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Evaluation of Postoperative Analgesia in Patients with Thoracolumbar Compression Fracture without Nerve Injury by CT using Filtered Back Projection Reconstruction Algorithm

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Abstract. *To study computed tomography (CT) images based on filtered back projection (FBP) reconstruction algorithm, and analyze the clinical efficacy of dexmedetomidine (Dex) combined with dezocine in thoracolumbar vertebral compression fractures patients without nerve injury during surgery, 75 patients with thoracolumbar vertebral compression fractures were divided into the experimental group (dexmedetomidine combined with dezocine intravenous injection) and the control group (dezocine intravenous injection). The anterior/middle vertebral height and kyphotic angle, assessment of thoracolumbar function (Japanese Orthopaedic Association Score) (JOA)/pain level (visual analogue scale) (VAS), onset of sensory block/palinesthesia/post-anesthesia care unit (PACU) stay/duration of anesthesia, dosage of intravenous analgesic drugs/rate of supplementary analgesics, adverse reactions, and other indicators were observed. It found that CT image was clearer and the resolution was higher after algorithm processing; after treatment, the height of anterior/middle vertebral height in the experimental group was greater than that in the control group,* $P < 0.05$*; JOA was greater than that in the control group, and VAS score was less than that in the control group,* $P < 0.05$*; the time of onset of sensory block/palinesthesia/PACU stay, the dosage of intravenous analgesic drugs/the rate of supplementary analgesic drugs, incidence of adverse reactions were less than those in the control group, and duration of anesthesia was greater than that in the control group,* $P < 0.05$*. Therefore, this drug has a significant analgesic effect on patients with thoracolumbar fracture after surgery.* *© 2022 Society for Imaging Science and Technology.*
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1. INTRODUCTION

Thoracolumbar vertebral compression fractures are common in traumatic injuries in clinical orthopedic surgery, and most of them cause the occurrence of fractures due to injury of thoracolumbar vertebral compression caused by strong external forces [1]. These patients experience considerable pain during conservative treatment and do not have a good reduction effect, in addition, complications such as pulmonary infection, urinary system infection, and the formation of venous thrombosis are likely to occur during long-term bed rest [2]. Therefore, if young and middle-aged patients develop thoracolumbar vertebral compression fractures, surgery is often recommended for treatment, and the common surgical methods include open reduction and screw-rod internal fixation of the vertebral body along the posterior approach [3]. However, there are still many controversies about the planning of surgical options for thoracolumbar vertebral compression fractures in clinical practice.

When thoracolumbar vertebral compression fractures occur without nerve injury, the patient's condition is relatively stable and the prognosis is relatively good. This type of fracture has no nerve injury, so indirect reduction by surgically distracting the pedicle along the posterior approach, followed by reduction of the bone block protruding from the spinal canal using the extension of the posterior longitudinal ligament, combined with internal fixation of the pedicle, is very beneficial for the restoration of vertebral anatomy [4, 5]. However, within 24 h after surgery, patients often have severe wound pain, making postoperative activities nearly impossible, reducing gastrointestinal peristalsis, inability to carry out timely functional exercises, affecting the speed of recovery of patients and increasing the incidence of postoperative adverse reactions [6]. Moreover, the incidence of intestinal obstruction in patients after surgery also increases, seriously affecting the prognosis of patients. The effective control of incision pain can promote patients to carry out early activities, facilitate the recovery of gastrointestinal function, and improve the prognosis of patients [7].

Dexmedetomidine (Dex) is an $\alpha 2$-adrenoceptor agonist that is relatively selective, widely distributed in the central and peripheral nervous systems, and has a good sedative effect. Dex has a significant selective effect on $\alpha 2$-adrenergic receptors when given slowly intravenously in the body at 10 to 300 μg/kg, and both $\alpha 1$ and $\alpha 2$-adrenergic receptors are affected when given slowly intravenously at high doses ($\geq$1000 μg/kg) in the body or when given rapidly intravenously [8, 9]. Dex has high safety and low incidence of adverse reactions. Because of its excellent anti-anxiety, sedative, and analgesic effects, it can inhibit sympathetic activity and has no obvious respiratory inhibition function,

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Table I. General information of two groups of patients.

Group	Number of cases	Gender proportion	Mean age	Location of injured vertebral body
Experimental group	$n = 40$	Male : Female = 24:16	51.85 ± 8.39	T_{11-12} 11 cases, L_{1-2} 20 cases, L_{3-5} 9 cases
Control group	$n = 35$	Male : Female = 21:14	48.06 ± 10.18	T_{11-12} 6 cases, L_{1-2} 18 cases, L_{3-5} 11 cases

and it is widely used in thoracolumbar vertebral compression fracture surgery. However, due to its short duration of efficacy and poor analgesic effect during patient activity, it can't play a great role in the overall postoperative recovery time of patients, so the application range is limited to some extent [10]. Dezocine is an organic compound belonging to κ receptor agonists and μ receptor antagonists, which is commonly used for postoperative analgesia and treatment of pain induced by viscera or tumors [11]. Few experts opine that the application of Dex combined with dezocine can solve the problem of short duration of the action of drug and prolong its half-life ($t_{1/2}$), thereby improving the efficacy of the drug [12].

Computed tomography (CT) is a type of X-ray imaging technique that can obtain cross-sectional images of an object from a sufficient number of X-ray projection data. CT uses the principle that X-rays generate attenuation through objects, and different tissue structures have different attenuation coefficients, which can represent the internal structure of objects to some extent. Through the data of different angles obtained by scanning the projection of objects through the CT system, few algorithms are adopted to obtain the X-ray attenuation coefficients of objects, which are converted into the corresponding gray values at the same time, so that the cross-sectional images corresponding to objects can be displayed [13, 14]. Compared with the traditional X-ray examination, CT scanning technology can clearly and intuitively detect the damage status of patients' lumbar and thoracic vertebrae, so as to better grasp the damage status of patients' vertebral body, which is helpful to guide clinical diagnosis and treatment, and to improve the prognosis of patients. Despite the maturity of CT technology, there are still some difficulties in high-resolution imaging, large-target imaging, and reducing radiation dose due to the limitations of existing CT imaging methods. The iterative reconstruction algorithm can construct a mathematical model for the process of CT scanning by discretization, and reconstruct the image by solving the linear equation. When the projection matrix is too large to be directly solved, the iterative approximation method is usually used to obtain the reconstructed image [15]. The iterative reconstruction algorithm includes algebraic reconstruction technique (ART) algorithm, gradient descent algorithm, and simultaneous algebraic reconstruction technique (SART) algorithm, each of which has its own advantages and disadvantages. Filtered back projection (FBP) is a representative of this reconstruction algorithm, which is widely applied in CT systems in the medical field. This algorithm has the advantages of simple realization and is rapid [16]. This study utilizes the FBP algorithm to analyze the CT images of thoracolumbar fractures patients without nerve injury and observe the clinical efficacy of Dex combined with dezocine in patients.

