using the markings on the tap. It was crucial to tap carefully to prevent unintentional guide wire displacement. To prevent unintended wire removal, the tap could not be moved beyond the guide wire's tip.

-While moving the tap forward, care should be given to avoid moving the guide wire. Fluoroscopy was utilised to check the depth of the tap and make sure the guide wire was not progressed. The correct screw was selected, having the right length, diameter, and type.

-The appropriate polyaxial driver was inserted into the assembly, and the combined tool was threaded onto the screw head while rotating it clockwise till it stops. The expanded tabs and the screw shank should line up, locking the screw's movement.

-The polyaxial screw was inserted into the pedicle after the combined instrument with the screw was

directed through a guide wire till the pedicle. Once the screw penetrated the body and passed through the pedicle, the guiding wire was disconnected. The indicators on the guide wire were watched while the screw was inserted to prevent unintentional movement.

The polyaxial screw was withdrawn by turning the handle in an anticlockwise manner while securely holding the expanded tab assembly after the screw had been inserted to the required depth. By manipulating the screw extension, the polyaxial capacity was confirmed. Lateral fluoroscopy was used to confirm that the total length of each screw was appropriately adjusted.

-The rod's length was determined by taking a reading at the caliper's top. The choice of a straight, kyphosed , or lordosed rod depends on the curvatures of the spine. The rod were orthogonal to the skin (in a parallel towards the axis of the slots of extension) and the rod holder was orthogonal to the skin surface.

-The rod's tip was placed inside the securely attached screw extension, and the rod had been inserted into the extension's cephalad slot. The distal end of the rod was lowered straight down until it touched the top of the screw head and was below the fascia. With each further extension, the rod holder was turned roughly 45 degrees to the superior side. By turning the extension about its axis, it was determined that the rod was in the extension. Nuts were positioned.

-By using distraction and compression forceps, we may compress or divert. The proximal end of the rod should be radiologically checked to see whether it is entirely seated within the screw head with around 5 mm overhanging from that head before the rod holder is removed.

-The screw extension was taken out, the fascia and skin were closed, and the final tightening/countertorque was applied.

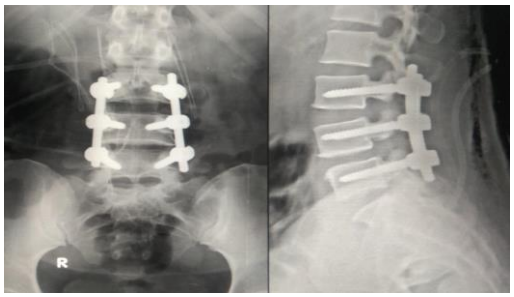


Figure (1) : Open fixation

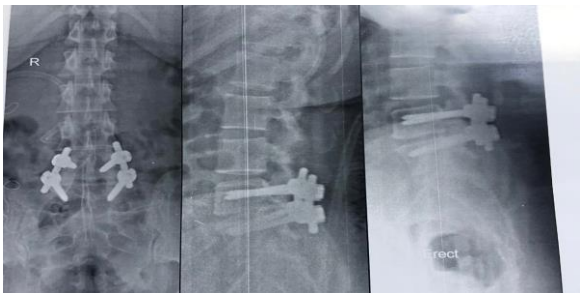


Figure (2): Open fixation

Figure (3): C-arm gave lateral view show transpedicular screws(**Percutaneous fixation)**

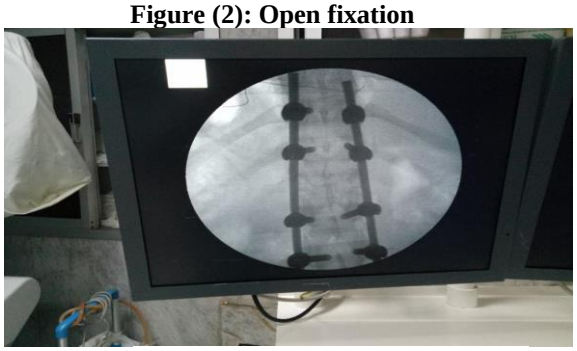


Figure (4): Postoperative radiographical images: anterior-posterior view **(Percutaneous fixation)**

