Thrita J Neu. 2024 June; 13(1): e149092. https://doi.org/10.5812/thrita-149092.

Published online: 2024 August 17. **Research Article**

Diabetic Patients with Chronic Pain After Lumbar Surgery Experienced Fewer Analgesic Effects of Laser Therapy

Masoume Masoumipour [1], Mehdi Salehi Barough [1,*], Babak Babakhani [2,**], Behnamedin Jameie [3,4], Abbas Majdabadi [5]

[1] Department of Medical Radiation Engineering, Central Tehran Branch, Islamic Azad University, Tehran, Iran
[2] Department of Brain and Spinal Cord Injury Research Centre, Neuroscience Institute, Tehran University of Medical Sciences, Tehran, Iran
[3] Department of Anatomy, School of Medicine, Iran University of Medical Sciences, Tehran, Iran
[4] Neuroscience Research Center, Iran University of Medical Sciences, Tehran, Iran
[5] Department of Laser Research Center of Dentistry, Dentistry Research Institute, Tehran University of Medical Sciences, Tehran, Iran

[*] Corresponding Author: Department of Medical Radiation Engineering, Central Tehran Branch, Islamic Azad University, Tehran, Iran. Email: me.salehi@iau.ac.ir
[**] Corresponding Author: Department of Brain and Spinal Cord Injury Research Centre, Neuroscience Institute, Tehran University of Medical Sciences, Tehran, Iran. Email: drbabakhanibabak@gmail.com

Received 2024 May 25; **Revised** 2024 July 7; **Accepted** 2024 July 9.

Abstract

Background: Recent studies indicate that several factors are associated with different responses to pain relief and alteration in reactions to non-pharmacological modalities and pharmacological medications. Biological processes appear to be contributory factors to these outcomes.
Objectives: The purpose of this study is to examine how laser therapy can help as a conservative approach for chronic pain after back surgery in patients with diabetes mellitus (DM).
Methods: This research included 22 diabetic patients and 26 non-diabetic patients with chronic pain after back surgery. Points of laser irradiation were determined by an ultrasound examination, specifically targeting bilateral sacroiliac joints, L2 - L3 through L5 - S1 facet joints, and the area of cluneal nerves. The duration of laser therapy was three weeks, with treatment sessions using an 808 nm diode laser at a power of 0.5W, performed every other day. Individuals were evaluated using the Oswestry Disability Index (ODI) and Numeric Rating Scale (NRS) before and after treatment, and again six months later.
Results: Oswestry Disability Index and Numeric Rating Scale scores decreased significantly after treatment and six months later. Furthermore, analysis of the data showed that diabetic patients experienced less therapeutic effect during and after laser therapy sessions.
Conclusions: Although laser therapy can reduce pain, diabetic patients reported a lower level of effectiveness compared to non-diabetic patients.

Keywords: Laser Therapy, Diabetes Mellitus, Chronic Pain, Pain Relief

1. Background

Chronic lumbar pain with unknown causes appearing and persisting after surgical intervention is specified as Failed Back Surgery Syndrome (FBSS). This condition involves complicated pathophysiology and multiple factors that can lead to chronic pain. Discectomy, laminectomy, or other spinal surgeries can result in spinal instability, spinal stenosis, and epidural fibrosis, which may aggravate existing pain and symptoms or create new ones after surgery (1).

Due to the multifactorial causes of pain and its relief, investigators have focused on factors such as age, gender, and underlying diseases (2). Research has shown that pain is more intense in certain patients because of hormonal, physiological, anatomical, and psychological factors (3). Painful conditions, restricted functional activity, and poor quality of life in patients with underlying diseases like diabetes mellitus (DM) result from damage to the peripheral nervous system, leading to reduced microcirculation and tissue damage (4). Current approaches for chronic pain management include both invasive and non-invasive methods. Before considering any invasive procedures, pharmacological treatments (5, 6) and conservative treatments, such as physical therapy modalities and rehabilitation (7)), should be regarded.

Researchers have evaluated laser therapy (LT) as an effective conservative treatment for neurodegenerative diseases. It has been found that LT reduces inflammation in damaged tissues by improving local microcirculation and inhibiting the release of inflammatory cytokines, which may prevent hyperalgesia and provide analgesia (8-10). Furthermore, the improvement of collagen synthesis, cell proliferation, and angiogenesis leads to tissue repair (11, 12).