2. MATERIALS AND METHODS

2.1 *General Information*

In this study, 75 patients with thoracolumbar vertebral compression fracture requiring surgical treatment in Zhangjiagang TCM Hospital from March 2016 to June 2020 were selected and divided into experimental group and control group according to random number table method. Inclusion criteria: (1) fracture patients without nerve injury; (2) fractured segment located at thoracic 11-lumbar 5 (T11-L5); (3) patients with clear history of trauma; (4) patients who were type A in AO classification of Magerl spinal fracture; (5) adult patients. Exclusion criteria: (1) patients with a history of chronic low back pain or lumbar surgery; (2) patients with osteoporosis, multiple organ injury, and severe underlying diseases; (3) patients with old thoracolumbar fracture shown by MRI examination; (4) patients with thoracolumbar tuberculosis or tumor-induced fracture. The general data of patients in the two groups were detailed in Table I.

There was no significant difference in gender ratio, mean age, and location of injured vertebral body between the two groups ($P > 0.05$). The patients and their families signed the informed consent form, and the study was approved by the medical ethics committee of Zhangjiagang TCM Hospital.

2.2 *Method*

All patients underwent posterior open reduction & internal fixation of vertebral fractures. Two groups of patients underwent rapid intravenous anesthesia: 2.0 mg/kg propofol, 0.3 μg/kg sufentanil, 0.15 mg/kg atracurium, tracheal intubation was performed after 3 min. After successful intubation, ventilator was used for mechanical ventilation, and respiratory parameters were adjusted to maintain the end-tidal carbon dioxide partial pressure between 35 and 45 mmHg (1 mmHg = 0.133 kPa). After entering the operating room, patients in the experimental group were iv administered 4 μg/kg/15 min of Dex (CAS No. 113775-47-6, Shanghai Haohong Biomedical Technology Co., Ltd.), followed by continuous infusion of 0.2 μg/kg/h until the end of the operation. Patients in the control group were administered the same amount of normal saline intravenously. The patients in the two groups were started on intravenous drip 0.1 mg/kg dezocine 10 min before surgery.

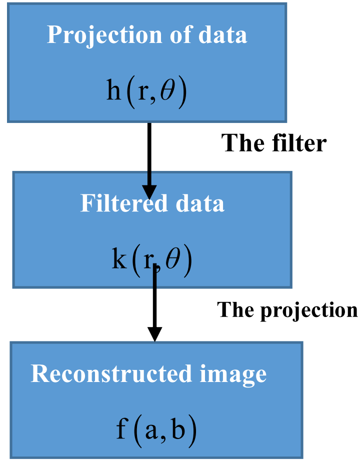

Figure 1. Steps of FBP algorithm.

2.3 *FBP Reconstruction Algorithm*

FBP is the most mature and widely used reconstruction algorithm in the field of CT imaging nowadays. The corresponding back-projection equation $g(a, b)$ is as follows:

$$g(a, b) = \int_0^{\pi} h(r, \theta)|_{r=a\cos\theta+b\sin\theta} d\theta. \quad (1)$$

By transforming the coordinate system of the integral variable in Eq. (1) from the rectangular coordinate system $\mathrm{u}-\mathrm{w}$ to the polar coordinate system $\omega-\theta$, Eq. (2) can be obtained.

$$f(a, b) = \int_0^{2\pi} \int_{-\infty}^{+\infty} F_{\text{polar}}(\omega, \theta) \mathrm{e}^{2\pi \mathrm{i}\omega(a\cos\theta+b\sin\theta)} \omega d\omega d\theta \quad (2)$$

$$F_{\text{polar}}(\omega, \theta) = F_{\text{polar}}(-\omega, \theta+\pi)$$

$$f(a, b) = \int_0^{\pi} \int_{-\infty}^{+\infty} F_{\text{polar}}(\omega, \theta)|\omega| \mathrm{e}^{2\pi \mathrm{i}\omega(a\cos\theta+b\sin\theta)} d\omega d\theta. \quad (3)$$

$F_{\text{polar}}(\omega, \theta)$ is replaced with $H(\omega, \theta)$, then (4) can be obtained:

$$f(a, b) = \int_0^{\pi} \int_{-\infty}^{+\infty} H(\omega, \theta)|\omega| \mathrm{e}^{2\pi \mathrm{i}\omega(a\cos\theta+b\sin\theta)} d\omega d\theta. \quad (4)$$

$|\omega|$ represents transfer function of ramp filter Ramp:

$$K(\omega, \theta) = |\omega| H(\omega, \theta) \quad (5)$$

$$f(a, b) = \int_0^{\pi} \int_{-\infty}^{+\infty} K(\omega, \theta) \mathrm{e}^{2\pi \mathrm{i}\omega(a\cos\theta+b\sin\theta)} d\omega d\theta. \quad (6)$$

One-dimensional inverse Fourier transform is used to simultaneously record the inverse transform of K as k:

$$f(a, b) = \int_0^{\pi} k(r, \theta)|_{r=a\cos\theta+b\sin\theta} d\theta. \quad (7)$$

FBP mainly includes two steps: filtering; back projection. The steps are given in Figure 1.

There are a few implementation methods of Ramp filtering. In fact, filtering can be done without Fourier transform. According to the Fourier transform theory, the multiplication in the ω domain is equivalent to the convolution in the r domain (Figure 2).

Ramp filter can be decomposed into two parts:

$$|\omega| = i\omega \times \frac{1}{i} rjn\omega. \quad (8)$$

The definition of $i = \sqrt{-1}$, $rjn\omega$ is as below:

$$rjn\omega = \begin{cases} 1 \cdots \omega > 0 \\ 0 \cdots \omega = 0 \\ -1 \cdots \omega < 0. \end{cases} \quad (9)$$

Two properties of Fourier transform are used here.

