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ANTERIOR APPROACH
TO LUMBAR SPINE

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Frontal lumbar procedures are frequently used since the “frontal lumbar interbody fusion” definition of Carpenter⁽²⁾ in 1932. Main areas of use of these applications are spinal deformity, spinal instability, tumors, infection or chronic lower back pains.

The purpose of every surgical operation is to obtain the best result with the least dissection and easiest method. Although some surgeons do not perform frontal procedures because it increases surgical trauma due to more dissections, indications such as disk prosthesis and laparoscopic surgery has become a part of the daily procedures.

Size of the surgical trauma is directly related to mortality and morbidity. On the other hand, Brau et al.⁽²⁾ reported 1.4% major vein laceration and 1.9% total vein injury in frontal lumbar procedures they performed between second lumbar and first sacral (L2-S1) vertebral level on 1315 patients. Dekutoski et al.⁽³⁾ reported the complication rate as 7-18% and 4-14% in lumbar region in the study published in May 2000. One of the reasons for using the above stated procedure more frequently is the strong relationship of disk degeneration with age^(4,5). Almost half of the population between the ages of 40 and 60 are affected from disk degeneration^(4,6). It is possible that frontal approach procedures will gradually increase in practice related to population aging and will become the primary treatment in the future. In this section we presented the findings we obtained in the light of our experiences related to procedures performed with low morbidity rates to lumbar vertebra.

Lateral Procedures

Frontal approach to upper lumbar vertebra is not possible due to the intra-abdominal organs and veins. During the approach to thoracolumbar junction, thorax and retroperitoneum should be opened and diaphragm should be severed. This approach presents serious morbidity. Even thoracotomy alone without any additional procedure disturbs respiratory functions. On the other hand, thoracic approach allows direct view of vertebra, only by pulling the lung forward, so it is deemed as a relatively easy area to perform perivertebral dissection.

Thoraco pherno laparotomy

Indication

Surgical treatment of vertebrectomy, lateral bone fusion and thoracholumbar region lesions; complicates reaching this region of the vertebra, and as well it is difficult due to morphological and biochemical diversity of the lesions located here. This approach is a good route to reach single or multiple levels of lower trocheal and upper lumbar vertebra.

Positioning

Patient is in 15-20 degrees reclining in right lateral decubitus position that allows a complete view of both sides of the vertebra (Figure 1). Table should be bent till the skin between iliac crest and lower rib is stretched. This position is used in every level of lateral extraperitoneal procedure.

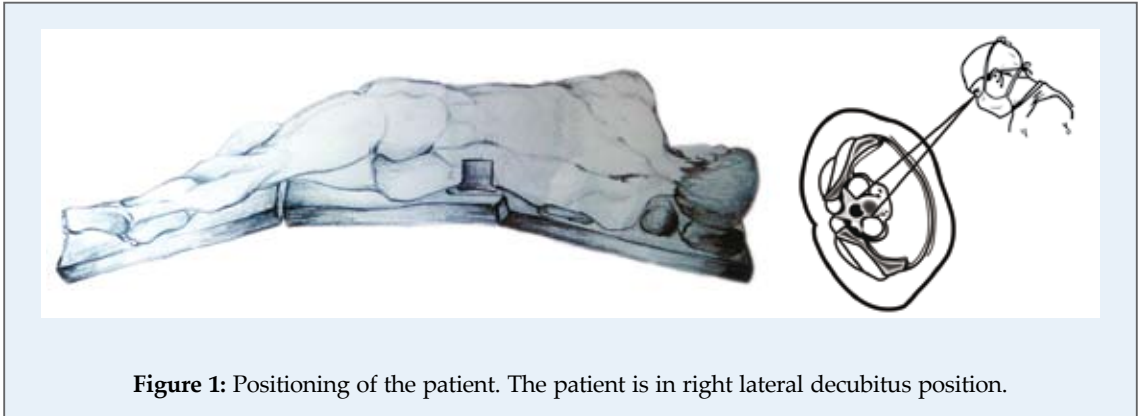


Figure 1: Positioning of the patient. The patient is in right lateral decubitus position.

Left lateral approach should be preferred in the mentioned procedure. However, if necessary, right lateral approach can provide the same view especially for tumors extending towards right in vertebra. The biggest disadvantage of right thoracotomy is its close functioning to vena cava and hepatic veins and its limited view due to the position of the liver.