2. Objectives

In our previous study, we assessed the impact of age on the efficiency of laser therapy in patients with FBSS (13). Building on that research, this study investigates the relationship between DM and the therapeutic effects of laser therapy on patients experiencing pain and disability after lumbar surgery, focusing on improving their quality of life and reducing pain.

3. Methods

This investigation was approved by the Tehran University of Medical Sciences (IR.TUMS.NI.REC.1399.016). The method of the study is depicted in Figure 1 as a graphical abstract.

3.1. Case Selection

Forty-eight individuals (22 diabetic patients and 26 non-diabetic patients) who experienced back or leg pain and underwent back surgery were included in the study. All participants were aged 30 to 75 years and had undergone lumbar surgery more than three months prior. Individuals with apparent skin diseases in the area of laser irradiation, allergic reactions, pregnancy, alcoholism, unmanaged psychiatric diseases, sustained neurologic deficits, a history of malignancy, or abnormal BMI were excluded from the study.

3.2. Treatment

A sonography device (convex transducer, Samsung Inc.) with frequencies of 4 - 8 MHz was used to determine irradiation points. Bilaterally, sacroiliac joints, facet joints from L2 - L3 to L5 - S1, and the supracrestal iliac zones were determined for Cluneal nerves.

Laser calibration was usually carried out to illuminate the target points before each session of laser therapy. In this study, an infrared diode laser (WLINT device IEC 60825-1:2014) with continuous mode and radiation was utilized. Laser therapy was administered every other day for three weeks. The dosimetry parameters of the laser therapy procedure are shown in Table 1.

3.3. Analysis

3.3.1. Numeric Rating Scale (NRS)

The Numeric Rating Scale was used to assess pain severity. This pain assessment tool is typically employed to evaluate pain intensity at a given moment on a 0 - 10 scale, with 0 indicating "no pain" and 10 representing "the worst pain possible" (14).

3.3.2. Oswestry Disability Index (ODI)

To assess functional disability, the ODI questionnaire was utilized to measure the patient's sustained functional disability. This questionnaire includes information about pain intensity, lifting, walking, sleeping, sitting, standing, sex life, personal care, traveling, and social life, regarding the effects of back or leg pain and the patient’s ability to manage daily life activities (15).

Both ODI and NRS were recorded before treatment, immediately after therapeutic sessions, and six months after treatment. The same medical practitioner evaluated all patients to ensure consistency.

3.3.3. Statistical Analysis

For data analysis, SPSS software (Version 25.0, NY: IBM Corp) was used. The repeated measurement test was utilized to compare the trends in ODI and NRS (continuous variables) at various time points.

4. Results

Collected data were shown as mean ± standard deviation (SD). Oswestry Disability Index and NRS scores were recorded after the laser therapy sessions and six months later, but not compared to pre-therapeutic values. Statistical analysis revealed significant differences between the collected data before and after therapeutic sessions, as well as during the six-month follow-up period, in the non-diabetic patient group ($P < 0.001$).

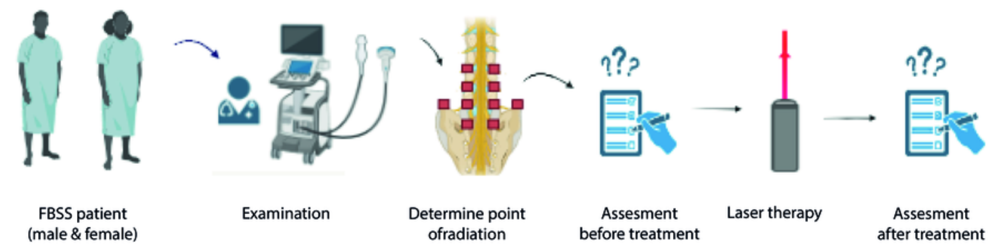

Figure 1. Graphical abstract to show the study procedure

Table 1. The Parameters of the Laser Beam

Parameters	Quantity
Wavelength (nm)	808
Output power (mw)	500
Spot size (cm^2)	0.25
Intensity (w/cm^2)	2
Dose (J/cm^2)	20
Time of radiation (s)	10

