

Predictive Factors of Efficacy of Transforaminal Epidural Steroid Injection for Patients with Lumbar Discogenic Radiculopathy in Neurosurgery Department

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Abstract

Background Data: Transforaminal Epidural Steroid Injection is one of the nonsurgical treatment methods for sciatic pain. The clinical outcome and predictive factors that affect its results are still under debate.

Purpose: The purpose of this study is to evaluate the results of transforaminal epidural steroid injection and identify factors for predicting success.

Study Design: A descriptive analytic cross sectional prospective study involving 45 patients with lumbar radiculopathy.

Patients and Methods: Forty-Five patients with lumbar radiculopathy were prospectively followed up at 2 weeks and 6 months after Transforaminal Epidural Steroid Injection. The intensity of radicular pain was scored on the Visual Analog Scale (VAS). Outcome was classified as "respondent" when the pain diminished by 50% or more, "Non-respondent" for a diminution of less than 50%. Duration of symptoms, affected level, position of disc herniation, degree of nerve root compression, pain intensity, and body mass index were chosen as predictive factors to study.

Results: The mean VAS scores were 7.381.11± before, 2.93 (SD 2.01) 2 weeks after the procedure, and 4.182.75± at 6 months follow-up. Outcome was graded as respondent in 31 patients (68.9%), and non-respondent in 14 patients (31.1%). Level and position of disc herniation, body mass index, and pain intensity were not predictive factors of radicular pain relief, whereas the symptom duration before the procedure and degree of nerve root compression were highly correlated with the pain relief outcome. Minor complications occurred in 2 patients.

Conclusion: Transforaminal Epidural Steroid Injection is a simple, safe, and effective nonsurgical procedure. Patients with shorter duration of symptoms, and minimal degree of nerve root compressions shows better improvement. (2013ESJ036)

Key Words: Lumbar Disc Prolapse, Sciatica, Low Back Pain, Steroids, Transforaminal injection.

Introduction

Lumbar radicular pain, a common entity in clinical practice, is frequently caused by disc herniation or degenerative changes in vertebrae. Various experimental studies have shown that this pain may occur as a result of mechanical compression and/or chemical radiculitis.^{20,25} Most patients recover with conservative care; as many as 90% of patients improve naturally after one year.³² To reduce this natural recovery time, numerous authors^{1,16, 26} have proposed local delivery of corticosteroids and anesthetics to the affected nerve root. Various studies have demonstrated the therapeutic value of this strategy, but some authors achieved only a modest short-term reduction in leg pain.

Lutz et al,¹⁹ in a study of 69 patients, reported a 70% pain decrease at the first-week follow-up, whereas Ng et al,²³ in a series of 43 patients, obtained only 26% global pain reduction, and 41.5% of patients had at least 2-point reduction in leg pain as noted by the Visual Analog Scale (VAS) scores. These disparities could be explained by numerous factors, including the procedure technique, evaluation patterns, and overall non-homogeneity of patients selected in these studies.

The purpose of our study is to evaluate pain reduction and identify predictive factors for clinical success of Transforaminal Epidural Steroid Injection.

Patients and Methods

Over a 1-year period, we prospectively followed 45 consecutive patients with lumbar radiculopathy for a minimal follow-up period of 6 months. Patients were recruited from the outpatient clinic of Suez Canal University Hospital, and all parameters were defined in this prospective clinical case series before the study.

The inclusion criteria were as follows: (1) chief complaint primarily of leg pain that did not respond to at least 4-weeks of conservative treatment with a combination of oral anti-inflammatory drugs and/or narcotics for severe pain, associated with physical therapy; (2) history, physical examination, and pain pattern consistent with lumbar radiculopathy; and (3) MR imaging or CT scan results, interpreted by a senior specialist, documenting disc herniation with nerve root compression at the level and side of the clinical symptoms. The exclusion criteria included prior spinal surgery at the same level, progressive neurologic deficit, pregnancy, and no root compression demonstrated by CT scanning or MR.

We selected some predictive factors to study its relation with success of the transforaminal epidural steroid injection. These factors included: duration of symptoms, affected radiculopathy level, position of disc herniation (central, posterolateral, or foraminal), degree of nerve root compression (as described by Choi et al,⁵ Figure 1), pain intensity, and body mass index.