Incision

After the determination of the target area and opposite intercostal space with C-armed fluoroscope, incision is performed in the intercostal space located at the one higher level. Because when the retractor is placed, while the upper fractures remain stable, lower ones stretch and open, and thereby the target tissue can be reached by entering through one upper level.

Because skin incision does not improve the view, there is no need to extend it towards the back of the patient. But extending the incision forward provides better view with less trauma and less rib fracture because the distal cartilages are more flexible.

To enter the pleural space, intercostal muscles are separated from the lower margins of ribs they are attached with electrocautery. Caution should be applied when ligating intercostal nerve and coagulating intercostal veins. After placing the retractor separating the ribs between the ribs, first costochondral joint is cut and retractor is opened. This operation protects the patient from the occurrence of rib fractures.

After costochondral joint is separated, incision is advanced downwards and abdominal muscles are separated from fat tissue.

Dissection

After a little incision performed to diaphragm at the level of costochondral joint to relieve the pressure on it, posterolateral section of diaphragm is incised 2 cm from the point where it binds to the ribs with cautery. In this way sufficient tissue is left for closure sutures.

If this incision is first performed in the front peritoneum may open and organ injury can occur, and if it is performed in the back it can cause vascular injury. After the first opening of diaphragm, the surgeon inserts the 2nd and 3rd fingers of his/her left hand to retroperitoneal tissue under the diaphragm and cuts the diaphragm with cautery from costochondral joint towards vertebra. After retractor is completely opened between ribs, incision is extended 1-2 cm further in parallel to the rib in order to protect the skin near the spine from stress related ischemia.

Segmenter artery in pervertebral tissue should be ligated during dissection and it should be cut in between the point it enters to foramen and aorta.

If it is cut close to the aorta, ligation of the vein in case it opens, is very difficult even impossible. If segmenter arteries are ligated in the foramen, circulation of nerve tissues degenerates. Slope given to the table should be corrected before placing the prosthesis (Figure 2). This situation enables to extend the incision from abdominal region to the 2nd or 3rd level. If it is necessary to reach to upper vertebra or disk space, incision can be extended along the spine towards the back and upper rib may be cut.

Anterolateral abdomen muscles are innervated by lower intercostal nerves. If the vertical part of the

incision is performed by separating the muscles, anterolateral muscle innervation is maintained and post surgery abdomen wall paresis can be avoided. After completing the procedure, thoracic drain is placed in the lower intercostal space close to posterior axillary line and the last hole of the drain is placed 2 cm high from the entry point. Retroperitoneal drain is not used, but careful hemostasis is performed.

Postoperative Course

Although serious functional evaluations are performed routinely before surgery the most dangerous complications after thoracotomy are pulmonary complications. Complications arise within 48-72 hours after surgery.

Pulmonary complications that occur in the meantime may cause progressive disorders in respiratory

functions. To prevent the functional disorders patient should start moving early and should do respiratory exercises with spirometer after the operation. Thorax drain should be extracted when the drainage liquid becomes clear and the amount falls to 150 ml/day after the second day. When there is atelectasis suspect the drain should not be extracted.

Retroperitoneal Approach

Retroperitoneal approach is used to reach the second and fourth levels of lumbar vertebra (L2-L4). With this approach complications that can occur in thoracotomy can be avoided and the fifth lumbar and the first sacral spine level (L5-S1) can not be reached due to the prevention of iliac arm in lumbar region.

