

The Use of Polyaxial Pedicle Screw for the Fusion of Lumbar Vertebra in Sheep

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Abstract: In this study, 10 sheep with the average age of 1.5 years old, weighing approximately 50-70 kg were used. Hemilaminectomy was performed in the interspace between L₄ and L₅ on the left side. The pedicle screws were attached to each other by means of a rod and the fixation process was accomplished by screwing the nuts on the top of the screws. Cortical bone graft obtained during the decortications of proc. transversus and proc. articularis and of laminae in the interspace between L₃ and L₆ was combined with grafts taken from ilium and placed between proc. transversuses. No screw loosened in none of the cases in 12 weeks period. Radiographic assessments were made on the 4, 8 and 12th weeks. In the assessments on 12th week, it was observed that ankylosis was completely formed.

Key words: Spine, pedicle screws, pedicular fixation, sheep, nuts, Turkey

INTRODUCTION

Total 3 techniques are routinely utilized in determination of starting point for drilling and screwing pedicle. These are intersection technique, pars technique and processus accessorius technique (Meyer and Rowlinson, 1996; Sterba *et al.*, 2007). Posterior screw applications to lumbar vertebrae were mostly employed vertebrae fractures, vertebral subluxation and luxation, disc herniae and laminectomies to achieve fusion among vertebrae (Meij *et al.*, 2007; Wang *et al.*, 2008).

Pedicle screw fixation can also be used in dogs with degenerative lumbosacral stenosis to stabilize L₇-S₁ joint spacing (Hasegawa *et al.*, 2005). Pedicle fixation technique provides a good protection for spinal segments and all vertebrae.

It was reported that the embedding of bone in bone-screw interface and osteointegration are fast and good and that implant loosening incidence was reduced by using screws with surface properties (Okuyama *et al.*, 2001). It was reported that pedicle screw and rod fixation was used in the lumbosacral vertebrae of dogs (Meheust *et al.*, 2000).

In this study, the aim is to achieve fusion between corpus vertebrae and to investigate the efficiency of the stabilization at L₃-L₆ levels by applying unilateral polyaxial pedicle screws and using cortical graft after dorsal laminectomy between these levels.

MATERIALS AND METHODS

The material of the study is composed of 10 adult sheep aged 1.5 and have body weight between 50-70 kg. The LL radiographies of lumbar vertebra was taken before the operation and the corpus lengths of vertebrae were measured (it was between 20-25 mm on average).

The animals were applied IM Xylazine hydrochlorur (Rompun[®], Bayer AG, Germany) at 0.3 mg kg⁻¹ dosage for premedication. After the animals were given Ketamin hydrochloride as IV at 10 mg kg⁻¹ (Ketalar[®], Pfizer, Turkey) for anesthesia induction, they were intubated and anesthesia was continued with isoflurane (Forane[®], Abbott, the UK). After space between Th₁₂ and S₁ was shaved and disinfected the animals were positioned at ventral recumbency on the operation table. After the processus transversuses on the left were revealed, hemilaminectomy was applied to the interspace between L_{4,5}. With the help of high-speed drilling and router, the decortication was performed to lateral surfaces of proc. transversuses and proc. articularises and laminae.

First of all, an opening was made via an awl from the caudal of facet joint on the pedicle so that screw can enter. From this point a pedicle canal was formed via a pedicle probe. In the assessment of the depth and integrity of the canal, Kirschner wire with chump end was used as a guide. Inside the canal a pedicle screw with appropriate diameter whose length was pre-determined

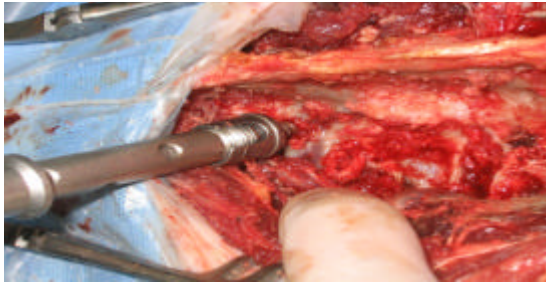


Fig. 1: The appearance of the pedicle screw placed

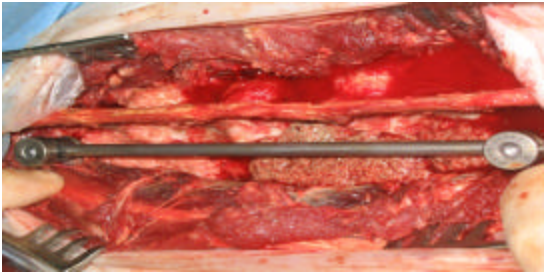


Fig. 2: The appearance of fixation and graft after placement

was placed (Fig. 1). Pedicle screws placed into L₃ and L₆ were attached to each other via a rod. After this rod was put on the heads of pedicle screws, the nuts were screwed thus fixation was completed (Fig. 2). In all animals autografts were taken from iliac crest and these corticocancellous bones were turned into small particles. Before applying rod between pedicle screws, cortical bone particles obtained during decortication and graft from ilium were brought together and applied between processus transversus. Later on, hemilaminectomy area was covered with adipose tissue and operation wound was routinely closed.