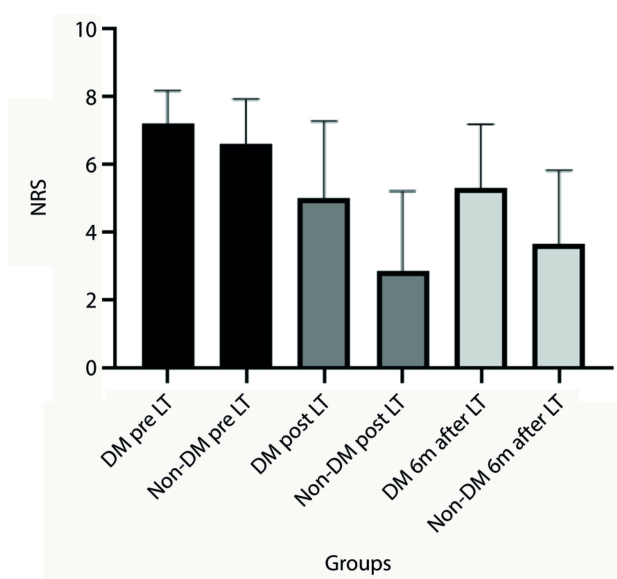

Figure 2. The Numeric Rating Scale (NRS) mean values before and after treatment sessions and 6 months after treatment. Analysis represent significant differences between diabetic patients and non-diabetic patients post laser therapy and 6 months after laser therapy ($P < 0.05$). (LT (Laser Therapy), DM (diabetes mellitus patients) and Non-DM (Non-diabetes mellitus patients)).

More specifically, changes in NRS scores pre- and post-laser therapy and six months after treatment were

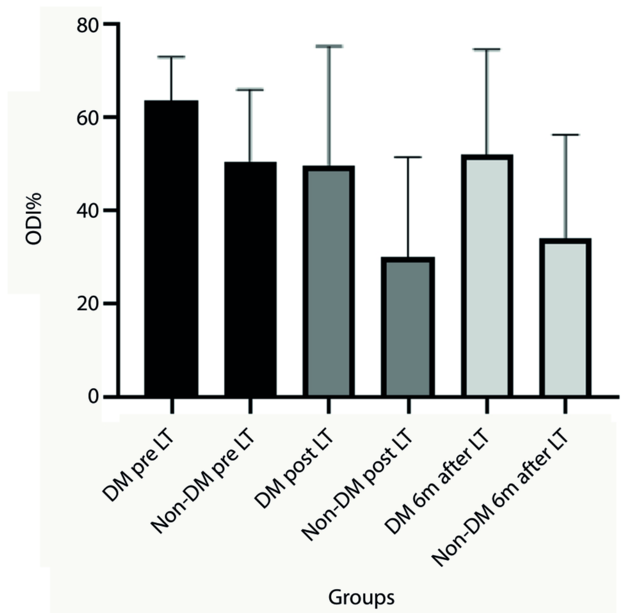

Figure 3. The Oswestry Disability Index (ODI) mean values before and after treatment sessions and 6 months after treatment. Analysis represent significant differences between diabetic patients and non-diabetic patients post laser therapy and 6 months after laser therapy ($P < 0.05$). (LT (laser therapy), DM (diabetes mellitus patients) and non-DM (non-diabetes mellitus patients)).

significant in diabetic patients ($P < 0.05$), while changes in ODI scores were not significant. Additionally, there were significant differences in the trend of ODI and NRS post-treatment values and six months after treatment between diabetic and non-diabetic patients ($P < 0.05$). Diabetic patients experienced fewer therapeutic effects during and after the laser therapy sessions (Figures 2 and 3).

5. Discussion

Chronic pain after surgery occurs when a surgical process leads to undesired problems or damage to intact tissues. The pathophysiology of chronic back or leg pain is complex and includes common causes such as disc herniation and degeneration (16), sacroiliac and facet joint dysfunction (17, 18), cluneal nerve damage (19, 20), and direct damage to muscular tissue (21).