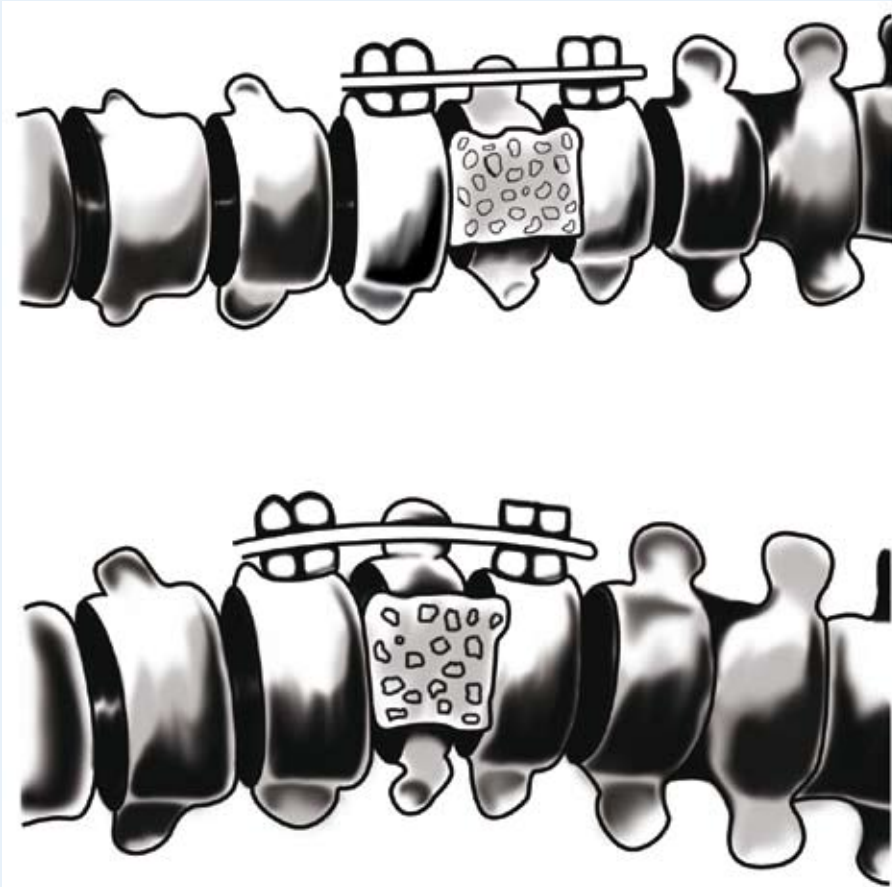


Figure 2: After the angle of the table is adjusted vertebra fixation should be performed
a) Correct b) False

Indication

Nucleus replacements, fusion surgeries, placement or extraction of cages and other instruments between vertebra bodies are its primary indications.

Position

The patient is in the position for thorax phreno laparotomy, but only slope point of the table is closer to the feet.

Incision for Extraperitoneal Approach

Target area and its correspondence in the skin are detected with C-arm fluoroscope. The edge of the 11th rib is resected without opening diaphragm if it is necessary for the extraperitoneal approach. A skin incision shaped “k” is performed between iliac crest and the last rib. Vertical part of the incision is on middle axillary line. Upper section turns back and goes in parallel with the rib edge and it is approximately 3 cm long.

Dissection

Finger dissection is performed in retroperitoneal tissue along the inner surface of transversal fascia from the posterior abdominal wall to vertebra body. Lateral dissection is identical to those in upper levels. But if psoas muscle is apparent in lower levels, it should be scraped starting from its frontal side to present muscle vertebra body. Because ureter is in the fat tissue, it does not have a risk of injury. Since lumbar plexus fibres can be monitored inside the psoas muscle, injury risk with type of dissection decreases significantly. In this approach frontal ecartation of peritoneal sac should be applied with caution. One of the organs situated under the retractor is the spleen. We prefer to use drain for this procedure.

Postoperative Course

Because the use of narcotic analgesics for the post-surgery pain may prolong the duration of ileus after the surgery, non steroid anti-inflammatory drugs should be preferred whenever possible. Oral feeding should be started with drugs 4-6 hours after the surgery. Early movement is important with regard to some complications after the surgery.

Ventral Approach

Both transperitoneal and extraperitoneal approaches are appropriate for lumbar fourth and sacral first (L4-S1) vertebra levels. Extraperitoneal approach may be performed in supine position with transverse paramedian (“ventrolateral”) incision or in lateral position with lumbar incision. On the other hand, anterior extraperitoneal procedure (“ventromedial”) should be applied to patients who previously underwent abdominal or spinal surgery or to patients with obesity.

Peritoneum sack and abdominal wall ecartation are not seen a lot in obese patients. And peritoneum dissection and ecartation of peritoneal sack can lead to problems in patients who previously underwent abdominal surgery.

Even if previous vertebra surgeries are performed with posterior approach, it shouldn't be forgotten that it can lead to frequent adhesions including the main veins as a result of bleeding and edema in the vertebra and perivertebral tissue. Accordingly it's useful to define the relationship between disk levels and veins before the surgery with computerized tomography (BT) or magnetic resonance (MR).