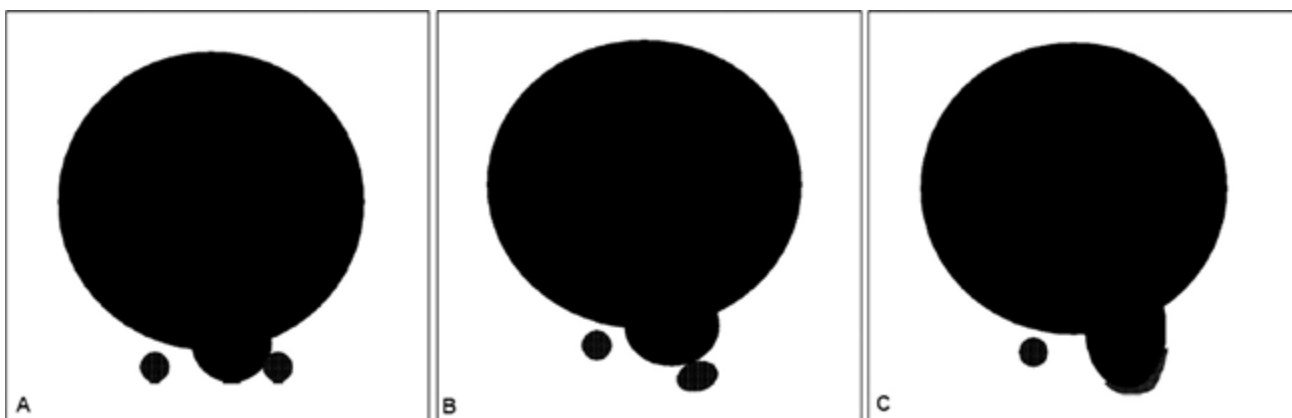


Figure (1). Degree of nerve root compression. (A) Grade I (abutment; the herniated disc abuts the nerve root, but the nerve is in its normal position. (B) Grade II (displacement); the herniated disc material displaces the nerve root, but the displaced root can be seen by MRI. (C) Grade III (entrapment); the nerve root is entrapped between the herniated disc and the lamina or facet. The entrapped nerve root is hardly detected by MRI.⁵

Procedure:

Injections were performed at the level that best matched the patient’s clinical and radiological presentation. The technique was standardized for all patients. Patient was placed in a prone position on a radiology table. Using a fluoroscope, a 22-gauge, 90-mm spinal needle was inserted under intermittent fluoroscopic guidance to the upper part of the foramina, at the suspected symptomatic radicular level. For L4 and L5 root injections, the needle was targeted to the corresponding transverse process. For the S1 root, the needle was inserted to the first sacral foramen. To confirm peri-radicular flow

within the nerve root sleeve, we administered 1 or 2 mL of contrast (Omnipaque 240, Amersham Health, Princeton, NJ) (Figure 2). Once adequate flow of contrast to the target area of the dorsal root ganglion was documented, 1 mL of corticosteroid (40 mg of Triamcnenolone Acetonide [Kenacort-A; Bristol-Mayer Squibb, Egypt] and 2ml 0.5% Bupivacaine hydrochloride (Marcaine; Astra USA) as a long-acting local anesthetic were slowly injected. After injection, patients were told to reduce their normal activity for the rest of the day. None of them received repeat injections.

Data Analysis:

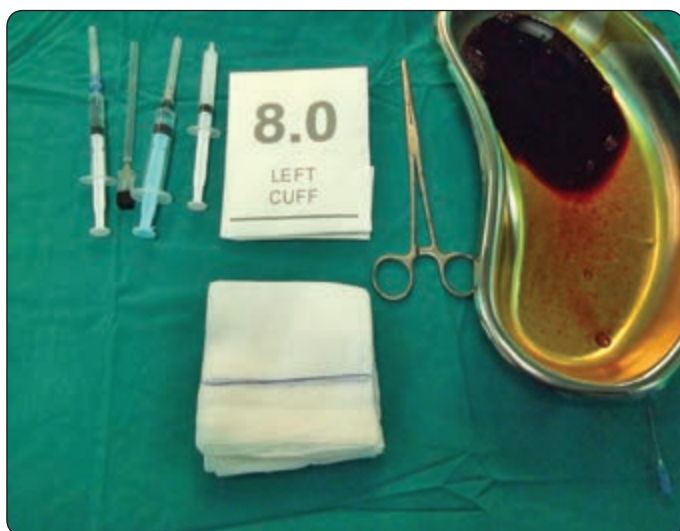


Figure (2). (Left): Preparation includes (from left to right) syringes with local anesthetic, spinal needle, contrast material, injected materials. (Right): Image after contrast injection, showing correct epidural spread of contrast around the nerve root.