Laser therapy has been utilized for treating various disorders due to its ability to heal damaged tissues, regulate cellular function, restore tissue homeostasis, and reduce acute and chronic pain (arthritis, tendinitis, back pain, fibromyalgia, etc.), thereby enhancing functional movement in patients (22-24). Laser therapy induces changes in the mitochondrial membrane potential caused by photochemical alterations related to specific photo-acceptor chromophores, which accelerates electron transport and ATP and Nicotinamide adenine dinucleotide (NADH) synthesis (25). Literature confirms that antioxidants can restore neurons by restoring mitochondrial activity and controlling reactive oxygen species (ROS) production. Additionally, lasers can increase antioxidants like glutathione and superoxide dismutase (SOD) and improve nerve function (26, 27). The decrease in pro-inflammatory cytokines (IL-1β, TNFα, IL-6, IL-8) inhibits the progression of inflammation, while NF-κB is downregulated and anti-inflammatory cytokines (IL-4, IL-10) are upregulated (28, 29). Due to LT's ability to promote regeneration and reduce degeneration, its effects can last longer than the treatment sessions (30).

In this context, some diabetic patients experience neuropathic pain along with back or leg pain. Even though laser therapy alleviates neuropathic pain (31), diabetic patients reported more intense pain following treatment compared to non-diabetic patients. Our findings indicated that laser therapy had fewer therapeutic effects for diabetic patients. Therefore, it is necessary to recommend additional medications and other approaches to achieve a better quality of life.

We acknowledge some limitations of our study, including non-homogeneous demographic features and the inability to control the patients' daily activities. More randomized clinical trials with larger sample sizes are needed for more confident outcomes.

5.1. Conclusions

For chronic pain after lumbar surgery, conservative treatment like low-power laser therapy can be advantageous and safe, but individuals with underlying diseases may experience less benefit.

Footnotes

Authors' Contribution: All authors contributed to the conception or design of the work and approved the final version of the manuscript.

Conflict of Interests Statement: Neither of the authors has any competing interests affecting this work.

Data Availability: The dataset presented in the study is available on request from the corresponding author during submission or after publication.

Ethical Approval: The present study was approved by the Brain and Spinal Cord Injury Research Center and Neuroscience Institute of Tehran University of Medical Sciences (IR.TUMS.NI.REC.1399.016).

Funding/Support: This research has no funding.

Informed Consent: Written informed consent was obtained from the participants.