Ventrolateral Approach**Indication**

Total disk prosthesis, fusion between vertebra bodies (anterior lumbar interbody fusion/ALIF), instrumentation or elimination with anterior approach are primary indications.

Position

The patient is in supine position and there is no need for any other arrangements.

Incision

A left transverse skin incision is performed approximately 6 cm above the disk level determined with C-arm fluoroscope. This incision is 1-2 cm lateral to the mid line.

Dissection

After frontal rectus sheath is opened, rectus muscle is excised with electrocautery starting from the outer

surface. It should be carefully coagulated to prevent the binding of inferior epigastric veins and branches or formation of hematoma. There is no need to excise the interior of the muscle.

Outer surface of the posterior sheath of the muscle is the most secure area for entering preperitoneal area that protects peritoneum. After fascia transversalis and peritoneum posterior sheath (structures apart from peritoneum) are separated the rear sheath should be excised 1-2 cm inwards. After posterior rectus sheath is excised, following the fascia between inner surface of fascia transversalis and preperitoneal fat tissue with finger dissection without entering the fat tissue, it should be started laterally and continued till the first resault formed by psoas muscle.

Ureter will stay in the fat tissue and will not be seen, there is no possibility of injury in this procedure. The finger should not move in inferolateral edge in preperitoneal tissue due to peritoneum internal inguinal ring along the dissection, because this forms the lower limit of dissection. In the upper part, to pull the peritoneum sack to internal region, 5-6 cm peritoneum dissection is adequate. Ecartation of peritoneum to internal region uncovers big veins and dissection continues directly in line with this view. Aorta comes in sight by cleaning fat tissue surrounding vena cava and bifurcations with blunt.

Veins should be kept away from the surgical area in order to protect them from the injury. For this purpose automatic retractors should be preferred. Vein surgery sets should be kept ready in operation room to repair the vein injuries. After spinal instrumentation is completed, frontal and posterior rectus sheath is repaired and skin is closed. Drain may not be used in this situation.

Postoperative Course

Narcotic analgesics may affect food tolerance otherwise normal diet is given in the same day. Early discharge is suggested.

Ventromedial Approach

Indication

Total disk replacement and frontal instrumentation are primary indications.

Incision

Laparotomy should be preferred to decrease the vascular and abdominal organ injury risk and to provide a better view and advantageous ecartation⁽⁷⁾. This method bases on the philosophy of protecting the abdominal organs, easing the ecartation, simplifying retroperitoneal approach and accessing frontal retroperitoneal directly. Mid line approach should be preferred in obese patients, or in complicated patients operated with posterior approach, in recurring cases and those who underwent abdominal and especially pelvic surgeries.

Vascular dissection is easier with this approach, because dissection of right iliac veins is much easier than extraperitoneal approach performed with transverse left transrectal incision (Figure 3). Four cm vertical mid line incision is performed right above the lesion detected with C-arm fluroscope. In weak patients palpation of sacral promontory and incision

