The Role of CT-Scan Guided Transforaminal Epidural Steroid Injection in Lumbar Radiculopathy

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Abstract: Background: Lumbar radiculopathy is a common clinical condition. An epidemiological review noted lifetime prevalence estimates ranging from 12.2% to 43% and annual prevalence ranging from 2.2% to 34%. Although the natural history is generally favorable, patients with radicular pain tend to have poorer outcomes, consume more health care resources, and have greater disability than patients with purely axial back pain. **Objectives:** The objective of this study was to assess the immediate and short-term effects of transforaminal epidural steroid injections in patients with lumbosacral radiculopathy. **Patients and Methods:** This study was conducted on 30 patients with lumbosacral radiculopathy. All patients were subjected to transforaminal epidural steroid injection and were followed up for 3 months. They were assessed clinically and functionally pre-injection and twice post-injection (1 and half month and 3-month post-injection). **Results:** A statistically significant difference regarding femoral nerve stretch test **(p-value <0.05)** and highly statistically significant difference regarding central LBP, SIJ pain, tingling & numbness; SLR; and CSLR between 1st visit post-injection and pre-injection visit **(p-value <0.01),** while there was no statistically significant difference regarding SIJ. Statistically significant difference regarding sacroiliac pain (p-value <0.05) and highly statistically significant difference regarding central LBP, tingling & numbness; SLR; and CSLR between 2nd visit post-injection and pre-injection visit (p-value <0.01), while there was no statistically significant difference as regards femoral nerve stretch test and SIJ test. **Conclusion:** Steroid injection treatment resulted in significant improvement of pain intensity and reduction in functional impairment after one month of treatment and after a three month follow up from baseline. Steroid injection had the highest functional improvement that was significantly associated with pain control, especially in patients with shorter disease duration.

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1. Introduction

Lumbar radiculopathy is a common clinical condition. An epidemiological review noted lifetime prevalence estimates ranging from 12.2% to 43% and annual prevalence ranging from 2.2% to 34% ***(Konstantinou and Dunn, 2008)***. Although the natural history is generally favorable, patients with radicular pain tend to have poorer outcomes, consume more health care resources, and have greater disability than patients with purely axial back pain ***(Kaufmann et al., 2013)***. The pathophysiology of radicular pain likely involves both mechanical nerve compression and an inflammatory response, mediated by inflammatory cytokines ***(Mulleman et al., 2006)***.

Epidural injection of medications for management of low back pain and lower extremity pain was introduced in 1901 by ***Cathelin (2000), Pasqier and Leri (2000)*** and ***Sicard (2000).*** The earliest technique for epidural steroids injection was the caudal approach, but it didn't gain international universal application until 1925, when ***Viner (2000)*** popularized its use for treating sciatica where he used procaine, Ringer's solution and saline ***(Ogoke, 2000)***.

The objective of an epidural steroid injection is to deliver corticosteroids close to the site of pathology, presumably into an inflammed nerve root resulting in a much higher local concentration of steroids in the target site ***(Dooley et al., 1988; Stanley et al., 1990)***. The epidurally administered steroids reduce inflammation by inhibiting the synthesis and/or release of a number of pro-inflammatory mediators and also causing reversible local anesthetic effect ***(Pasqualucci et al., 2007)***.

Numerous reports of effectiveness of epidural steroid injections have varied in their response rates from 18% to 90%. Surprisingly, most controlled studies involving epidural steroid injections were performed without fluoroscopic guidance, whereas few uncontrolled open-ended clinical trials used it to ensure delivering the injectate into at least the epidural

space if not to the target site. The major cause of disparity proposed is technical error which includes sub-optimal placement or non-placement of the needle in the correct position near the target nerve route leading to the failure of delivery of steroids to the target site ***(Manchikanti et al., 2010; Roberts et al., 2009)***.