(1) Multiplication of iω in the Fourier domain (ω domain) is equivalent to derivation in the spatial domain (r domain).

(2) The inverse Fourier transform of the function $-irjn\omega$ is $1/(\pi r)$, and the convolution $1/(\pi r)$ is called Hilbert transform. Through the relationship given in Fig. 2, the ramp filter can be expressed as follows:

$$k(r, \theta) = \frac{dh(r, \theta)}{dr} * \frac{1}{\pi r}. \quad (10)$$

The equation is back-projection to obtain Eq. (11):

$$f(a, b) = \int_0^{\pi} \int_{-\infty}^{+\infty} L\partial S_\theta f d\theta. \quad (11)$$

L is a Hilbert transform operator and ∂ is a differential operator.

Since the FBP algorithm focuses on the central region of the image pixel in operation, the reconstruction efficiency is high, and there is no high requirement for the computer level. It aimed to restore the detail features of CT images to the maximum extent, so the projection data after filtering the frequency of specific bands in the signal are back-projected. The schematic diagram is shown in Figure 3.

2.4 *Observation Indexes*

(1) Measurement of anterior and middle vertebral height and kyphotic Cobb angle: picture archiving and communication system (PACS) of CT machine and imaging station was used for measurement and data analysis. The height of anterior and middle vertebral body was calculated as the percentage of the ratio of the height of anterior and middle edge of injured vertebral body to the height of anterior and middle edge of normal vertebral body before and after operation; (2) Evaluation of lumbar function: Japanese Orthopaedic Association Score (JOA) was used, including four indicators such as subjective symptoms, clinical signs, limitation of daily activities, and bladder function, with a total score of 29 points. The lower the score, the more obvious the dysfunction; (3) Assessment of pain degree: visual analogue scale (VAS) was adopted, with a score range of $0 \sim 10$ points. The lower the score, the less severe the pain in patients;

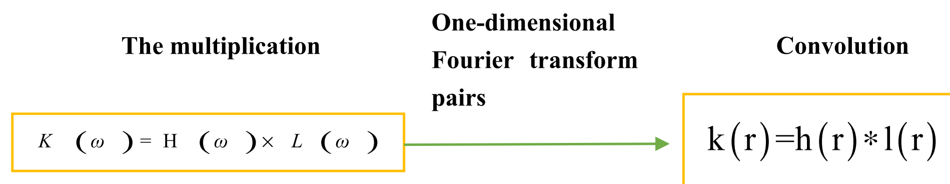

Figure 2. Property of Fourier transform.

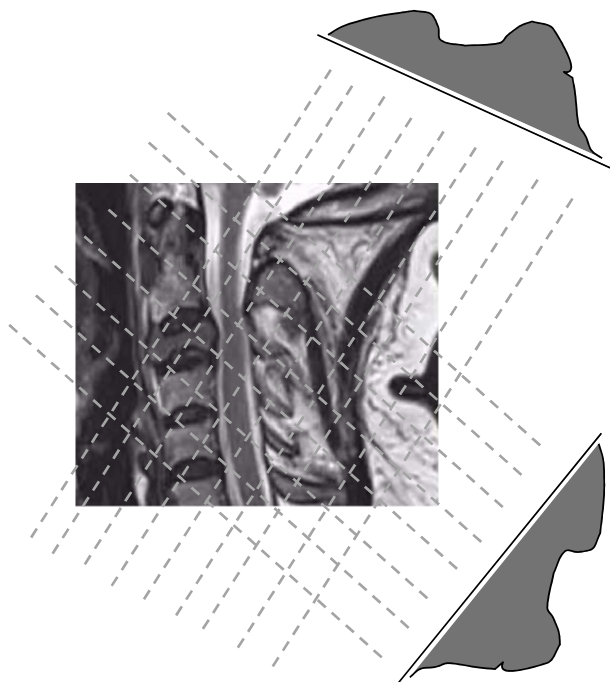

Figure 3. Back-projection schematic.

(4) The onset time of sensory block, duration of anesthesia, and dosage of intravenous analgesic drugs were compared between the two groups; (5) The time of palinesthesia, stay of post-anesthesia care unit (PACU), and the rate of supplementary analgesic drugs were compared between the two groups; (6) The occurrence of nausea, vomiting, dizziness, and other adverse reactions were observed in the two groups.

2.5 *Statistical Analysis*

SPSS 19.0 statistical software was used to process the data. Measurement data were expressed as mean ± standard deviation ($\bar{x} \pm s$). Paired t-test was used to compare the means of the same group before and after treatment. Two independent sample t-test was used to compare the means between the two groups. Enumeration data were expressed as relative number. χ^2 test was used. When $P < 0.05$, the difference was statistically significant.

3. RESULTS

3.1 *Analysis of Experimental Results*

ART and POCS-TVM reconstruction algorithms are compared. Table II shows that FBP algorithm has advantages in reconstruction quality and reconstruction time.

3.2 *Anterior, Middle Vertebral Height, and Kyphosis Cobb Angle*

A 67-year-old male patient (typical case) was admitted to the Hospital due to lumbar compression fracture. The FBP reconstruction algorithm was applied to process the CT images of the patients (Figures 4 and 5). Subsequently, the height of anterior vertebral edge, middle vertebral edge, and kyphotic Cobb angle of injured vertebra before and after treatment in the experimental group and the control group were compared (Figures 6–8).

By observing Figs. 4–8, the CT image processed by the FBP reconstruction algorithm was clearer and more resolved than that before treatment; compared with that before treatment, the height of anterior and middle edge of vertebral body in the two groups at 1 week and 3 months after treatment was significantly increased, $P < 0.05$, and the difference had statistical significance; the kyphosis angle of injured vertebral body was significantly decreased, $P < 0.05$, and the difference had statistical significance; after 3 months of treatment, the height of anterior and middle edge of vertebral body in the experimental group was significantly greater than that in the control group, $P < 0.05$.

3.3 *Evaluation of Thoracolumbar Function and Pain Degree*

The comparison of thoracolumbar function assessment (JOA score) and thoracolumbar pain severity assessment (VAS score) before and after treatment between the experimental group and the control group is illustrated in Figures 9 and 10.

As given in Figs. 9 and 10, compared with that before treatment, the JOA scores of the two groups at 1 week and 3 months after treatment were significantly increased, VAS scores were significantly decreased, $P < 0.05$, and the difference had statistical significance; the JOA scores of the experimental group at 1 week and 3 months after treatment were significantly higher than those of the control group, VAS scores were significantly lower than those of the control group, $P < 0.05$, and the difference had statistical significance.

