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PEDICLE SCREW MONITORING BY PEDICLE STIMULATING PROBE IN SPINAL SURGERY

OMURGA CERRAHİSİNDE PEDİKÜL UYARICI DUYARGASI İLE PEDİKÜL VİDALARININ GÖZLEMLENMESİ

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SUMMARY:

In lumbar spine spinal cord is not under risk of injury but nerve roots which are responsible for lower extremity function can be injured by malpositioned pedicle screws. In the present study we aimed to evaluate the pedicle screw malpositions by pedicle probe and its use in lumbar spinal surgery cases.

Total number of pedicle screws applied was 126 which all were applied to the lumbar spine. All neuromonitoring was performed using transcranial motor-evoked potentials, sensory-evoked potentials, spontaneous and triggered electromyography. Pedicle screw positions were also checked by pedicle probe and fluoroscopy.

Eight of the 126 pedicle screws were accepted as malpositioned .One screw position at fluoroscopy images suggested superolateral malpositioning but normal response. Position of one screw was interpreted as accurate by both pedicle stimulation and fluoroscopy but screw violated the medial wall of the pedicle.

Intraoperative monitoring including pedicle stimulation in adjunct with somatosensorial evoke potentials and motor evoked potentials helps to decrease the risk of neurologic injury. However pedicle stimulation response can be normal in lateral, supero-lateral, and even in medial pedicle wall breech if screw do not contact nerve root. In conclusion, treating physician should use all available tools in order to detect screw malposition.

Key words: *pedicle screw, intraoperative neuromonitoring, pedicle screw stimulation*

Level of evidence: *Retrospective clinical study, Level III*

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ÖZET :

Lomber omurga cerrahisinde spinal kord tehlike altında olmasa alt ekstremite innervasyonunda önemli olan sinir kökleri pedikül vidası malpozisyonu nedeni ile yaralanabilir. Çalışmamızda lomber omurgada pedikül vidalarının malpozisyonunu pedikül stimülasyonu yöntemi ile araştırmayı amaçladık.

Toplam 126 pedikül vidası lomber omurgaya uygulandı. İntraoperatif nöromonitörizasyon için transkranial motor-uyarılma potansiyelleri, duyusal-uyarılma potansiyelleri, spontan ve tetiklenen elektromyografi teknikleri kullanılmıştır. Pedikül vidalarının pozisyonu ayrıca skopi ve pedikül probu ile kontrol edildi.

Yerleştirilen vidalardan sekizinde malpozisyon saptandı. Bu vidalardan biri skopi görüntülerinde süperolateral yerleşimli yorumlanmasına rağmen pedikül stimülasyonunda anormal cevap saptanmadı. Bir başka vida hem skopi görüntülerinde hem de stimülasyon sonrası doğru yerleşimli olarak kabul edilmesine rağmen intraoperatif olarak pedikülün medial duvarında kırık oluşturduğu gözlendi.

İntraoperatif monitörizasyonda kullanılan motor-uyarılma ve duyusal uyarılma potansiyel ölçümlerine ek olarak kullanılan pedikül stimülasyon tekniği faydalı olmasına rağmen pedikül vidasının lateral, süperolateral ve hatta sinir köküne temas olmadan medial duvar kırıklarında normal cevap verebilmektedir. Bu nedenle cerrahın sadece bir tekniğe güvenmeden pedikül vidasının pozisyonu için elindeki tüm imkânları kullanması gerekmektedir.

Anahtar kelimeler: *Pedikül vidası, intraoperatif monitörizasyon, pedikül stimülasyonu*

Kanıt düzeyi: *Retrospektif klinik çalışma, Düzey III*

INTRODUCTION:

The advent of rigid spinal surgical implants has allowed surgeons to correct increasingly complex spinal deformities. However, strong corrective forces applied to spinal deformities has significant risk for neurologic deficit including loss of motor function in the lower extremities. In addition the strength of the construct relies on the integrity of the pedicles in which the pedicle screws were applied. Also breaches of the pedicle walls may lead to neurologic compromise as well as pain syndromes [2-3,11].

In the spine with deformity pedicle screw application becomes more challenging due to misshapen or small pedicles [10]. In lumbar spine spinal cord is not under risk of injury but nerve roots which are responsible for lower extremity function can be injured by malpositioned pedicle screws. Intraoperative evoked EMG monitoring of pedicle screws has proven to be a simple, safe, and efficacious technique in accurate placement of pedicle screws. Current less than 5 mA is highly associated with pedicle wall breach [2-3].

In the present study we aimed to evaluate the pedicle screw malpositions by pedicle probe and its use in lumbar spinal surgery cases.

MATERIALS AND METHOD:

Twenty-two patients with different diagnosis were included in the study (Table-1). Of them 15 were female and 7 were male. The average age of the patients was 58.3 years (Range; 16-77 years). Majority of the cases was spinal stenosis

Table-1. Patients demographics and number of pedicle screws applied.