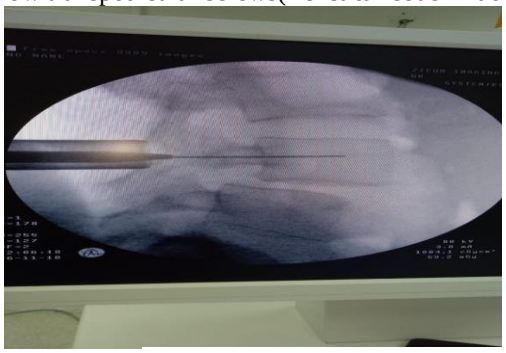


Figure (5): The pedicle screws were inserted along the guide wire

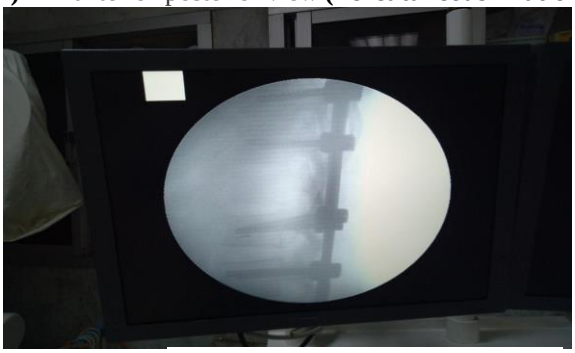


Figure (6): Postoperative radiographical images: Lateral view

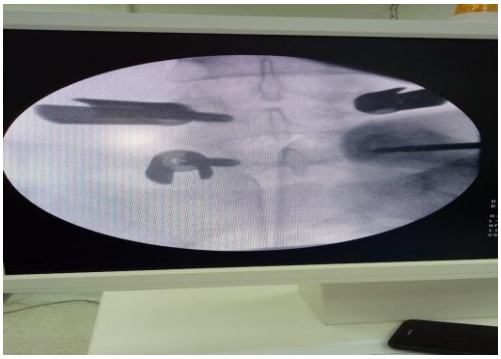


Figure (7): Pedicles were tapped with a tap cannula from the lateral pedicular margin until it reached the medial margin of the pedicle in AP view (**Percutaneous fixation)**

5-pre-and post-procedural evaluation
Clinical assessment
1-Neurological state: is assessed 12 months after surgery by calculating the momentary postoperative American Spinal Injury Association (ASIA) score.

2-Prolo economical and functioning scales for rating one year after surgery. Participants were asked to estimate their own economical and functioning circumstances, and the final patient score was calculated by adding his activity and pain ratings (which ranged from 2 to 10).

3-Cosmesis: is rated on a visual analogue scale from 0 (very bad) to 10 (excellent) by the patient and a separate surgeon. The scores are then computed, and the mean is determined. The individual's and the independent surgeon's assessments are averaged to provide the final cosmesis score**.**

6-Determination of CPK:
serum creatine phosphokinase (CPK) measurement, CPK's ability to catalyse the reversible conversion of a phosphate group from phosphocreatine to ADP serves as the basis for determining its kinetics. glucose-6-phosphate dehydrogenase (G6P-DH) and Hexokinase (HK) also catalyse other reactions in addition to this one. Depending on the catalytic concentration of CK in the sample, the amount of NADPH production may be determined photometrically **(9).** 40 µl of serum were added to 1 ml of the active reagent, mixed, and then incubated for two minutes to complete the reaction. Absorbances were measured for three minutes at intervals of one minute. Averaging absorbance changes per minute and the variation between absorbances were computed. **(9).**

7-STATISTICAL ANALYSIS:

The statistical analysis was carried-out using the SPSSPC+ version 25 computer program. Chi^2 –test was used for examination the most common operations fit to the patients according to the age and sex of the patient and the sit of application of the operation (Opend or percutanepous). Also, t-test was utilized for comparing between the two operations pre and post application in the level of CPK among the patients.

RESULTS

Effect of age and sex on the application of the open and percutaneous thoraco-lumbar spine fixation for treatment of muscle damage of thoraco-lumbar spine.

Our results observed in Table (1) and Figure (8 and 9) cleared that, the application of the two methods of open versus percutaneous thoraco-lumbar spine fixation not differ (Significantly (P > 0.05) among sex and age of the patients.