3.4 *Onset Time of Sensory Block, Duration of Anesthesia, and Dosage of Intravenous Analgesic Drugs*

The comparison of the onset time of sensory block, duration of anesthesia, and dosage of intravenous analgesic drugs between the experimental group and the control group is given in Figure 11.

Table II. Analysis of reconstruction quality.

Reconstruction method	Normalized mean square distance	Average absolute distance	Worst-case distance	Reconstruction seconds
ART	0.5398	0.4875	0.5681	376
POCS-TVM	0.1574	0.1532	0.2098	411
FBP	0.0652	0.0472	0.0725	42

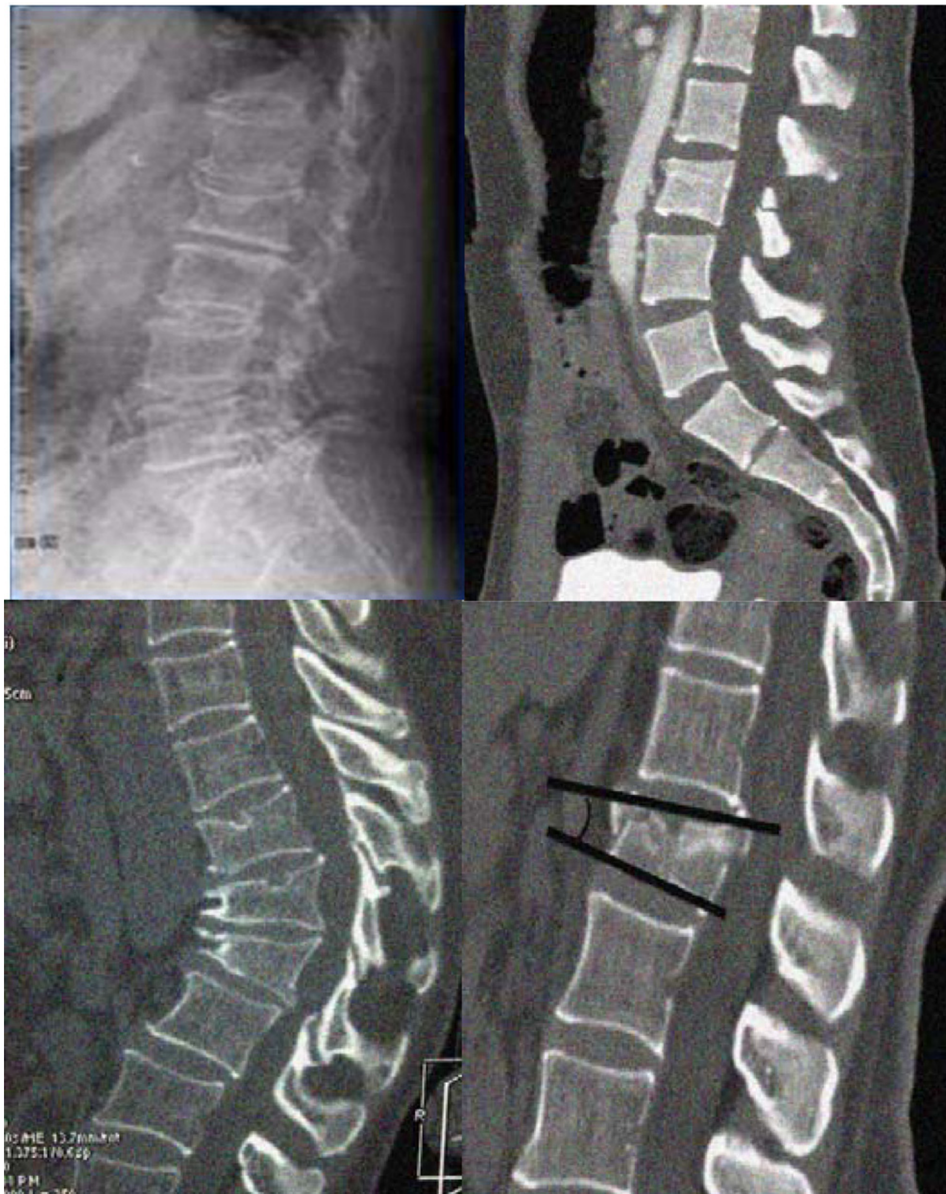

Figure 4. CT image of patients before FBP reconstruction algorithm. (Note: the black mark at the lower right corner indicates the vertebral compression angle.)

The onset time of sensory block and the dosage of intravenous analgesic drugs in the experimental group were significantly less than those in the control group, and the duration of anesthesia was significantly greater than that in the control group, $P < 0.05$, and the difference was statistically significant.

3.5 *Recovery Time, PACU Stay, and Rate of Supplementary Analgesic Drugs*

The comparison of recovery time, PACU stay, and rate of supplementary analgesic drugs between the experimental group and the control group is given in Figure 12.