Epidural drug injections in the lumbar spine can be delivered by many approaches including: interlaminar, caudal & transforaminal approaches. The interlaminar approach was considered at first to be the preferable route as it is directed more closely to the assumed site of pathology than the caudal approach thus facilitating the delivery of the injectate to its target site using smaller volumes of medications ***(Manchikanti et al., 2010; Roberts et al., 2009)***. However, it has some disadvantages such as extra-dural placement of the needle (which may go unrecognized without CT-Scan guidance) and the discriminatory cranial flow of the solution in the epidural space. The use of this technique results in deposition of medication in the posterior epidural space. On the contrary, disc/nerve root pathology occurs in the anterior epidural space ***(Rados et al., 2011)***. In addition, various studies reported the failure of the interlaminar approach to produce statistically significant clinical improvements ***(Fredman et al., 1999; Manchikanti et al., 2010)***.

Transforaminal epidural steroid injections (TFESI) have emerged as an alternative to both interlaminar and caudal injections. Some reports mentioned the use of this approach for epidural drug injections, such as ***Robecchi and Capra (2001)*** in 1952 in the Italian literature, when they performed a peri-radicular injection of hydrocortisone on the first sacral route and reported relief of lumbar and sciatic pain in a female patient, then ***(Lievre et al., 1953)*** and colleagues in the French literature in 1953 reported transforaminal injection of steroids on the level of the first sacral route ***(Nelson and Landau, 2001).*** Since then, transforaminal epidural injection has been widely used as it is considered as an effective mean for the management of many cases of low back pain and lower extremity pain ***(Manchikanti et al., 1999)***.

The major advantage of transforaminal approach for therapeutic injections is that it ensures that the injected medications incorporates all the sites where the pathology can affect the nerve, which extends from the disc level in the subarticular zone to the extraforaminal zone, including the ventral epidural space ***(Manchikanti et al., 2010)***. Despite this major advantage, considerable controversy continues to surround the relative efficacy of the different types of epidural steroid injection, its indications, selection criteria, and its cost-effectiveness ***(Wilkinson and Cohen, 2013)***.

Aim of the Work

The objective of this study was to assess the immediate and short-term effects of transforaminal epidural steroid injections in patients with lumbosacral radiculopathy.

2. Patients and Methods

Patients

This study was conducted on thirty patients with symptoms and signs of lumbosacral radiculopathy according to North American Spine Society.

They were recruited from Physical medicine, Rheumatology and Rehabilitation clinics of El Agouza Military Rehabilitation Center.

Thirty age and gender - matched healthy individuals were included as a control group.

Inclusion criteria:

Patient's ≥17 years old with clinical symptoms and signs suggestive of radiculopathy were diagnosed as follows according to North American Spine Society:

- **Clinical criteria (symptoms & signs):**

The clinical diagnosis of lumbosacral radiculopathy was made if the patient complained of central (localized) low back pain and/or pain at the sacroiliac joints radiating to one or both lower limbs associated with tingling and numbness in one or both lower limbs in addition to one or more of the following signs:

- Uni or bilateral sciatica.
- Uni or bilateral femoralgia.
- Uni or bilateral mild lower limb muscle weakness.
- Drop foot (uni or bilateral).

The patient was considered having acute radiculopathy if he/she was complaining of the above mentioned symptoms & signs for a period of 1 week to 2 months, and was considered having chronic radiculopathy if he/she was complaining of the above mentioned symptoms & signs for period of 2 months to 1 year or more.

Exclusion criteria:

1. Patients younger than 17 years old and older than 65 years.
2. Patients with back pain associated with infection, inflammation and tumors.
3. Patients for whom transformational injection is contraindicated e.g. (infection at site of injection or bleeding diathesis especially with warfarin or oral anticoagulants, uncontrolled diabetes mellitus and pregnancy).

Methods

This was a prospective randomized controlled study approved by Ain Shams medical ethical

committee. Patients who met the eligibility criteria and agreed to participate in the study received a general explanation of the study and signed a concent.