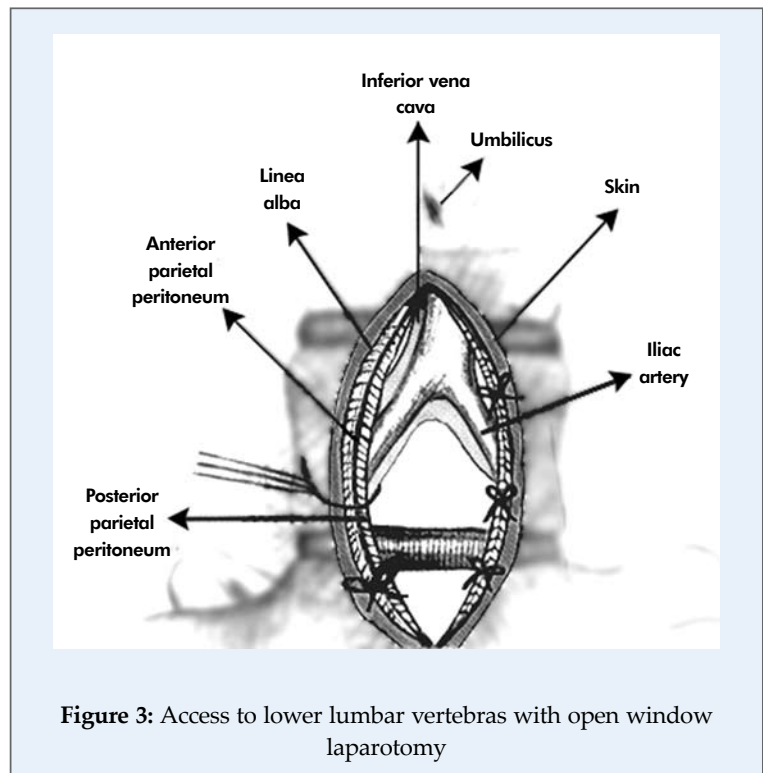


Figure 3: Access to lower lumbar vertebrae with open window laparotomy

accompanying its projection are deemed sufficient. It should not be forgotten that incision should be adjusted to provide a point of view right across the distance and in parallel with the upper and lower plaques, in other words entering frontal side of the disk vertically is not correct.

Dissection

After exploration of peritoneum space, small intestine should be pulled to the right and sigmoid colon to the left. Then, posterior parietal peritoneum is opened in the same direction but longer (approximately 6-8 cm). Posterior peritoneum is freed in every direction with finger dissection. Free lips of posterior peritoneum are sutured with 2/0 monofilament string at 1 cm intervals to frontal peritoneum and linea alba.

The most important point is, to begin the suture for safety reasons from the upper edge, because intestinal injuries occur more frequently in the lower edge. Because the trace of the ureter is outside the surgical area, ureter is not searched. When the window created from frontal and posterior peritoneum is completed vein dissection is started.

For a successful surgery the relationship between vascular anatomy and lumbosacral vertebra should be understood completely.

Tribus⁽⁸⁾, measured L5-S1 vertebra distance with vena cava bifurcation in 37 cadavers and determined the distance as average 18 cm (7 – 36 mm). To reach this level the area between left principal iliac vein and right principal iliac artery is used. The distance between is average 33.5 mm (12-50 mm).

Based on the measurements and experiences, left principal iliac vein can be moved in this way because disk is at the cross and at this level it is 12 mm to the left of mid line. Vena cava bifurcation and left iliac vein should be dissected and should be drawn away from the surgery area for not causing damage in the interventions under bifurcation. Left iliac vein is more close to mid line when compared with other veins in this level. This dissection in the levels of fifth lumbar and first sacral (L5-S1) is sufficient in most of the patients to reach the disk space. Cappalades⁽⁹⁾ showed that this dissection is sufficient in 90% of the patients with a study based on magnetic resonance (MR) imaging. Median sacral veins are coagulated almost always before the movement of aorticaval bifurcation and iliac veins. The idea that median sacral veins are located in mid line is not always true, they can be located in both sides of the line.

In the approach to lumbar fifth and sacral first (L5-S1) vertebra level, if there isn't enough space between iliac veins, right and left principal iliac veins and arteries are dissected and they are hanged with vascular band. Principal iliac vein, iliolumbar and sometimes lateral sacral veins are emptied. Before hanging iliac vein, especially posterior side should be controlled not to damage these arms. Instead of simple ligation of arms coming out of iliac veins, control with double clips or suture is safer. Hypogastric plexus is placed between iliac veins in front of the last lumbar vertebra and promotorium.

The opening of this area is completed with blunt dissection, electrocautery and traumatic surgery can lead to retrograde ejaculation. There are 3 ways to