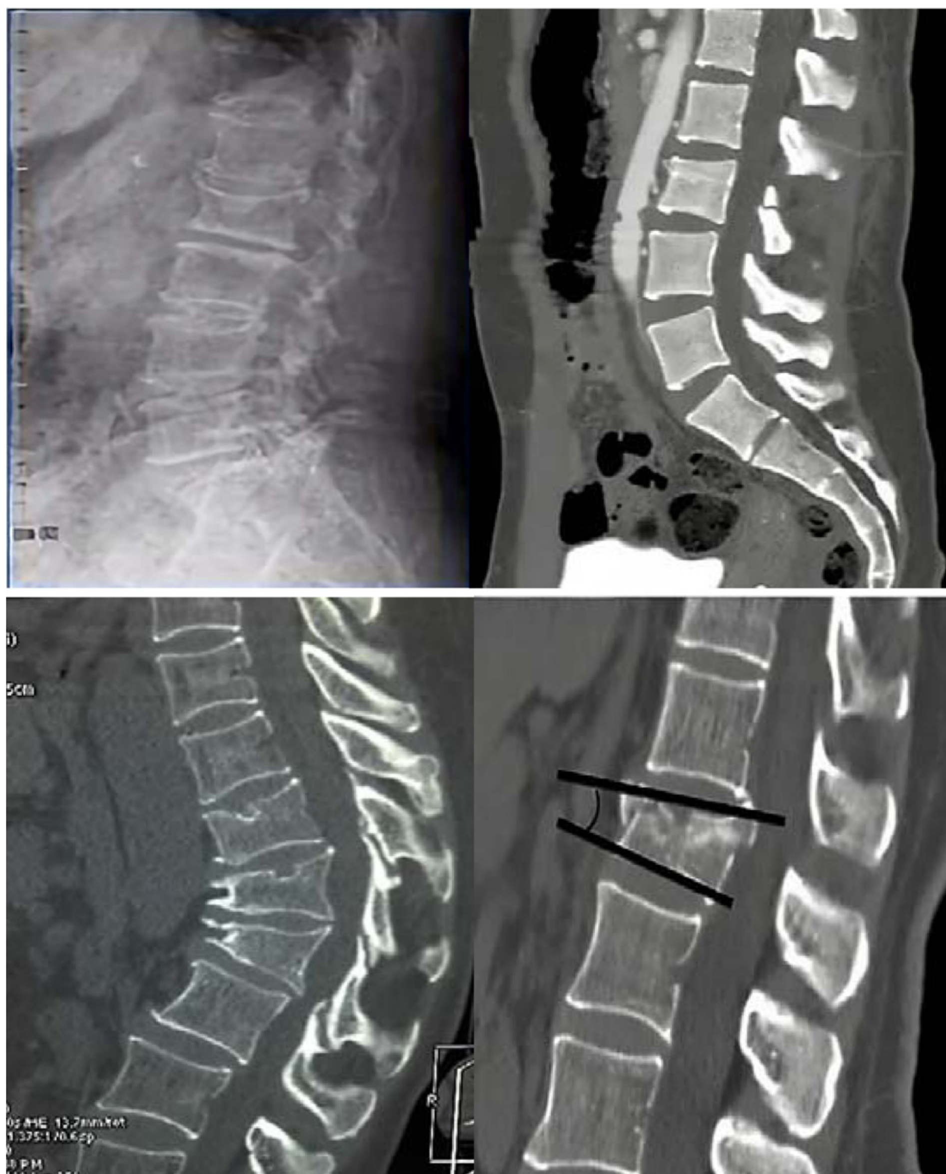

Figure 5. CT image of patients after FBP reconstruction algorithm.

The recovery time, PACU stay time, and analgesic drug supplement rate in the experimental group were significantly less than those in the control group ($P < 0.05$), and the differences were statistically significant.

3.6 *Adverse Reactions*

The comparison of adverse reactions between the experimental group and the control group is shown in Figure 13.

The incidence of nausea, vomiting, and dizziness in the experimental group was significantly lower than that in the control group ($P < 0.05$).

4. DISCUSSION

Thoracolumbar vertebral compression fractures are very common in clinical spinal injuries, most of which are caused by strong external forces, and patients with osteoporosis are relatively more likely to develop thoracolumbar vertebral compression fractures [17]. Clinically, the purpose of surgical treatment of simple thoracolumbar vertebral compression fractures with screw-rod system is to restore the height of the vertebral body and use the means of indirect reduction with pedicle system, in order to relieve the compression of the nerve and reconstruct the stability of the spine. In thoracolumbar vertebral compression fractures patients without nerve injury, the reconstruction of spinal stability and pain relief during treatment are the most important [18].

In this study, FBP reconstruction algorithm was used to process the CT images of the patients, and the efficacy of Dex combined with dezocine and dezocine alone in the treatment of thoracolumbar vertebral compression fractures without nerve injury was compared. It was found that the height of anterior vertebral body and middle vertebral body

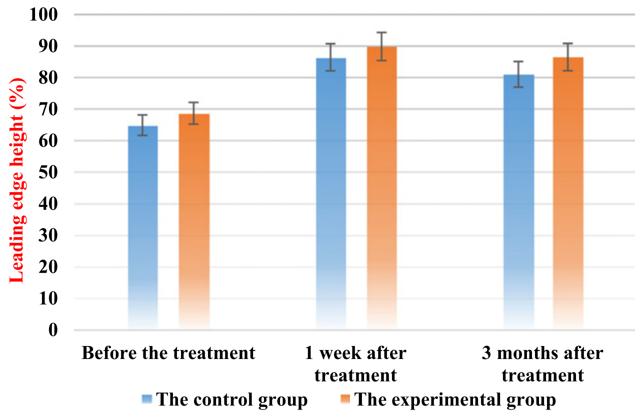

Figure 6. Comparison of height of anterior edge of injured vertebra before/after treatment between the two groups. (* indicates $P < 0.05$ compared with that before treatment, and # indicates $P < 0.05$ compared with the control group.)

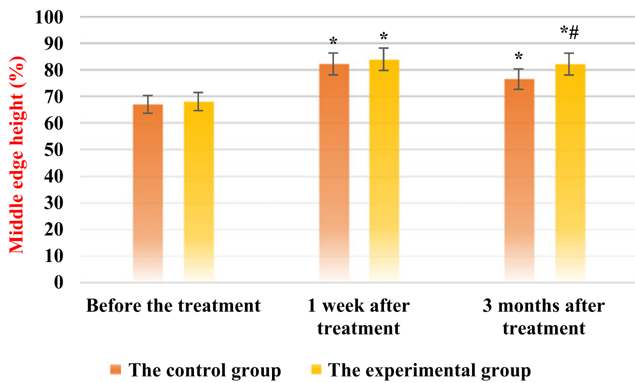

Figure 7. Comparison of height of middle edge of injured vertebra between two groups before and after treatment. (* indicates $P < 0.05$ compared with that before treatment, and # indicates $P < 0.05$ compared with the control group.)