References

1. Rigoard P, Blond S, David R, Mertens P. Pathophysiological characterisation of back pain generators in failed back surgery syndrome (part B). *Neurochirurgie*. 2015;**61 Suppl 1**:S35-44. [PubMed ID: 25456443]. https://doi.org/10.1016/j.neuchi.2014.10.104.
2. Zerriouh M, De Clifford-Faugere G, Nguena Nguefack HL, Page MG, Guenette L, Blais L, et al. Pain relief and associated factors: A cross-sectional observational web-based study in a Quebec cohort of persons living with chronic pain. *Front Pain Res (Lausanne)*. 2024;**5**:1306479. [PubMed ID: 38560482]. [PubMed Central ID: PMC10978597]. https://doi.org/10.3389/fpain.2024.1306479.
3. Pieretti S, Di Giannuario A, Di Giovannandrea R, Marzoli F, Piccaro G, Minosi P, et al. Gender differences in pain and its relief. *Ann Ist Super Sanita*. 2016;**52**(2):184-9. [PubMed ID: 27364392]. https://doi.org/10.4415/ANN_16_02_09.
4. Obrosova IG. Diabetes and the peripheral nerve. *Biochim Biophys Acta*. 2009;**1792**(10):931-40. [PubMed ID: 19061951]. https://doi.org/10.1016/j.bbadis.2008.11.005.
5. Canos A, Cort L, Fernandez Y, Rovira V, Pallares J, Barbera M, et al. Preventive analgesia with pregabalin in neuropathic pain from "failed back surgery syndrome": Assessment of sleep quality and disability. *Pain Med*. 2016;**17**(2):344-52. [PubMed ID: 26398133]. https://doi.org/10.1111/pme.12895.
6. Khosravi MB, Azemati S, Sahmeddini MA. Gabapentin versus naproxen in the management of failed back surgery syndrome; a randomized controlled trial. *Acta Anaesthesiol Belg*. 2014;**65**(1):31-7. [PubMed ID: 24988825].
7. Desai MJ, Nava A, Rigoard P, Shah B, Taylor RS. Optimal medical, rehabilitation and behavioral management in the setting of failed back surgery syndrome. *Neurochirurgie*. 2015;**61 Suppl 1**:S66-76. [PubMed ID: 25456441]. https://doi.org/10.1016/j.neuchi.2014.09.002.
8. Vallone F, Benedicenti S, Sorrenti E, Schiavetti I, Angiero F. Effect of diode laser in the treatment of patients with nonspecific chronic low back pain: A randomized controlled trial. *Photomed Laser Surg*. 2014;**32**(9):490-4. [PubMed ID: 25141218]. https://doi.org/10.1089/pho.2014.3715.
9. Glazov G, Yelland M, Emery J. Low-level laser therapy for chronic non-specific low back pain: A meta-analysis of randomised controlled trials. *Acupunct Med*. 2016;**34**(5):328-41. [PubMed ID: 27207675]. [PubMed Central ID: PMC5099186]. https://doi.org/10.1136/acupmed-2015-011036.
10. Masoumipoor M, Jameie SB, Janzadeh A, Nasirinezhad F, Soleimani M, Kerdary M. Effects of 660- and 980-nm low-level laser therapy on neuropathic pain relief following chronic constriction injury in rat sciatic nerve. *Lasers Med Sci*. 2014;**29**(5):1593-8. [PubMed ID: 24634001]. https://doi.org/10.1007/s10103-014-1552-1.
11. Rosso MPO, Buchaim DV, Kawano N, Furlanette G, Pomini KT, Buchaim RL. Photobiomodulation therapy (PBMT) in peripheral nerve regeneration: A systematic review. *Bioengineering (Basel)*. 2018;**5**(2). [PubMed ID: 29890728]. [PubMed Central ID: PMC6027218]. https://doi.org/10.3390/bioengineering5020044.
12. Andreo L, Ribeiro BG, Alves AN, Martinelli ASA, Soldera CB, Horliana A, et al. Effects of photobiomodulation with low-level laser therapy on muscle repair following a peripheral nerve injury in wistar rats. *Photochem Photobiol*. 2020;**96**(5):1124-32. [PubMed ID: 32125691]. https://doi.org/10.1111/php.13255.
13. Masoumipour M, Barough MS, Jameie SB, Majdabadi A, Hosseinitabatabaei N, Babakhani B. Therapeutic effects of low-level laser therapy on pain and disability of patients with failed back surgery syndrome. *Indian J Orthop*. 2024;**58**(4):417-23. [PubMed ID: 38544539]. [PubMed Central ID: PMC10963664]. https://doi.org/10.1007/s43465-024-01099-2.
14. Lazaridou A, Elbaridi N, Edwards RR, Berde CB. Pain assessment. *Essentials Pain Med*. 4th ed. Elsevier; 2018. p. 39-46. e1. https://doi.org/10.1016/B978-0-323-40196-8.00005-X.
15. Fairbank JC, Pynsent PB. The Oswestry Disability Index. *Spine (Phila Pa 1976)*. 2000;**25**(22):2940-52. discussion 2952. [PubMed ID: 11074683]. https://doi.org/10.1097/00007632-200011150-00017.
16. Daniell JR, Osti OL. Failed back surgery syndrome: A review article. *Asian Spine J*. 2018;**12**(2):372-9. [PubMed ID: 29713421]. [PubMed Central ID: PMC5913031]. https://doi.org/10.4184/asj.2018.12.2.372.
17. Yoshihara H. Sacroiliac joint pain after lumbar/lumbosacral fusion: Current knowledge. *Eur Spine J*. 2012;**21**(9):1788-96. [PubMed ID: 22581257]. [PubMed Central ID: PMC3459112]. https://doi.org/10.1007/s00586-012-2350-8.
18. Unoki E, Abe E, Murai H, Kobayashi T, Abe T. Fusion of multiple segments can increase the incidence of sacroiliac joint pain after lumbar or lumbosacral fusion. *Spine (Phila Pa 1976)*. 2016;**41**(12):999-1005. [PubMed ID: 26689576]. https://doi.org/10.1097/BRS.0000000000001409.
19. Kuniya H, Aota Y, Kawai T, Kaneko K, Konno T, Saito T. Prospective study of superior cluneal nerve disorder as a potential cause of low back pain and leg symptoms. *J Orthop Surg Res*. 2014;**9**:139. [PubMed ID: 25551470]. [PubMed Central ID: PMC4299373]. https://doi.org/10.1186/s13018-014-0139-7.