All patients were subjected to the following:

1. Full medical history taking with emphasis on:

1. Age, gender and occupation.
2. Onset, course and duration of symptoms.
3. Central (localized) low back pain.
4. Pain at the sacroiliac joints radiating to one or both lower limbs.
5. Tingling and numbness in one or both lower limbs.
6. Weakness in one or both lower limbs

2. Full physical and neurological examination with emphasis on:

Examination of the lumbosacral spines and lower extremity.

i. **Inspection:**

- (Front): symmetry of shoulders
- (Side): lumbar lordosis
- (Behind): scars – muscle wasting - scoliosis

ii. **Palpation of:**

- Spinal processes for tenderness & alignment
- Paraspinal muscles for tenderness & spasm

iii. **Sensory examination**

- Superficial sensation:

Pinprick test: Whether the patient has normal pinprick-induced sensation.

- Deep sensation: Proprioceptive sensation including sense of position, sense of movement and vibration.

iv. **Motor examination**

- Muscle state
- Muscle tone (hypertonia – hypotonia – normotonia
- Grading of muscle power of lower limb muscles using:
- From 0 to 5 with 0 means no power & 5 means full power.

The five provocative tests that were performed included:

- Distraction
- Thigh Thrust.
- FABER (flexion, abduction, and external rotation).
- Compression
- Gaenslen's

3. Laboratory investigations including:

- Erythrocyte sedimentation rate (ESR) and Quantitative C reactive protein (CRP).
- Complete blood count (CBC)
- Fasting blood sugar
- Kidney function tests: Blood urea nitrogen (BUN), Serum uric acid and creatinine.
- Liver function tests: serum aspartate amino transferase (AST), serum alanine amino transferase (ALT) and bilirubin.
- Coagulation profile (to check for any bleeding tendency

4. Electrophysiological studies:

- The following electro diagnostic studies were performed using Cadwell (Sierra Wave):

1. Motor nerve conduction studies of tibial and peroneal nerves
2. Sensory nerve conduction study of the sural nerve
3. F-wave study and H-reflex of the tibial nerve

Reassessment of the patients:

Patients were assessed clinically and via the VAS for back pain and leg pain and the Oswestry disability index for functional outcome in 2 visits post injection.

The first visit was scheduled at the 6th week post-injection to assess the immediate effect of the injected epidural steroid, and the second visit was scheduled at 12^{th} week post-injection to assess the short-term effect. Then statistics was done.

Statistical Analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23. So, the p-value was considered significant as the following: P-value > 0.05: Non significant (NS), P-value < 0.05: Significant (S), P-value < 0.01: Highly significant (HS).

3. Results

The laboratory investigations were normal in all patients except the ESR which was mildly high in 3 patients.

Table (1): Shows clinical and functional data at pre injection, 1st visit (45 days) and 2nd (90 days)

Data		**Pre injection no=30**	**1st visit (45 days) no=30**	**2nd visit (90 days) no=30**
Central LBP	Positive	29 (96.7%)	10 (33.3%)	13 (43.3%)
	Negative	1 (3.3%)	20 (66.7%)	17 (56.7%)
Pain of SIJ	Positive	17 (56.7%)	6 (20.0%)	8 (26.7%)
	Negative	13 (43.3%)	24 (80.0%)	22 (73.3%)
SLR	Positive	29 (96.7%)	15 (50.0%)	17 (56.7%)
	Negative	1 (3.3%)	15 (50.0%)	13 (43.3%)
CSLR	Positive	23 (76.7%)	12 (40.0%)	12 (40.0%)
	Negative	7 (23.3%)	18 (60.0%)	18 (60.0%)
FNS	Positive	4 (13.3%)	2 (6.7%)	2 (6.7%)
	Negative	26 (86.7%)	28 (93.3%)	28 (93.3%)
SIJ	Positive	13 (43.3%)	6 (20.0%)	8 (26.7%)
	Negative	17 (56.7%)	24 (80.0%)	22 (73.3%)
VAS	Range	6 – 9	0 – 4	0 – 6
	Median (IQR)	8 (7 - 8)	1 (0 - 2)	1 (0 - 2)
ODI	Range	28 – 94	0 – 40	0 – 46
	Median (IQR)	66 (58 - 70)	8.5 (2 - 18)	12 (4 - 26)