During patients consultation at the outpatient clinic, the intensity of radicular pain was scored by every patient on the VAS, from 0 (no pain) to 10 (maximal intensity). Based on the pain score before the procedure, pain relief percentages 2 weeks and 6mo after infiltration were calculated and classified as “respondent ” when the pain was completely resolved or had diminished by 50% or more, “non-respondent ” for a diminution of less than 50% or an increase in pain.

Statistical Analysis:

To determine the relationship among the MR findings, duration of symptoms and the clinical outcome, the differences between the responder

and non-responder groups in terms of the injection level, the type of herniation, the location of the herniated disc, the grade of nerve root compression and the duration of symptoms were analyzed using Chi-Square or Fisher’s exact tests. Student’s *T* test was used for comparing the size of the herniated discs, patient age and gender, and the pre-injection symptom duration between the two groups. A logistic regression analysis was also used to determine the factors contributing to a successful clinical outcome. Statistical analysis and tests were specified according to the variable type. A commercially available PC-based software package (SPSS V16.0) was used.

Results

The study included 45 consecutive patients with lumbar radiculopathy. Mean age was 38.2 years, 30 (66.7%) were males, while 15 (33.3%) were females. The mean VAS scores were 7.381.114± before, 2.932.005± weeks after the procedure, and 4.182.75± at 6-months follow up evaluation, with significant pain relief (P 0.001). Two weeks after the

procedure, outcome was graded as respondent (VAS decrease >50%) in 31 patients (68.9%), and non-respondent (VAS decrease <50% or increase) in 14 patients (31.1%) (Table 1). Among the 31 patients with respondent group, the mean pain score dropped from 7.350.99± to 1.770.88±, with a mean decrease of 5.8. In these patients, pain was scored after 6 months of follow-up and pain relief was classified as still respondent for 88% of the patients.

Table (1). Demographic Data of the Studied Population.

	Total	Response: Patients' No. (%)	
		Respondent	Non-Respondent
No. of patients	45	31 (68.9%)	14 (31.1%)
Age (mean)	38.2 Years	36.7	41.7
Gender			
Male	30 (66.7%)	23	7
Female	15 (33.3%)	6	9
Mean VAS score			
Before procedure	7.38	7.35	7.43
2wks after procedure	2.93	1.77	5.5
6 mos after procedure	4.18	2.71	7.43

NB: mos: months, wks: weeks, No: number

The mean duration of radicular pain before infiltration was 6.38 months (range 1 to 42 months). For those who were considered "respondents", the mean duration of their symptoms was 5.06 months compared to non-respondents (9.29 months). Duration of symptoms was found to be significant predictor of good outcome ($p < 0.001$). Degree of compression of the nerve root as seen on MRI and described by Choi et al,⁵ was also found to be a significant predictor factor ($P < 0.001$). Mild compression "abutment" was associated with better improvement followed by "displacement" then "entrapment". Meanwhile, as determined by CT scanning or MR, the disc herniation was central in 11 patients (24.4%), posterolateral in 26 patients (57.8%), and foraminal in 8 patients (17.8%). The position of the herniated lumbar disc was not significant predictor for pain improvement.

Most of patients had radiculopathy of L5 root

(46.7%), followed by radiculopathy of S1 root (31.1%), then radiculopathy of L4 root (13.3%), and radiculopathy of L3 root (8.9%). Statistical analysis of the level of radiculopathy on improvement of pain after injection did not find any significant correlation ($P = 0.408$).

Body mass index was very similar in patients who responded (24.4) compared to those who did not respond (25.5). Body mass index was not found to predict the improvement of pain after transforaminal epidural steroid injection ($P = 0.269$). Table (2) shows the statistical analysis of the studied predictive factors for improvement of pain after injection.