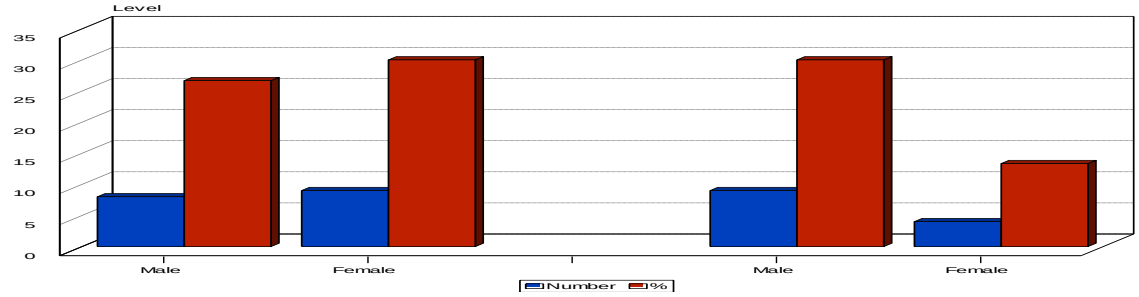
The results cleared that, the open fixation method more commonly used in female 18 (30 %) than the male 16 (26.67 %), also, the percutaneous fixation more prevalent in male 18 (30 %) than female 8 (13.34 %).

Also, the results cleared that, the open fixation method patient age was 42.47 year, while, in the percutaneous fixation patient age was 40.72 year.

Table (1): Effect of sex and age of the patients on the application of application of the open and percutaneous thoraco-lumbar spine fixation for treatment of muscle damage of thoraco-lumbar spine

Parameters	Group 1 Open fixation	Group 2 Percutaneous fixation	Test-value	Significance
Number	34	26		
Sex				
Male	16 (26.67 %)	18 (30 %)	1.25NS	0.57NS
Female	18 (30 %)	8 (13.34 %)		
Age	42.47±8.40	40.72±11.18	t-value = 0.47	0.63NS

NS = Non-significant at (P > 0.05)



Open fixation **Percutaneus fixation**

Figure (8): Effect of patient sex on the application of application of the open and percutaneous thoraco-lumbar spine fixation for treatment of muscle damage of thoraco-lumbar spine

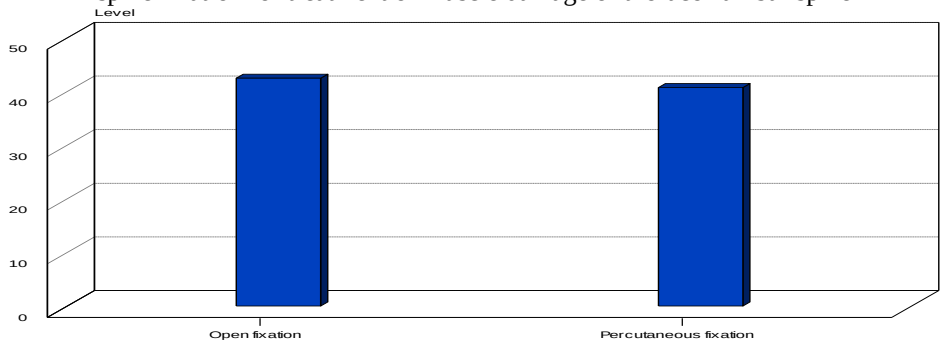


Figure (9): Effect of patient age on the application of application of the open and percutaneous thoraco-lumbar spine fixation for treatment of muscle damage of thoraco-lumbar spine

Spinal level of operation:

Our results observed in Table (2) and Figure (10) cleared that, the site of the operation differ significantly ($P < 0.05$) among group 1 (open fixation metgod) and group 2 (Percutaneous fixation).

The higher level of open fixation observed in L3-4-5 as it was 8 (13.34 %), L4-5 as it was 8 (13.34 %), L4-5-S1 as it was 8 (13.34 %).

While, in percutaneous fixation its higher level was observed in L4-5 as it was 6 (10 %), followed by its site in L4-L5 4 (6.66 %) and in L5-S1 as it was 4 (6.66 %).

Table (2): Sit of fixation.

Spin level	Group		Total
	Group (1) Open fixation	Group (2) Percutaneous fixation	
L1-D11	0 (0 %)	2 (3.34 %)	2 (3.34 %)
L1-D11-12	2 (3.34)	0 (0 %)	2 (3.34 %)
L1-L3-4	0 (0 %)	2 (3.34 %)	2 (3.34 %)
L2	0 (0 %)	2 (3.34 %)	2 (3.34 %)
L2-L4	0 (0 %)	2 (3.34 %)	2 (3.34 %)
L3	0 (0 %)	2 (3.34 %)	2 (3.34 %)
L3-4-5	8 (13.34 %)	0 (0 %)	8 (13.34 %)
L4-5	8 (13.34 %)	6 (10 %)	14 (23.33 %)
L4-5-S1	8 (13.34 %)	0 (0 %)	8 (13.34 %)
L4-L5	0 (0 %)	4 (6.66 %)	4 (6.66 %)
L5-LS1	0 (0 %)	2 (3.34 %)	2 (3.34 %)
L5-S1	8 (13.34 %)	4 (6.66 %)	12 (20 %)
Total	34 (56.67 %)	26 (43.33 %)	60 (100 %)