RESULTS AND DISCUSSION

The threaded parts of screws were sent in to cover at least $\frac{3}{4}$ of corpus vertebra as seen in the post-operative radiographies taken from each case. During operation, no fracture happened on the surfaces of joints and each pedicle screw tightly clutched spinal segment. During or after operation no screw loosening was seen. In one case, it was suspected that damage occurred in dura mater and a small amount of Cerebrospinal Fluid (CSF) came from the canal. However, the flow of CSF liquid stopped in 2-3 min. In this case, the screw was placed from the previous vertebra (L₂). After operation 9 cases stood up without any problem (12-16 h) and it was determined that proprioceptive reflex, deep pain sense, patellar and cranial

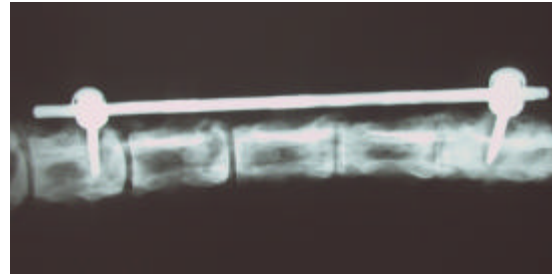


Fig. 3: Radiographic image on postoperative 12th week

tibial reflexes were normal. In the case in which CSF came from pedicle canal, standing up was realized after the 3rd day and proprioceptive reflex turned to normal 1 week later. Radiographic assessment was performed on the 4, 8 and 12th weeks.

In the radiographies taken on the 4th week, callus formation was not significant. In the radiographies taken on eight week callus formation and vertebra formation and ankylosis between vertebrae were evident and on the twelfth week ankylosis was completely formed (Fig. 3). As spondylosis was formed between vertebrae after the 12th week, pedicle screws were removed from each case according to surgical rules under general anesthesia.

Pedicle screw and rod fixation which are recently used in human spine stabilization (Okuyama *et al.*, 2001; Hasegawa *et al.*, 2005) has not yet become a routine application in veterinary practice because of high material prices (Aldini *et al.*, 2002; Meij *et al.*, 2007). In pet animal cases when stabilization of columna vertebralis is disrupted, modified segmental fixation technique has been used to achieve fixation of vertebrae for a long time. However, this fixation method cannot provide a good stabilization and loosening and sliding are observed (Sharp and Wheeler, 2005). In this model study on sheep, it was determined that when pedicle screws were placed correctly and properly, stabilization between vertebrae was very good and besides no loosening of screw and rods were observed. Furthermore, it was also observed that there was no restriction in animals' movements after operation.

Only a few studies on animals' lumbar vertebrae's fixation with pedicle screws (*in vivo* or *in vitro*) so far used fixed headed pedicle screws (Aldini *et al.*, 2002; Hasegawa *et al.*, 2005; Meij *et al.*, 2007). It was found out that the 360 degree polyaxial pedicle screws fit easily and better with joining rods and that the heads of screws easily clutched rods without sloping the rods a lot as they could move all directions. Therefore, researchers are of the opinion that polyaxial pedicle screws keep rods on appropriate axis and screws are exposed less stress in postoperative period and postoperative screw loosening in polyaxial screws will be rarer compared to other screw

types. Stabilization of lumbar vertebrae with pedicle screw is a risky and experience requiring process. A small deviation in the application of pedicle screw technique can lead to complications like damage to spinal cord, screw come out and even vertebra fracture (Meij *et al.*, 2007; Sterba *et al.*, 2007). In this study, among the complications mentioned above, a slight damage to dura mater occurred only in one case. Researchers think that this situation resulted from directing screw angle towards medial more than required. During the process great damages to spinal cord and dura mater increase the possibility that patient cannot stand up.

In sheep, compared to thoracic vertebrae, the diameters of lumbar vertebrae are larger and have more marked pedicles. Therefore, it is easier to place pedicle screw to lumbar vertebrae. It was reported that pedicle screws of 4.0 mm diameter are experimentally used in sheep and dogs in the stabilization of sacrum and lumbar vertebrae (Aldini *et al.*, 2002; Meij *et al.*, 2007).

In the study, it is concluded that the screws of 4.0 mm diameter and 35 mm length are enough in lumbar vertebrae stabilization and that screw diameters are of suitable sizes for pedicle canals in sheep of 45-55 kg. Researchers think that the screw diameters larger than 4.0 mm can be large for pedicle canal and lead to fractures in vertebrae. Considering the sizes of lumbar vertebrae, researchers think that pedicle screw diameter should not exceed 3.5-4.00 mm in adult middle and large race sheep. Researchers are of the opinion diameters smaller than this size cannot provide a strong fixation.

It was reported that autologous cortical bone grafts in intervertebral spaces in block were employed together with pedicle screw fixation following disc resection to fasten fusion of lumbar vertebrae and bone cell proliferation (Ido *et al.*, 2001). In this study, it is used corticocancellous grafts among vertebrae to achieve a fast ankylosis. Researchers think that rapid ankylosis formation between vertebrae after the 8th week can be attributed to the completeness of pedicle screw stabilization and the efficiency of the graft materials used.

CONCLUSION

In this study, it was found out that application of unilateral polyaxial pedicle screw particularly to lumbar vertebrae was easy and stabilizations with these screws are complete and adequate. It was determined that adequate stabilization achieved with the use of graft material lead to formation of a fast fusion. Researchers are of the opinion that this study is a pioneering study for cases which come into being as a result of cauda equina syndrome or which require stabilization lumbar vertebrae in dogs.

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