Minor local complications occurred in 2 patients (4.4%) after the procedure in this series. One patient had superficial infection that improved within 10 days with antibiotics, the other patient had vasovagal attack for few minutes and improved after resuscitation.

Table (2). Statistical Analysis of the Studied Predictive Factors for Improvement after Injection

	No. of Patients	Response		P value
		Respondent	Non-Respondent	
No. of Patients	45	31	14	
Mean Symptom duration	mo 6.38	mo 5.06	mo 9.29	0.001
Degree of compression				0.001
- Abutment	18	15	3	
- Displacement	20	16	4	
- Entrapment	7	0	7	
(Body Mass Index (mean	24.7	24.4	25.4	0.269
Radiculopathy level				0.408
- L3	(8.9) 4	(100) 4	(0) 0	
- L4	(13.3) 6	(50) 3	(50) 3	
- L5	(46.7) 21	(67) 14	(33) 7	
- S1	(31.1) 14	(71) 10	(29) 4	
Position of Disc Herniation				0.892
- Central	(24.4) 11	(73) 8	(27) 3	
- Posterolateral	(57.8) 26	(69) 18	(31) 8	
- Foraminal	(17.8) 8	(63) 5	(37) 3	

Discussion

Lumbosacral radiculopathy is a common disease and a prevalent medical and socioeconomic problem.¹⁰ Most patients recover with conservative care, including bed rest, oral medication, lumbar corset, and physical therapy,^{31,32} but symptoms persist over several months in 10% of patients and eventually require surgery.³ Numerous local treatments have been proposed for these patients. Historically, epidural steroid injections have been used as an adjunct in the treatment of resistant radiculopathy.^{1,4,34} More recently, use of lumbar transforaminal injection to accurately deliver a high concentration of corticosteroid to the target site of the painful nerve root has demonstrated higher efficacy.³⁵ Various studies have shown that local infiltration of anesthetic and steroid can provide both short- and long-term pain relief.

The pain-relief efficacy results for this technique are inconsistent in the literature. Lutz et al,¹⁹ in 69 patients with disc herniation, and Botwin et al² in a degenerative stenosis population (34 patients) both reported a pain decrease of more than 70% according to VAS scores at the early follow-up (with around

75% successful long-term outcome for patients who had pain reduction of at least 50% after a mean of 1.8 injections per patient). On the other side, Ng et al,²³ Lee et al,¹⁸ and Karppinen et al,¹³ obtained only 35% to 45% leg pain improvement at the 2 week follow-up. These different results could be explained by differences in study design.

The procedure can be performed under fluoroscopic¹⁹ or CT scan guidance,¹⁸ which could ensure accurate positioning of the needle tip, but no comparative study has demonstrated any superiority of CT scan guidance. One key feature of both techniques is that the injected contrast medium spreads peripherally around the nerve root and medially through the intervertebral foramen to the epidural space, thus certifying that the target area is reached.

The evaluation procedures of the different studies are difficult to compare. Most of the authors assessed pain relief on the basis of the global intensity of pain decrease in their population,^{13,35} associated with standing tolerance, walking tolerance, and the Roland 5 point pain rating or satisfaction scale.^{2,23} Like Viton,³⁶ we graded pain relief on the basis of the percentage pain decrease for each patient as

expressed on the Visual Analogue Scale score.

The foraminal infiltration efficacy differences in the literature could be mainly explained by the inclusion criteria, which generated different patient populations regarding the age, pathology, and level of radiculopathy or pain duration before the procedure. Identifying the predictive factors for clinical success of infiltrations around nerve roots could ensure optimal selection of patients who would benefit most after this procedure. As in all the different studies, we noted no influence of patient age or radiculopathy level on the pain outcome.

Controversial results have been reported on the efficacy of steroid infiltration in patients with radicular pain secondary to disc herniation or foraminal stenosis. Lutz et al,¹⁹ reported that patients with lateral recess stenosis responded less favorably than patients with disc herniation alone, and they were more likely to require surgical intervention to decompress the area of stenosis. On the other hand, Botwin et al,² in 34 patients with radicular leg pain from degenerative lumbar stenosis, obtained a 75% successful long-term outcome, with at least 50% reduction between pre-injection and post-injection pain scores.