$Chi^2 = 25.24$** ** = Significant at ($P < 0.01$)

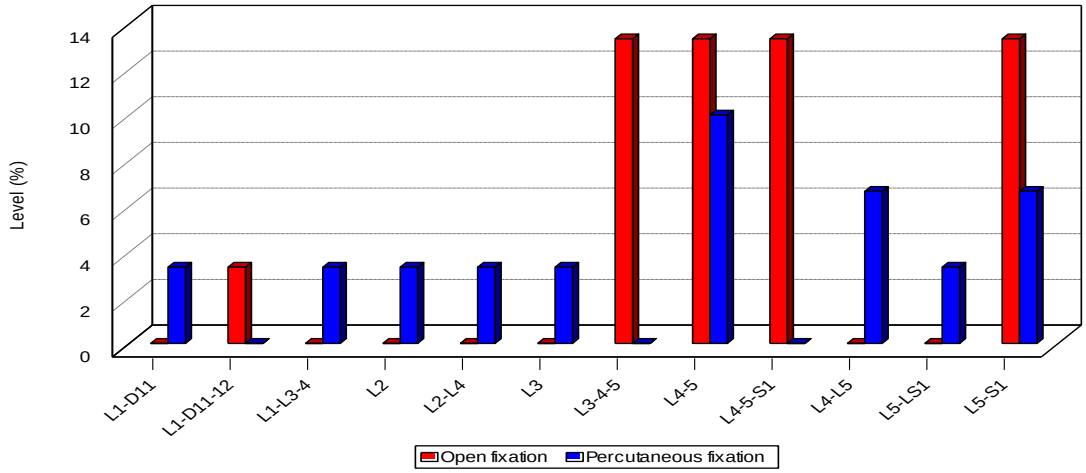


Figure (10): Site of fixation

3- Level of CPK among the open and percutaneous thoraco-lumbar spine fixation operations for treatment of muscle damage of thoraco-lumbar spine

our results observed in Table (3) and Figure (11) cleared that, the CPK level differ significantly ($P < 0.01$) between Group 1 (Open fixation) and group (2) (Percutaneous fixation) before and after operation and between the type of operation.

The results cleared that, the level of CPK in open fixation method higher than its level in percutaneous fixation as it reached to 79.94 and 950 before and after treatment, while, in percutaneous fixation its level was 49.76 and 94.23 before and after treatment.

Table (3): Level of CPK among the open and percutaneous thoraco-lumbar spine fixation operations for treatment of muscle damage of thoraco-lumbar spine

Parameters	Group 1 Open fixation	Group 2 Percutaneous fixation	Test-value	Significance
Number	34	26		
CpK pre	79.94±24.61	49.76±16.56	t-value = 3.80	0.001***
CpK post	950.82±908.70	94.23±16.04	t-value =3.38	0.002**

*** = Significant at ($P < 0.001$)

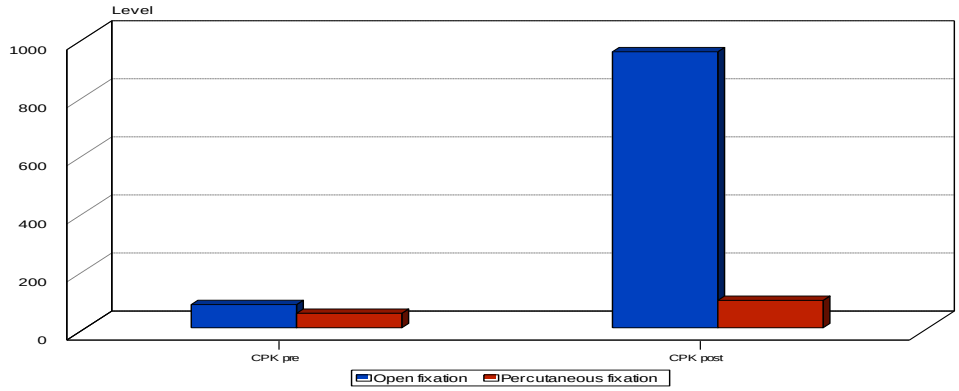


Figure (11): Level of CPK among the open and percutaneous thoraco-lumbar spine fixation operations for treatment of muscle damage of thoraco-lumbar spine

DISCUSSION

In the majority of instances, posterior spinal surgery increased CPK levels by over two times the upper limit.