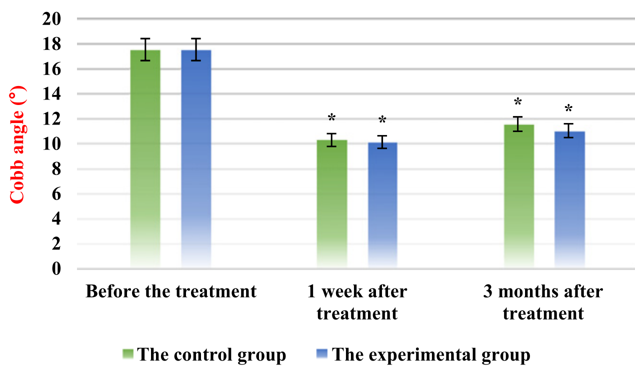

Figure 8. Comparison of kyphotic Cobb angle between the two groups before and after treatment. (* indicates $P < 0.05$ compared with that before treatment.)

in the experimental group was significantly greater than that in the control group at 3 months after treatment, $P < 0.05$, but there was no significant difference in the kyphotic Cobb angle between the two groups at 1 week and 3 months after treatment, $P > 0.05$. This result suggests that nailing of the injured vertebra can improve vertebral body

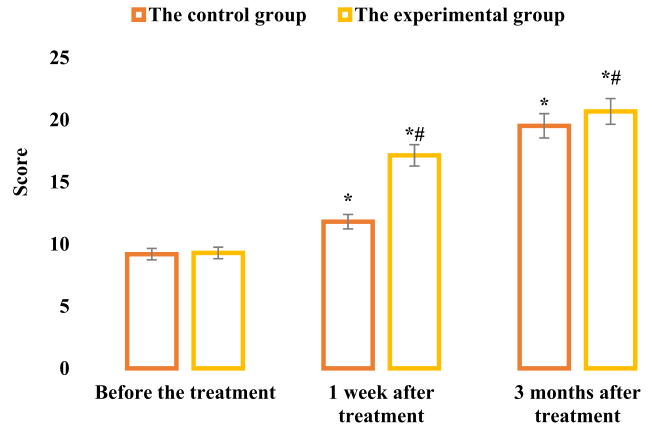

Figure 9. Comparison of JOA scores between the two groups before and after treatment. (* indicates that compared with that before treatment, $P < 0.05$, # indicates that compared with the control group, $P < 0.05$.)

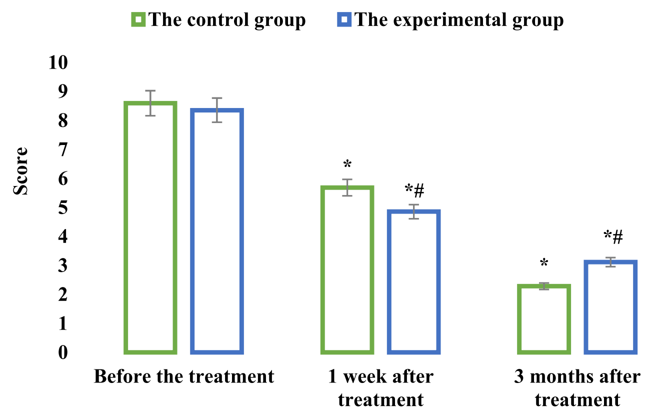

Figure 10. Comparison of VAS scores before/after treatment between the two groups. (* indicates $P < 0.05$ compared with that before treatment, and # indicates $P < 0.05$ compared with the control group.)

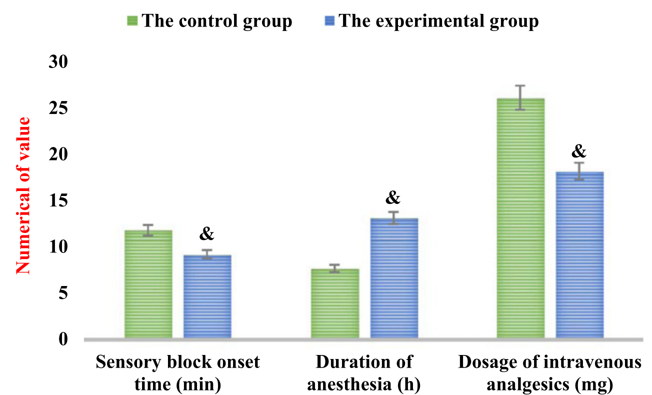

Figure 11. Comparison of onset time of sensory block, duration of anesthesia, and dosage of intravenous analgesic drugs between the two groups. (& indicates $P < 0.05$, the difference is statistically significant.)

height and normal physiological curvature in patients with thoracolumbar vertebral compression fractures. Because in the screw fixation of the injured vertebra, it can make the reduction more accurate, solve the problem of insufficient

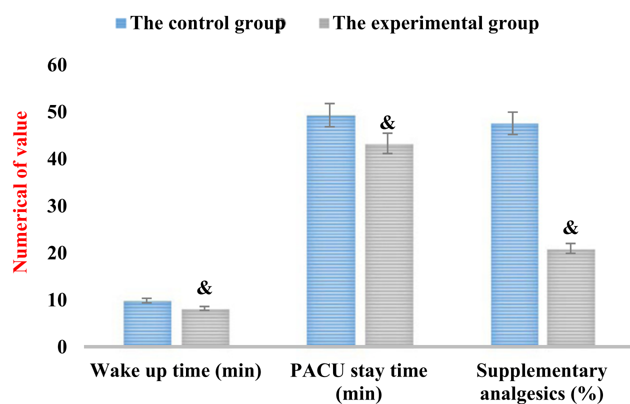

Figure 12. Comparison of recovery time, PACU stay, and analgesic drug supplement rate between the two groups. (& indicates $P < 0.05$, the difference is statistically significant.)

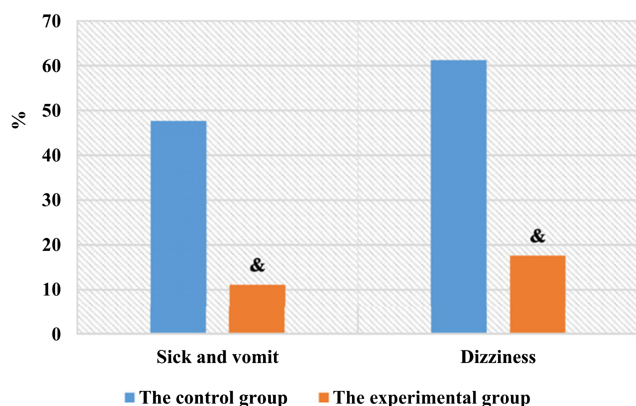

Figure 13. Comparison of incidence of adverse reactions between the two groups. (& indicates $P < 0.05$, the difference is statistically significant.)

reduction or excessive expansion, and is more beneficial to the injured vertebra. The experimental group used Dex combined with dezocine, which bought time for the early rehabilitation of patients. This is just similar to the findings of Li et al. (2021) [19]. Dex combined with dezocine can directly act on peripheral vascular smooth muscle cells, have an effect on α2B receptors, promote microvascular contraction, prolong the drug action time, and improve the drug effect, so that the effect of infiltration anesthesia can be enhanced, with better clinical efficacy.