Current study showed that the degree of nerve root compression is one of the highly significant factors to predict the improvement of pain after injection. Patients with minimal root compression had more improvement compared to those with root displacement or entrapment. This could be explained as pathological changes with minimal root compression may involve chemical and inflammatory but not structural changes that can respond better with steroids and anesthetics. With more degree of root compression ischemic changes may alter the response to injection. On the other hand, Riew et al,²⁷ reported a better outcome in terms of improvement of low back pain for a stenotic group compared with a lumbar disc herniation group at final follow-up. Several mechanisms could explain the efficacy of steroids on radicular pain in disc herniation as well as in degenerative conflict. The effect of mechanical compression caused by lumbar disc herniation and chemical irritation of the nerve root from leakage of disc materials is well documented in different studies.^{9,24} Various chemical mediators have been shown to induce pain. Chemotoxic pain mediators such as matrix metalloproteinase,

c-fos, phospholipase A2, prostaglandin E2, and cytokines are present in abnormal quantities in disc herniation.^{15,32} A study by Roberts et al,²⁹ demonstrated that the more the disc is degenerated, the higher the affinity for staining of matrix metalloproteinases. In degenerative spine, there is usually intermittent compression of the nerve roots. This could lead to venous congestion, hyperemia, and perhaps leakage of neurotoxic substances. In-vitro studies, simulating lumbar stenosis, have shown that venous congestion, intraneural edema, and impaired axonal transport occur secondary to chronic compression.^{7,33} Corticosteroids are known to inhibit prostaglandin synthesis,¹² impair both cell-mediated and humoral immune responses, stabilize cellular membranes, and block nociceptive C-fiber conduction.^{6,11,17,28} Steroids also might inhibit the formation of nerve root edema. The rationale underlying the use of steroid infiltration is based on the results of studies that demonstrated abnormal concentrations of nociceptive and inflammatory mediators around lumbosacral disc lesions, leading to chemical neuroradiculitis in both herniation and degenerative disease.

In the present study, the duration of symptoms before the procedure was found to be a significant factor for predicting injection efficacy. This has already been noted by Ng et al,²³ who achieved a modest reduction in VAS at 3 months' follow-up in patients with chronic symptoms. In a very small group of 25 patients with disc herniation, Vad et al,³⁵ already reported the negative impact of a long pain duration of over 1 year in 2 patients on the outcome. In 69 patients with disc herniation, Lutz et al¹⁹ found that patients with a pre-injection symptom duration of more than 24 weeks did not respond favorably (duration of less than 36 weeks with 78.8% success, whereas 64.7% success was obtained in 17 patients with a symptom duration of 36 weeks). Kaufmann TJ et al,¹⁴ in their retrospective study, emphasized the importance of injection in the first 3 months of symptoms as this group was more likely to achieve a successful outcome. Our results are in line with those of other studies. At the 2-week follow-up, we noted a mean 35% decrease in leg pain in a population of patients with 6.38 months of mean pain duration, whereas Karppinen¹³ reported 45% after 2.4 months of mean pain duration and Ng et al,²³ only 25% in more chronic patients (16.9 months). This could

be explained by chronic compression resulting in microvascular injury, which can lead to nerve root ischemia, edema, and demyelination.³⁰ Irreversible neurophysiologic changes related to chronic inflammation, including irritation, may take place with chronic neural compression, perhaps rendering the nerve root refractory to management with the local administration of steroid. This suggests that in treating patients with radiculopathy we should be more aggressive and implement these treatments earlier in the course of the illness, which could ultimately change patients' long-term outcome.

Body Mass Index was not a predictive factor for the outcome after transforaminal epidural steroid injection in this study. This is supported by a study done by McCormick ZZ, and Plataras C,²¹ that showed that this procedure was as effective in providing pain relief in obese, overweight, and non-overweight patients, without significant difference between these groups.

We reported minor complications in 2 patients (4.4% in this series. Epstein NE⁸ in his commentary article, reported that the literature showed that many patients might develop unreported or under-reported complications. According to him, other life-threatening infection, spinal fluid leak (0.4-6%), positional headaches (28%), adhesive arachnoiditis (6-16%), hydrocephalus, air embolism, urinary retention, allergic reaction, intravascular injections (7.9-11.6%), stroke, blindness, neurological deficit/paralysis, hematomas, seizures, and death were reported in his review of literature. On the other hand, McGrath et al,²² reported 103 minor complications in 3,964 lumbar transforaminal epidural injections over 7 years (2.4%).