Table (2): Comparison between pre-injection visit and 1st visit post-injection as regards the clinical and functional data

		Before Injection	**1st Visit**	**Test Value**	**P-Value**	**Sig.**
		No. (%)	**No. (%)**			
Central LBP	Positive Negative	29 (96.7%) 1 (3.3%)	10 (33.3%) 20 (66.7%)	26.447	<0.01	HS
Pain of SIJ	Positive Negative	17 (56.7%) 13 (43.3%)	6 (20.0%) 24 (80.0%)	8.531*	<0.01	HS
SLR	Positive Negative	29 (96.7%) 1 (3.3%)	15 (50.0%) 15 (50.0%)	16.705	<0.01	HS
CSLR	Positive Negative	23 (76.7%) 7 (23.3%)	12 (40.0%) 18 (60.0%)	8.297*	<0.01	HS
FNS	Positive Negative	4 (13.3%) 26 (86.7%)	2 (6.7%) 28 (93.3%)	0.741	0.389	NS
SIJ	Positive Negative	13 (43.3%) 17 (56.7%)	6 (20.0%) 24 (80.0%)	3.774*	>0.05	NS
VAS score	Range Median (IQR)	6 – 9 8 (7 - 8)	0 – 4 1 (0 - 2)	-4.936ǂ	<0.01	HS
ODI Score (%)	Range Median (IQR)	28 – 94 66 (58 - 70)	0 – 40 8.5 (2 - 18)	-4.785ǂ	<0.01	HS

P-value >0.05: Non significant (NS);
P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*: Chi-square test; ‡: Wilcoxon Rank test

The Previous table shows **that there was** highly statistical significant difference between **(Before Injection** & **1st visit)** regarding (Central LBP, Pain of SIJ, Tingling & Numbness; SLR; CSLR; VAS Score; and ODI Score (%)) with **(p-value <0.01) and** there was statistically significant difference found regarding FNS with **(p-value <0.05),** while there was no statistically significant difference found regarding SIJ. with **(P-value >0.05).**

Table (3): Comparison between (1st visit and 2nd visit) regarding symptoms, clinical examination, VAS scoring and ODI questionnaire

		1st visit (45 days) No. = 30	2nd visit (90 days) No. = 30	Test Value	P Value	Sig
Central LBP	Positive Negative	10 (33.3%) 20 (66.7%)	13 (43.3%) 17 (56.7%)	0.635	>0.05	NS
Pain of SIJ	Positive Negative	6 (20.0%) 24 (80.0%)	8 (26.7%) 22 (73.3%)	0.373*	>0.05	NS
SLR	Positive Negative	15 (50.0%) 15 (50.0%)	17 (56.7%) 13 (43.3%)	0.268	>0.05	NS
CSLR	Positive Negative	12 (40.0%) 18 (60.0%)	12 (40.0%) 18 (60.0%)	0.000*	>0.05	NS
FNS	Positive Negative	2 (6.7%) 28 (93.3%)	2 (6.7%) 28 (93.3%)	0.000	>0.05	NS
SIJ	Positive Negative	6 (20.0%) 24 (80.0%)	8 (26.7%) 22 (73.3%)	0.373*	>0.05	NS
VAS Score	Range Median (IQR)	0 – 4 1 (0 - 2)	0 – 6 1 (0 - 2)	-2.401‡	<0.05	S
ODI Score	Range Median (IQR)	0 – 40 8.5 (2 - 18)	0 – 46 12 (4 - 26)	-2.392‡	<0.05	S

P-value >0.05: Non significant (NS);
P-value <0.05: Significant (S);
P-value< 0.01: highly significant (HS)
*: Chi-square test; ‡: Wilcoxon Rank test

Table (4): Comparison between pre-injection visit and 2nd visit post-injection as regards the clinical and functional data