The common symptom of patients with thoracolumbar vertebral compression fracture is low back pain, which has a great impact on the quality of life of patients. The relevant literature pointed out that the early relief of pain is very beneficial to the rehabilitation of patients [20]. The VAS score of the experimental group was significantly lower than that of the control group at 1 week and 3 months after treatment ($P < 0.05$), indicating that the use of Dex combined with dezocine can effectively relieve the pain of patients with thoracolumbar vertebral compression fractures. Some scholars found that in addition to low back pain, immobility and other symptoms and signs, patients with thoracolumbar vertebral compression fracture have an impact on the function of the urinary bladder, and have a great impact on the psychological status and quality of life of patients [21]. The JOA scores of the experimental group were significantly higher than those of the control group at 1 week and 3 months after treatment ($P < 0.05$). The results showed that the use of Dex combined with dezocine had a good effect on postoperative back pain, wound healing, and improvement of thoracolumbar function. Dex combined with dezocine can reduce the postoperative pain of patients, improve the postoperative comfort of patients, and provide help for the prognosis of patients. The adverse reactions caused by Dex combined with dezocine are smaller, and analgesic drugs can be avoided. The application advantages are obvious.

In the process of surgical treatment for patients with thoracolumbar fracture, great soft tissue injury will occur, which makes the patients have severe pain in the postoperative wound for a long time, thus affecting the early activities of the patients, slow wound recovery, prolonging the duration of stress state of the patients and affecting the rehabilitation training of the patients [22]. It was reported in the literature that the implementation of intravenous medication during anesthesia is currently an effective analgesic modality [23]. Nowadays, researchers apply this method in a variety of surgeries, all of which have good analgesic effect and contribute to the rehabilitation of patients. In the past, dezocine alone was used for anesthesia in clinical practice, but during block induction, endotracheal intubation, and extubation, the hemodynamic changes of patients were great. Dex has a significant analgesic effect, which can reduce the use of morphine on the first day after surgery, relieve the pain of patients, and reduce the occurrence of postoperative nausea, vomiting, dizziness, and other adverse reactions. Dex combined with dezocine is very safe in monitoring anesthesia, and the analgesic effect is significantly increased when the two drugs are used in combination, but the sedative effect does not superimpose [24, 25]. This study found that the onset time of sensory block, recovery time, and time spent in PACU in the experimental group were significantly shorter than those in the control group, the time of anesthesia maintenance was significantly greater than that in the control group, the use of intravenous analgesics was also significantly lower than that in the control group, and the incidence of adverse reactions (nausea, vomiting, dizziness) was also significantly smaller than that in the control group. It indicates that Dex combined with dezocine had a significant analgesic effect on patients with thoracolumbar fracture after operation, effectively relieving the postoperative pain of patients and facilitating the prognosis of patients. Moreover, it caused fewer adverse reactions and could reduce the supplement rate of analgesics, with good application advantages.

5. CONCLUSION

The CT images under the FBP reconstruction algorithm were studied to analyze the clinical efficacy of Dex combined with dezocine during surgical treatment of thoracolumbar

vertebral compression fracture patients without nerve injury. It was found that the CT image after treatment with the reconstruction algorithm was clearer and more resolved than that before treatment; after 3 months of treatment, the height of the anterior and middle edges of the vertebral body in the experimental group was significantly greater than that in the control group; at 1 week and 3 months after treatment, the JOA scores were significantly greater than those in the control group, and the VAS scores were significantly less than those in the control group; the onset time of sensory block and the dosage of intravenous analgesic drugs were significantly less than those in the control group, and the duration of anesthesia was significantly greater than that in the control group; the recovery time, PACU stay time, and the rate of supplementary analgesic drugs were significantly less than those in the control group; the incidence rate of adverse reactions was significantly less than that in the control group, $P < 0.05$. In conclusion, Dex combined with dezocine intravenous injection has a significant postoperative analgesic effect on patients with thoracolumbar fracture, effectively relieving the postoperative pain of patients, which is conducive to good prognosis of patients, and with high safety. This combination can be clinically promoted.

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REFERENCES

[1] E. Jacobs, R. Senden, C. McCrum, L. W. van Rhijn, K. Meijer, and P. C. Willems, "Effect of a semirigid thoracolumbar orthosis on gait and sagittal alignment in patients with an osteoporotic vertebral compression fracture," Clin. Interv. Aging. **14**, 671–680 (2019) PMID: 31043773; PMCID: PMC6469477.

[2] K. Martikos, T. Greggi, C. Faldini, F. Vommaro, and A. Scarale, "Osteoporotic thoracolumbar compression fractures: long-term retrospective comparison between vertebroplasty and conservative treatment," Eur. Spine J. **27**, 244–247 (2018) Epub 2018 Apr 19. PMID: 29675674.

[3] H. Hu, X. Lin, L. Tan, C. Wu, Z. Zhong, J. Zeng, and J. Deng, "Surgical treatment strategy for the "shell" phenomenon after thoracolumbar fracture," Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi **33**, 49–55 (2019) Chinese. PMID: 30644260; PMCID: PMC8337254.

[4] Y. Zhang, Q. Zhao, X. Qin, Y. Qiu, and Z. Zhu, "SRS-Schwab grade IV osteotomy combined with satellite rod for thoracolumbar old osteoporotic fracture with severe kyphosis," Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi **33**, 259–264 (2019) Chinese. PMID: 30874379; PMCID: PMC8337931.

[5] F. Ullah, M. A. Habib, M. Farhan, S. Khalid, M. Y. Durrani, and S. Jabbar, "Semantic interoperability for big-data in heterogeneous IoT infrastructure for healthcare," Sustainable Cities Soc. **34**, 90–96 (2017).

[6] S. Lin, J. Hu, L. Wan, L. Tang, Y. Wang, Y. Yu, and W. Zhang, "Short-term effectiveness comparison between robotic-guided percutaneous minimally invasive pedicle screw internal fixation and traditional open internal fixation in treatment of thoracolumbar fractures," Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi **34**, 76–82 (2020) Chinese. PMID: 31939239; PMCID: PMC8171838.