No Patients	Age	Gender	Diagnosis	Number of pedicle screws
1	69	F	Spinal Stenosis	L4-S1 (6 screws)
2	76	F	Spinal Stenosis	L4-5 (4 screws)
3	60	F	Spinal Stenosis	L4- L5 (4 screws)
4	61	F	Spondylolisthesis	L4-S1 (6 screws)
5	77	F	Spinal Stenosis	L2 -L5 (8 screws)
6	65	F	Spondylolisthesis	L2- L4 (6 screws)
7	61	F	Spinal Stenosis	L3- L5 (5 screws)
8	70	F	Spinal Stenosis	L2- L5 (8 screws)
9	16	M	Congenital scoliosis	L1-4 (5 screws)
10	41	M	Spinal Stenosis	L4 S1 (6 screws)
11	74	F	Spinal Stenosis	L3- L4 (4 screws)
12	34	F	Flat back syndrome	L1-5 (6 screws)
13	60	F	Spinal Stenosis	L1-S1 (11 screws)
14	63	F	Lumbar kyphosis	L3- S2 (8 screws)
15	61	M	Spinal Stenosis	L5- S1(4 screws)
16	65	M	Spinal Stenosis	L3 -L5(5 screws)
17	53	M	Flat back syndrome	L3- S1(6 screws)
18	41	M	L3 fracture	L1-L2 (4 screws)
19	49	M	Flat Back syndrome	L2-5 (6 screws)
20	64	F	Spondylolisthesis	L3- L4 (4 screws)
21	47	F	Spinal Stenosis	L4-L5 (4 screws)
22	75	F	Spinal Stenosis	L2-L5 (7 screws)

in 13 patients and followed by spondylolisthesis (n:3) and flat back syndrome (n:3). One patient had congenital scoliosis, one patient had lumbar fracture, and one patient had lumbar kyphosis. Total number of pedicle screws applied was 126 which all were applied to the lumbar spine.

All neuromonitoring was performed using transcranial motor-evoked potentials, sensory-evoked potentials, spontaneous and triggered electromyography [3,12]. Stimulation and recording was performed using Medtronic's nerve integrity monitoring (NIM®) system. Anesthesia was maintained using a total intravenous anesthesia approach and with no neuromuscular relaxant other than a single dose of a short acting agent to facilitate intubation. For each pedicle stimulation surgeon was warned if current is less than 5 mA.

Pedicle screw positions were also checked by pedicle probe and fluoroscopy. Screws were removed or repositioned if any of the followings were noticed; 1- decreased signal after pedicle stimulation, 2- malpositioned pedicle screw in fluoroscopy, 3- peroperative finding of pedicle wall breach in cases that underwent decompression surgery.

RESULTS:

Eight of the 126 pedicle screws were accepted as malpositioned according to the criterion described above. Currents of pedicle stimulation were normal in one screw but fluoroscopy images suggested superolateral malpositioning. Position of this screw was changed without any abnormal finding in pedicle stimulation. Position of one screw was interpreted as accurate by both pedicle stimulation and fluoroscopy. However during decompression it was seen that the screw violated the medial wall of the pedicle without compromising the nerve root. This screw was removed without replacement. Remaining six malpositioned screws were applied in a congenital scoliosis case. Fluoroscopic images were interpreted as accurate placement of the pedicle screws but pedicle stimulation revealed a current less than 5 mA. These six screws were removed and their position was changed without any decrease in pedicle stimulation. There was no complication including neurologic deficit postoperatively in these patients.

DISCUSSION:

Stagnara's wake-up test has been only available method of observing spinal cord function intraoperatively [14]. Although this test has been utilized since mid-70's it also has several limitations including; ability to test the spinal cord function only after desired correction was achieved, potential risk in patients with primary diseases, and limited use in mentally retarded individuals [1,8-9,13].

The combined monitoring of sensory evoked potentials and motor evoked potentials during spine surgery decreases the false-negative rates of reporting [4-6]. It has been conclusively demonstrated that intraoperative spinal cord monitoring facilitates detection of impending spinal cord deficit and facilitates early responses that are likely to preserve spinal cord function[1,7].

Pedicle screw instrumentation systems for spinal arthrodesis are in widespread use. Malpositioned screws can induce loss of fixation, neuronal injury, and pain syndromes. Intraoperative evoked EMG monitoring of pedicle screws has proven to be a simple, safe, and efficacious technique in accurate placement of pedicle screws. A positive EMG response at or below a constant-current of < 6-10 mA may be an indication for inspection, redirection, or removal of the pedicle screw [2]. Normal free-run EMG response is predictive of the lack of nerve root injury or irritation. An abnormal EMG response during a spine procedure may or may not be associated with a clinical deficit [6], while on the contrary, normal EMG responses do not insure against lateral breeches.

In our study we observed no positive response with pedicle stimulation in two pedicle screws, however these screws were malpositioned either in fluoroscopy or intraoperatively. Although on screws breeched medial wall of the pedicle pedicle stimulation did not suggest any abnormal response as there was no contact between pedicle screw and nerve root.

In conclusion, intraoperative monitoring including pedicle stimulation in adjunct with somatosensorial evoked potentials and motor evoked potentials helps to decrease the risk of neurologic injury. However pedicle stimulation response can be normal in lateral, supero-lateral, and even in medial pedicle wall breech if screw do not contact nerve root. In this regard, it is mandatory for the surgeon not to rely on only neuromonitoring but to use all available components (fluoroscopy, intraoperative inspection) in order to detect implant malpositions.

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