		Before Injection No.=30	2nd visit (90 days) No.=30	Test value	P-value	Sig.
Central LBP	Positive Negative	29 (96.7%) 1 (3.3%)	13 (43.3%) 17 (56.7%)	20.317	<0.01	HS
Pain of SIJ	Positive Negative	17 (56.7%) 13 (43.3%)	8 (26.7%) 22 (73.3%)	5.554*	<0.05	S
SLR	Positive Negative	29 (96.7%) 1 (3.3%)	17 (56.7%) 13 (43.3%)	13.416	<0.01	HS
CSLR	Positive Negative	23 (76.7%) 7 (23.3%)	12 (40.0%) 18 (60.0%)	8.297*	<0.01	HS
FNS	Positive Negative	4 (13.3%) 26 (86.7%)	2 (6.7%) 28 (93.3%)	0.741	>0.05	NS
SIJ	Positive Negative	13 (43.3%) 17 (56.7%)	8 (26.7%) 22 (73.3%)	1.832*	>0.05	NS
VAS Score	Range Median (IQR)	6 – 9 8 (7 - 8)	0 – 6 1 (0 - 2)	-4.873‡	<0.01	HS
ODI Score	Range Median (IQR)	28 – 94 66 (58 - 70)	0 – 46 12 (4 - 26)	-4.785‡	<0.01	HS

P-value >0.05: Non significant (NS);
P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*: Chi-square test; ‡: Wilcoxon Rank test

The Previous table shows that there was highly statistical significant difference between **(Before Injection & 2nd visit)** regarding (Central LBP, Tingling & Numbness; SLR; CSLR; VAS].

Table (5): Comparison between pre-injection visit, 1st visit and 2nd visit post-injection as regards the clinical and functional data

		Before Injection	1st visit (45 days)	2nd visit (90 days)	Test Value	P-Value	Sig
		No. = 30	No. = 30	No. = 30			
Central LBP	Positive Negative	29 (96.7%) 1 (3.3%)	10 (33.3%) 20 (66.7%)	13 (43.3%) 17 (56.7%)	28.512	<0.01	HS
Pain of SIJ	Positive Negative	17 (56.7%) 13 (43.3%)	6 (20.0%) 24 (80.0%)	8 (26.7%) 22 (73.3%)	0.373*	<0.01	HS
SLR	Positive Negative	29 (96.7%) 1 (3.3%)	15 (50.0%) 15 (50.0%)	17 (56.7%) 13 (43.3%)	17.501	<0.01	HS
CSLR	Positive Negative	23 (76.7%) 7 (23.3%)	12 (40.0%) 18 (60.0%)	12 (40.0%) 18 (60.0%)	0.000*	<0.01	HS
FNS	Positive Negative	4 (13.3%) 26 (86.7%)	2 (6.7%) 28 (93.3%)	2 (6.7%) 28 (93.3%)	1.098	>0.05	NS
SIJ	Positive Negative	13 (43.3%) 17 (56.7%)	6 (20.0%) 24 (80.0%)	8 (26.7%) 22 (73.3%)	0.373*	>0.05	NS
VAS Score	Range Median (IQR)	6 – 9 8 (7 - 8)	0 – 4 1 (0 - 2)	0 – 6 1 (0 - 2)	-2.401‡	<0.01	HS
ODI Score	Range Median (IQR)	28 – 94 66 (58 - 70)	0 – 40 8.5 (2 - 18)	0 – 46 12 (4 - 26)	-2.392‡	<0.01	HS

P-value >0.05: Non significant (NS);
P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)
*: Chi-square test; ‡: Friedman test

The Previous table shows that there was highly statistical significant difference between **(Before injection, 1st visit & 2nd visit)** regarding (Central LBP, pain of SIJ, Tingling & Numbness; SLR; CSLR; Vas Score; and ODI Score (%)) with **(p-value <0.01)** while there was no statistically significant difference found regarding FNS and SIJ. With **(P-value >0.05).**

Table (6): Correlation between disease duration and (VAS Score, ODI Score (%)) Before Injection, 1st visit (45 days) and 2nd visit (90 days)