The thoracolumbar vertebra fracture, one of the indications of posterior spinal surgery, frequently comes on by high-intensity, severe accidents that are connected to the spine's architecture. The thoracolumbar segments T10-L2, a somewhat small area, is where the progressive transition from thoracic kyphosis to lumbar lordosis occurs. Lack of costovertebral protection prevents stress from being transferred to a greater sagittal articular surface, making spinal injuries easier to develop

(10). The best kind of therapy for treating spinal injuries is surgery. **(11,12).**

Our results on the effect of age and sex on the application of the **open and percutaneous thoraco-lumbar spine fixation for degree of muscle damage of thoraco-lumbar spine. Cleared that,** the application of the two methods of open versus percutaneous thoraco-lumbar spine fixation not differ (Significantly (P > 0.05) among sex and age of the patients.

The results cleared that, the open fixation method more prevalaent in female 18 (30 %) than the male 16 (26.67 %), also, the percutaneous fixation more prevalent in male 18 (30 %) than female 8 (13.34 %).

These results agreed with the results of **(13)** where they observed that, the percutaneus fixation method more prevalent in male than female. While, the age of its application ranged from 37 – 38 years.

Also, the results cleared that, the open fixation method patient age was 42.47 year, while, in the percutaneous fixation patient age was 40.72 year.

While, our results on the Spinal level of operation cleared that, the higher level of open fixation observed in L3-4-5 as it was 8 (13.34 %), L4-5 as it was 8 (13.34 %), L4-5-S1 as it was 8 (13.34 %).

While, in percutaneous fixation its higher level was observed in L4-5 as it was 6 (10 %), followed by its site in L4-L5 4 (6.66 %) and in L5-S1 as it was 4 (6.66 %).

While our results on the level of CPK among the open and percutaneous thoraco-lumbar spine fixation operations for degree of muscle damage of thoraco-lumbar spine cleared that, the level of CPK in open fixation method higher than its level in percutaneous fixation as it reached to 79.94 and 950 before and after treatment, while, in percutaneous fixation its level was 49.76 and 94.23 before and after treatment.

Our results agreed with the results of (**14)** where they observed that, following lumbar spine surgeries, time-related variations in creatine phosphokinase MM isoenzyme (CPK-MM) activity were noted. After surgery, there was a rise in activity, which peaked one day later. 1-2 weeks following the surgery, it then returned to the usual levels in the two groups. Immediately after surgery, the mean CPK-MM was 1390 ± 162.95 U/l in Group I and 982.2 ± 520.29 U/l in Group II (P< 0.05).

Additionally, these outcomes matched those of (13) where They discovered that the initial serum CPKs for individuals in the two types (Opend and percutaneous) fixation prior the surgery were similar when comparing the variations in pre-operative and post-operative serum CPK between the two groups of participants. At 24 hours after surgery, the serum CPKs of those participating in the MIPPSO group and the TOPSO group, respectively, were 201.34±45.96 IU/l and 465.61±45.27 IU/l. At post-operative 48 hours, the mean concentrations were 129.67±56.25 IU/l and 252.39±42.65 IU/l, correspondingly. When contrasted with before the surgery, the serum CPKs of the two groups were all considerably higher at 24 hours post-op (P <0.05). The amounts were lower 48 hours after the procedure, although they were remained greater than before (P <0.05). At post-operative 24 and 48 h, the serum CPKs in the TOPSO group were substantially greater than those in the MIPPSO group (P <0.05).

These findings were linked to the difficulty of CPK passing through the cell membrane, and the danger of cell membrane injury if it is released into the circulation. CPK gets released into the blood when the membrane of muscle cells is damaged and permeability of cells is raised by mechanical forces like hypoxia, ischemia, and other conditions. CPK concentration is minimal in typical human blood circulation. The extent, range, and duration of muscle stripping are all connected with an increase in blood creatine phosphokinase activity.

Consequently, CPK is a more accurate signal when evaluating muscle damage and judgement on the efficiency of the open or percutaneous operation for preservation of muscle from damage **(15)**.

This study concluded that, the level of CPK is higher in its level in opend group than the percutaneous group, The extent, range, and duration of muscle stripping are all linked with blood creatine phosphokinase activity. Consequently, creatine phosphokinase is a more accurate signal when evaluating muscle damage and judgement on the efficiency of the open or percutaneous operation for preservation of muscle from damage and so, the percutaneous fixation method is preferable and more efficient for treatment of skeletal muscle damage.

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