[7] S. Shaees, M. R. Naeem, M. Arslan, H. Naeem, S. H. Ali, and H. Aldabbas, "Facial emotion recognition using transfer learning," *Int'l. Conf. on Computing and Information Technology, University of Tabuk, Kingdom of Saudi Arabia. 2020 Mar.* (IEEE, Piscataway, NJ, 2020).

[8] A. D. Kaye, D. J. Chernobylsky, P. Thakur, H. Siddaiah, R. J. Kaye, L. K. Eng, M. W. Harbell, J. Lajaunie, and E. M. Cornett, "Dexmedetomidine in enhanced recovery after surgery (ERAS) protocols for postoperative pain," Curr Pain Headache Rep. **24**, 21 (2020) PMID: 32240402; PMCID: PMC7223065.

[9] A. Davy, J. Fessler, M. Fischler, and M. Le Guen, "Dexmedetomidine and general anesthesia: a narrative literature review of its major indications for use in adults undergoing non-cardiac surgery," Minerva Anestesiol. **83**, 1294–1308 (2017) Epub 2017 Jun 22. PMID: 28643999.

[10] M. Shi, S. Miao, T. Gu, D. Wang, H. Zhang, and J. Liu, "Dexmedetomidine for the prevention of emergence delirium and postoperative behavioral changes in pediatric patients with sevoflurane anesthesia: a double-blind, randomized trial," Drug Des. Devel. Ther. **13**, 897–905 (2019) PMID: 30936683; PMCID: PMC6421876.

[11] Q. Song, G. Liu, D. Liu, and C. Feng, "Dezocine promotes T lymphocyte activation and inhibits tumor metastasis after surgery in a mouse model," Invest New Drugs **38**, 1342–1349 (2020) Epub 2020 Mar 13. PMID: 32170576.

[12] Y. Q. Huang, S. H. Guo, R. Liu, S. M. Zhu, J. L. Sun, and Y. X. Yao, "Additive analgesic effect of dexmedetomidine and dezocine administered intrathecally in a mouse pain model," Oncotarget **9**, 24391–24397 (2018) PMID: 29849948; PMCID: PMC5966251.

[13] H. Naeem and A. A. Bin-Salem, "A CNN-LSTM network with multi-level feature extraction-based approach for automated detection of coronavirus from CT scan and X-ray images," Appl. Soft Comput. **113**, 107918 (2021) Epub 2021 Sep 27. PMID: 34608379; PMCID: PMC8482540.

[14] S. A. Ostby, J. G. Evans, H. J. Smith, T. K. L. Boitano, M. D. Toboni, M. A. Heimann, J. S. Booth, J. J. Thomas, and J. Michael Straughn Jr., "Reducing emergency department (ED) computed tomography (CT) utilization in women treated for gynecologic cancers," Gynecol. Oncol. **156**, 288–292 (2020) Epub 2019 Nov 22. PMID: 31767189.

[15] Z. H. Lv, D. L. Chen, R. R. Lou, and Q. J. Wang, "Intelligent edge computing based on machine learning for smart city," Future Gener. Comput. Syst. **115**, 90–99 (2021) ISSN 0167-739X.

[16] Y. Li, J. L. Zhao, Z. H. Lv, and J. H. Li, "Medical image fusion method by deep learning," Int'l. J. Cogn. Comput. Eng. **2**, 21–29 (2021) ISSN 2666-3074.

[17] A. T. Harding, B. K. Weeks, C. Lambert, S. L. Watson, L. J. Weis, and B. R. Beck, "Exploring thoracic kyphosis and incident fracture from vertebral morphology with high-intensity exercise in middle-aged and older men with osteopenia and osteoporosis: a secondary analysis of the LIFTMOR-M trial," Osteoporos Int. **32**, 451–465 (2021) Epub 2020 Sep 15. PMID: 32935171.

[18] D. B. Franklin 3rd., A. T. Hardaway, B. W. Sheffer, D. D. Spence, D. M. Kelly, M. S. Muhlbauer, W. C. Warner Jr., and J. R. Sawyer, "The role of computed tomography and magnetic resonance imaging in the diagnosis of pediatric thoracolumbar compression fractures," J. Pediatr. Orthop. **39**, e520–e523 (2019) PMID: 30589678.

[19] Q. Li, H. Yao, M. Xu, and J. Wu, "Dexmedetomidine combined with sufentanil and dezocine-based patient-controlled intravenous analgesia increases female patients' global satisfaction degree after thoracoscopic surgery," J. Cardiothorac. Surg. **16**, 102 (2021) PMID: 33882970; PMCID: PMC8059176.

[20] L. Zhou and J. Zhou, "Spinal dorsal rami injection and radiofrequency neurolysis for low back pain caused by osteoporosis-induced thoracolumbar vertebral compression fractures," J. Rehabil. Med. Clin. Commun. **4**, 1000056 (2021) PMID: 33884156; PMCID: PMC8054747.

[21] P. Y. Chiu and J. C. Liao, "Surgical outcomes in thoracolumbar fractures with pure conus medullaris syndrome," Biomed. J. **42**, 277–284 (2019) Epub 2019 Sep 11. PMID: 31627870; PMCID: PMC6818151.

[22] S. X. Xie, Z. C. Yu, and Z. H. Lv, *Computer Modeling in Engineering & Sciences* (Tech Science Press, Henderson, NV, 2021), vol. 128, pp. 489–522.

[23] D. Y. Park, I. Choi, T. G. Kim, W. J. Kim, I. Y. Shin, and E. K. Khil, "Gray ramus communicans nerve block for acute pain control in vertebral compression fracture," Medicina (Kaunas) **57**, 744 (2021) PMID: 34440950; PMCID: PMC8400661.

[24] W. Cui, Q. Liu, S. Xiong, and L. Qiao, "LC-MS/MS method for simultaneous quantification of dexmedetomidine, dezocine, and midazolam in rat plasma and its application to their pharmacokinetic study," J. Anal. Methods Chem. **2018**, 3184759 (2018) PMID: 29888025; PMCID: PMC5985101.

[25] J. Hu, X. J. Su, H. L. Si, R. X. Song, F. Zhang, X. J. Qiu, and X. P. Chen, "Simultaneous determination of celecoxib, dezocine and dexmedetomidine in beagle plasma using UPLC-MS/MS method and the application in pharmacokinetics," Drug Des. Devel. Ther. **15**, 2529–2541 (2021) PMID: 34163139; PMCID: PMC8214532.