20. Iwamoto N, Isu T, Kim K, Chiba Y, Morimoto D, Matsumoto J, et al. Treatment of low back pain elicited by superior cluneal nerve entrapment neuropathy after lumbar fusion surgery. *Spine Surg Relat Res*. 2017;**1**(3):152-7. [PubMed ID: 31440627]. [PubMed Central ID: PMC6698489]. https://doi.org/10.22603/ssrr.1.2016-0027.

21. Lassiter W, Bhutta BS, Allam AE. Inflammatory Back Pain. *StatPearls*. Treasure Island (FL); 2024. eng.

22. Ash C, Dubec M, Donne K, Bashford T. Effect of wavelength and beam width on penetration in light-tissue interaction using computational methods. *Lasers Med Sci*. 2017;**32**(8):1909-18. [PubMed ID: 28900751]. [PubMed Central ID: PMC5653719]. https://doi.org/10.1007/s10103-017-2317-4.

23. Huang YY, Sharma SK, Carroll J, Hamblin MR. Biphasic dose response in low level light therapy - an update. *Dose Response*. 2011;**9**(4):602-18. [PubMed ID: 22461763]. [PubMed Central ID: PMC3315174]. https://doi.org/10.2203/dose-response.11-009.Hamblin.

24. Hsieh YL, Hong CZ, Chou LW, Yang SA, Yang CC. Fluence-dependent effects of low-level laser therapy in myofascial trigger spots on modulation of biochemicals associated with pain in a rabbit model. *Lasers Med Sci*. 2015;**30**(1):209-16. [PubMed ID: 25190639]. https://doi.org/10.1007/s10103-014-1654-9.

25. Chang SY, Lee MY, Chung PS, Kim S, Choi B, Suh MW, et al. Enhanced mitochondrial membrane potential and ATP synthesis by photobiomodulation increases viability of the auditory cell line after gentamicin-induced intrinsic apoptosis. *Sci Rep*. 2019;**9**(1):19248. [PubMed ID: 31848399]. [PubMed Central ID: PMC6917700]. https://doi.org/10.1038/s41598-019-55711-9.

26. Janzadeh A, Nasirinezhad F, Masoumipoor M, Jameie SB, Hayat P. Photobiomodulation therapy reduces apoptotic factors and increases glutathione levels in a neuropathic pain model. *Lasers Med Sci*. 2016;**31**(9):1863-9. [PubMed ID: 27640000]. https://doi.org/10.1007/s10103-016-2062-0.

27. Huang YY, Nagata K, Tedford CE, McCarthy T, Hamblin MR. Low-level laser therapy (LLLT) reduces oxidative stress in primary cortical neurons in vitro. *J Biophotonics*. 2013;**6**(10):829-38. [PubMed ID: 23281261]. [PubMed Central ID: PMC3651776]. https://doi.org/10.1002/jbio.201200157.

28. Pires D, Xavier M, Araujo T, Silva JJ, Aimbire F, Albertini R. Low-level laser therapy (LLLT; 780 nm) acts differently on mRNA expression of anti- and pro-inflammatory mediators in an experimental model of collagenase-induced tendinitis in rat. *Lasers Med Sci*. 2011;**26**(1):85-94. [PubMed ID: 20737183]. https://doi.org/10.1007/s10103-010-0811-z.

29. Wu JY, Chen CH, Wang CZ, Ho ML, Yeh ML, Wang YH. Low-power laser irradiation suppresses inflammatory response of human adipose-derived stem cells by modulating intracellular cyclic AMP level and NF-kappaB activity. *PLoS One*. 2013;**8**(1). e54067. [PubMed ID: 23342077]. [PubMed Central ID: PMC3546978]. https://doi.org/10.1371/journal.pone.0054067.

30. Akkurt E, Kucuksen S, Yilmaz H, Parlak S, Salli A, Karaca G. Long term effects of high intensity laser therapy in lateral epicondylitis patients. *Lasers Med Sci*. 2016;**31**(2):249-53. [PubMed ID: 26714978]. https://doi.org/10.1007/s10103-015-1841-3.

31. Mansouri V, Arjmand B, Rezaei Tavirani M, Razzaghi M, Rostami-Nejad M, Hamdieh M. Evaluation of efficacy of low-level laser therapy. *J Lasers Med Sci*. 2020;**11**(4):369-80. [PubMed ID: 33425286]. [PubMed Central ID: PMC7736953]. https://doi.org/10.34172/jlms.2020.60.