Data	Disease duration								
	ASS. Before Injection			1st visit (45 days)			2nd visit (90 days)		
	r	P-value	Sig.	r	P-value	Sig.	r	P-value	Sig.
VAS	0.398*	0.030	S	0.608**	0.000	HS	0.368*	0.045	S
ODI	0.465**	0.010	S	0.648**	0.000	HS	0.432*	0.017	S

Table (7): Correlation between VAS score and ODI score before injection, 45 days post-injection and 90 days post-injection:

	VAS Score								
	ASS. Before Injection			1st visit (45 days)			2nd visit (90 days)		
	r	P-value	Sig.	r	P-value	Sig.	r	P-value	Sig.
ODI Score (%)	0.613**	0.000	HS	0.594**	0.001	HS	0.456*	0.011	S

4. Discussion

This study was conducted on 30 patients with lumbosacral radiculopathy. The objective of our study was to assess the immediate and short-term effects of transforaminal epidural steroid injections in patients with lumbosacral radiculopathy.

All patients were subjected to CT-guided transforaminal epidural steroid injection and were followed up for 3 months. They were assessed clinically and functionally pre-injection and twice post-injection (45 days and 90 days post-injection).

Regarding demographic data, the study included 15 men (50 %) and 15 women (50%). Their mean age was 41 ± 13.23 years, their mean BMI was 24.80 ± 2.49, and the average disease duration was 6.07 months (ranging from 1 - 18 months). These findings denote that lumbosacral radiculopathy affect women and men equally and occurred in our patients in the middle age which is a highly productive age. Other

authors found similar results, including ***Ekedahl et al. (2018).***

The results of clinical assessment showed that the disease onset was gradual and progressive in all patients with disease duration ranging from 0.43 to 60, and a median (IQR) of 6.07 (1-18) months which denotes that most of our patients had chronic lumbosacral radiculopathy. Twenty-nine patients (96.6%) complained of central low back pain and 1 patient complained of pain over the sacroiliac joint. Twenty-nine patients (96.6%) had positive SLR, 23 (76%) had positive contralateral SLR, and 4 patients had (13%) positive femoral nerve stretch. Similarly, other studies like ***Bono (2018)*** reported that, disc herniations may be associated with a positive femoral stretch test.

The visual analogue scale ranged from 6 to 9 with a Median (IQR) of 8 (7-8) denoting that the low back pain in our patients was moderate. The ODI score ranged from 28 % to 94 % with a Median (IQR) of 66 (58-70). This means that all patients had degree of functional limitation ranging from minimum to severe disability. 53.3% of our patients had score from 61%-80 % which (crippled) which means that back pain impinges on all aspects of patient's life. Of note, the VAS of these crippled patients ranged from 7 to 9 which may implicate that, this degree of functional disability may be related to the severity of pain.

The electrodiagnostic studies were normal in all our patients expect 8 patients in whom there was significant side-to-side difference in H-wave latency. These results reflect the fact that EDX is commonly normal in patients with lumbosacral radiculopathy despite symptoms and positive stretch tests and this is mostly due to masking of abnormally conducting root by other normally conducting roots.

MRI showed that 60% of our patients had L4-5 radiculopathy, denoting that the most common roots affected are L4-5. This agrees with Beyaz, 2017 who reported (58.1%) of patients had L4-% radiculopathy.

Regarding central LBP and SIJ pain, comparison between pre-injection visit and 1st visit post-injection revealed, statistically significant decrease in central low back pain, sacroiliac pain, in the 1st visit post-injection compared to pre-injection visit ($p<0.05$). Our results agreed with the results obtained by Kotb and colleagues in 2018 who investigated CT-guided transforaminal epidural steroid injection, and reported a significant improvement of pain intensity and reduction in functional impairment after one month of treatment and after a three month follow up from baseline.

Our results and kotb's results denote that CT-guided transforaminal injection is effective in reducing pain and sensory symptoms and that pain improvement is achieved during the 1st month post-injection ***(Kotb et al., 2018).***

Comparison between pre-injection visit and 2nd visit post-injection revealed, a statistically significant reduction in sacroiliac pain, central low back pain, in the 2nd visit compared to pre-injection visit ($p<0.05$).