This study had several limitations. It was not compared with a control population or with a group of different modality of management and consequently a placebo effect or natural improvement could not be assessed. Most patients with radicular pain have significant spontaneous improvement over time and the improved results in patients with short duration pain may in fact partially represent natural improvement that may occur with time in this subgroup. The actual impact of this factor is unknown because there was no control population.

It would have been interesting to conduct more assessments during the study period to assess a possible rebound effect, as suggested by Karppinen

et al,¹³ The main difficulty is that it was a single-injection study (ie, multiple injections may produce a more sustained effect^{19,35}), and it would have been interesting to know which population could have benefitted from a second or third infiltration in a short- and long-term follow-up. Further studies are now required to assess patient groups according to the cause of pain, its duration before the procedure, and the overall effect of the first infiltration.

Conclusion

We conclude that peri-radicular infiltration of steroids with long acting anesthetic, through a transforaminal epidural approach, is a simple, safe and effective nonsurgical procedure that should be performed quite early in the course of the illness to obtain radicular pain relief in both disc herniation and degenerative lesions as it is less beneficial in patients with more chronic radicular pain. Patients with radiological evidence of mild root compression are expected to improve more than those with more degree of root compression.

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الملخص العربي

العوامل التنبؤية لفعالية حقن الكورتيزون فوق الأم الجافية عبر الثقب العصبي لمرضى اعتلال جذور الأعصاب الناتجة عن الغضروف القطني بقسم جراحة الأعصاب

مقدمة: يعتبر حقن الستيرويد فوق الأم الجافية عقب الثقب من أحد طرق العلاج الغير جراحي لآلام مرضى اعتلال الجذور العصبية القطنية (عرق النسا). وتعتبر النتائج السريرية والعوامل التنبؤية التي تؤثر على نتائجه قيد المناقشة حتى الآن.

الهدف: الغرض من هذه الدراسة هو تقييم نتائج حقن الستيرويد فوق الأم الجافية عقب الثقب وتحديد عوامل التنبؤ لنجاحه.

الطرق: تم عمل دراسة وصفية مستقبلية تشمل ٤٥ مريضاً مصابين باعتلال الجذور العصبية القطنية. وتم تقييم التحسن في شدة الألم بعد الحقن بأسبوعين وبعد ستة أشهر مقارنة بما كان عليه قبل الحقن. وتم استخدام المقياس البصري للقياس. وتم تصنيف المرضى إلى مستجيبين عندما تقل حدة الألم إلى ٥٠٪ أو أكثر. أو غير مستجيبين إذا قلت حدة الألم بنسبة أقل من ٥٠٪. عما كانت عليه قبل الحقن. وتم اختبار عدد من العوامل التنبؤية لنجاح الحقن وهي: مدة الأعراض قبل الحقن ومستوى الاعتلال ومكان الانزلاق الغضروفي ومدى الضغط على جذور الأعصاب وشدة الألم ومؤشر الكتلة للجسم.

النتائج: أظهر المؤشر البصري لقياس الألم حدوث تحسن في حدة الألم من ٧.٣٨ درجة إلى ٢.٩٣ درجة بعد أسبوعين من الحقن و ٤.١٨ درجة بعد ٦ أشهر منه. كان عدد المستجيبين ٣١ مريضاً (٦٨.٩٪) وعدد غير المستجيبين ١٤ مريضاً (٣١.١٪). وكانت بعض العوامل التنبؤية لنجاح الحقن وهي مستوى الاعتلال ومكان الانزلاق الغضروفي وشدة الألم ومؤشر الكتلة للجسم غير مرتبطة بالتحسن. بينما كانت عوامل التنبؤ الأخرى وهي مدة الأعراض ومدى الضغط على جذور الأعصاب إيجابية إحصائياً في التنبؤ بالتحسن. وقد حدثت مضاعفات طفيفة في اثنين من المرضى فقط.

الاستنتاج: حقن الستيرويد فوق الأم الجافية عقب الثقب إجراء غير جراحي وآمن وبسيط وفعال. ويظهر التحسن بشكل أفضل في المرضى الذين يعانون من الأعراض منذ فترة قصيرة وكذلك الذين عندهم درجة بسيطة من الضغط على جذور الأعصاب.