These findings partially agreed with the findings in ***a study by Haseeb et al. in 2019***, who studied the clinical effectiveness of oxygen-ozone therapy combined with steroid versus steroid injection alone at different follow-up period. They found satisfactory better clinical outcomes "regarding pain scores, SIJ pain, tingling and numbness" in both groups after two weeks, three months and at 6 months. Implying that, steroid injection is effective in reducing pain and improving symptoms whether used solely or with other modalities as oxygen therapy.

Comparison between the 1st & 2nd visits post-injection revealed, non-significant difference ($p>0.05$) regarding central LBP and SIJ pain, which came in agreement with Kotb and colleagues in 2018.

Regarding SLR, CSLR, FNS and SIJ tests, comparison between pre-injection visit and 1st visit post-injection also revealed, the results of femoral nerve stretch, straight leg raising and cross-straight leg raising test significantly reduced ($p<0.05$) in the 1stvisit, while there was no statistically significant difference ($p>0.05$) regarding SIJ test.

Comparison between pre-injection visit and 2nd visit post-injection revealed, a statistically significant reduction ($p<0.05$) in straight leg raising and crossed straight leg raising in the 2nd visit post-injection compared to pre-injection visit. These findings denote that the improvement in pain, sensory symptoms, and radiculopathy were evident in the 1st visit post-injection continued for at least 3 months post-injection. However, we found no statistically significant difference ($p>0.05$) regarding femoral nerve stretch and sacroiliac joint tests.

Our results related to femoral nerve stretch test which revealed non-significant change ($p>0.05$) in the test in the 2nd visited compared to pre-injection visit is supported by a study performed by Sultan and colleagues in 2019 who also found non-significant difference in femoral nerve stretch test results post-transforaminal epidural steroid injection. femoral nerve stretch test ***(Sultan et al., 2019),*** We think that our femoral nerve stretch test results, may denote that L2 - L3 radiculopathy is more resistant to treatment compared to L4 - L5 and S1 radiculopathy.

Comparison between the 1st & 2nd visits post-injection revealed, non-significant difference ($p>0.05$) regarding SLR, CSLR, FNS and SIJ tests, which came in agreement with ***(Kotb et al., 2018).***

Regarding VAS score, comparison between pre-injection visit and 1st visit post-injection also revealed, *a* highly statistically significant difference ($p<0.01$) found as regards VAS Score. VAS score significantly reduced 45 days post-injection compared to pre-injection denoting improvement in pain and as well as in functional abilities post-injection and that this improvement can happen during the 1st 6 weeks post-injection. Our results as regards VAS score agreed with the results obtained by (***Fish etal., 2008)*** who found significant improvement in VAS score post-steroid injection. These findings confirm that CT-guided injection not only results in pain reduction but also leads to functional improvement. Functional improvement is very important as it impacts patient's quality of life because if pain just decreases without parallel functional improvement, it can still interfere with the patient's lifestyle.

Our results as regards VAS score disagree with the results obtained by ***Miskin et al. (2018)***, who found no difference in immediate post-procedural pain scores ***(Miskin et al., 2018).*** This disagreement may be related to an important limitation in Miskin's study in which the authors did not record numeric pain scores in every case.

Comparison between pre-injection visit and 2nd visit post-injection revealed, a highly statistically significant difference ($p<0.01$) regarding VAS score in the 2nd visit post-injection compared to the pre-injection visit. VAS score significantly reduced 90 days post-injection compared to pre-injection score ($P<0.05$). These results came in agreement with ***Sultan et al. (2019)***, who investigated the functional outcome of transforaminal epidural steroid injection in lumbosacral radiculopathy, and found a statistically significant decrease in pain severity using VAS score post injection in patients with symptom duration less than 3 months compared with patients with longer duration of symptoms.

Comparison between the 1st & 2nd visits post-injection revealed, a statistically significant difference found between the two visits as regards VAS score with ($p<0.05$). These results came in agreement with ***Fish et al. (2008) and Miskin et al. 2018.***

Regarding ODI score, comparison between pre-injection visit and 1st visit post-injection also revealed, highly statistically significant difference ($p<0.01$) found as regards ODI Score (%). ODI score significantly reduced 45 days post-injection compared to pre-injection ($p<0.05$) denoting improvement in functional abilities post-injection and that this improvement can happen during the 1st 6 weeks post-injection.

Our results as regards ODI score agreed with the results obtained by ***Fish et al. in 2008*** who found significant improvement in ODI score post-steroid injection.

Fish et al. (2008) and Miskin et al. (2018) also implied that, CT-guided steroid injections, help reducing pain and disability in short-term period of 1.5 months among lumbar radiculopathy patients.

Comparison between pre-injection visit and 2nd visit post-injection revealed, a highly statistically significant reduction ($p<0.01$) regarding ODI score in the 2nd visit post-injection compared to the pre-injection visit. ODI score significantly reduced 90 days post-injection compared to pre-injection score ($P<0.01$). These results came in agreement with ***Sultan et al. (2019)***, who found a significant improvement in the ODI functional score post injection in patients with symptom duration less than 3 months compared with patients with longer duration of symptoms.

Our results related to ODI came also in agreement with Hammerich and co-workers in 2019. They studied the effectiveness of physical therapy combined with epidural steroid injection in patients with lumbar spinal stenosis, and found significant improvement in ODI score at 10 weeks and at 1 year post in patients group who received epidural steroid injection only as well as in patients group who received epidural injection combined with physiotherapy with no significant difference between the 2 patients groups which denote that epidural steroid injection alone leads to functional improvement through improving pain and decreasing inflammation and that functional improvement does not entirely depends on physical therapy alone although it is an important treatment option ***(Hammerich et al., 2019).***

Comparison between pre-injection visit and 2nd visit post-injection revealed, a statistically significant difference found between the two visits as regards VAS score and ODI score with ($p<0.05$) while there was no statistically significant difference ($p>0.05$) found between the two visits as regards central low back pain, pain of SIJ, tingling and numbness, SLR, CSLR, FNS and SIJ. These results came in agreement with ***Fish et al. (2008) and Miskin et al. (2018).***

In our study, we found significant positive correlation between disease duration and each of VAS score and ODI score pre-injection as well as post-injection which means that with chronicity of the disease, both pain and functional impairment increases. This finding highlights the importance of early treatment and intervention before the condition becomes chronic. Also, there was significant positive correlation between VAS and ODI pre-injection and post injection. This implies a strong relation between pain severity and functional impairment and that when pain decrease, the functional abilities of the patient

improves and it explains our previously mentioned results regarding improvement of VAS and ODI score post-injection. It was found that steroid injection inhibits cytokine production and, conversely, proinflammatory cytokines, such as (IL-1β) and (TNF-α), which modulate intracellular GC (glucocorticoid) metabolism. This may contribute to the nonlinear dose–response curve for stimulation and suppression of inflammation by steroid injection, and therefore subsequently lead to functional improvement ***(Frew, 2019).***

Our results of correlation studies agreed with Kotb and co-workers in 2018 who studied CT-guided transforaminal epidural steroid injection and vertebral axial decompression in the management of acute lumbar disc herniation, and reported a significant inverse correlation between disease duration with each of VAS and ODI percent of improvement ***(Kotb et al., 2018).*** On the other hand, ***Seo et al. (2019)*** studied the responsiveness of outcome measures after spine injection, and reported poor agreement between the Oswestry disability index and the other measures especially VAS score (Intraclass correlation coefficient was 0.160). This disagreement between our study and Seo' study may be due to difference in study population Seo included 164 patients with neck or low back pain who and received prior spine injections. Also, Seo' study was retrospective and lacked careful follow up for disability assessment.

Conclusion

Steroid injection treatment resulted in significant improvement of pain intensity and reduction in functional impairment, this improvement occurred during the 1st month post-injection and continued for at least 3 months post-injection. Steroid injection had the highest functional improvement that was significantly associated with pain control, especially in patients with shorter disease duration.

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