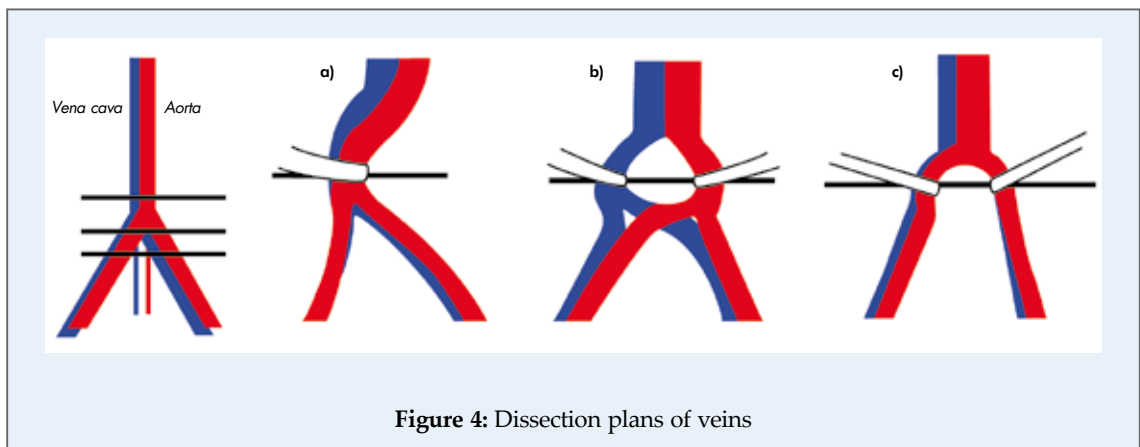


Figure 4: Dissection plans of veins

reach L4-L5 vertebra level which are explained by Kleeman and Regan⁽¹⁰⁻¹¹⁾:

- If the bifurcations are above the disk (Figure 4a) hanging of iliac vein and right iliac artery is not suggested.
- If the bifurcations are below the disk (Figure 4b) vena cava and aorta should be pulled together to the left or vena cava to the right and aorta to the left. With the thought to limit one side of the surgical area with a large vein is safer than having large veins in both sides, the first method should be preferred always.
- If aorta bifurcation is above and vena cava bifurcation is in the same level or below (Figure 4c), route between iliac artery and vein is suggested more. Posterior connections should be definitely defined for bleeding control, when iliac vein is moved.

After spinal surgery is completed, temporary sutures placed between posterior and frontal peritoneum are cut and posterior peritoneum layers are sutured together. Afterwards abdomen frontal wall is closed as a single layer. Even though this approach can cause additional trauma because it is transperitoneal, it is the best approach for disk replacement or all other types of instrumentation methods. Because it sees the vertebra directly from the front, it can overlook both sides.

Postoperative Course

Start of the normal diet occurs later compared with extraperitoneal approach but liquid food is started on the same day.

References

- 1- Carpenter N: Spondylolisthesis. *Br J Surg* 19:374-386,1932.
- 2- Brau SA, Delamarter RB, Schiffman ML, Williams LA, Watkins RG: Vascular injury during anterior lumbar surgery. *Spine J* 4(4):409-412,2004.
- 3- Dekutoski MB, Norvell DC, Dettori JR, Fehlings MG, Chapman JR: Surgeon perceptions and reported complications in spine surgery. *Spine* 35(9S):S9-S21,2010.
- 4- Boden SD, Davis DO, Dina TS, Patronas NJ, Wiesel SW: Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects: A prospective investigation. *J Bone Joint Surg Am* 72(3):403-408,1990.
- 5- Benoist M: Natural history of the aging spine. *Eur Spine J* (Supply 12) 2:586-S89, 2003.
- 6- Jarvik JJ, Hollingworth W, Heagerty P, Haynor DR, Deyo RA: The longitudinal assessment of Imaging and disability of the Back (LAID Back) study: Baseline data. *Spine* 26(10):1158-1166, 2001.
- 7- Carilli S, Oktenoglu T, Ozer AF: Open-window laparotomy during a transperitoneal approach to the lower lumbar vertebrae: New method for reducing complications. *Minim Invasive Neurosurg* (4):227-229, 2006.
- 8- Tribus CB, Belanger T: The vascular anatomy anterior to the L5-S1 disk space. *Spine* 26(11):1205-1208, 2001.
- 9- Capellades J, Pellise F, Rovira A, Grive E, Pedraza S, Villanueva C: Magnetic resonance anatomic study of ilio-cava junction and left iliac vein positions related to L5-S1 disc. *Spine* 25(13):1695-1700, 2000.
- 10- Kleeman TJ, Michael Ahn U, Clutterbuck WB, Campbell CJ, Talbot-Kleeman A: Laparoscopic anterior lumbar interbody fusion at L4-L5: An anatomic evaluation and approach classification. *Spine* 27(13):1390-1395, 2002.
- 11- Regan JJ, Aronoff RJ, Ohnmeiss DD, Sengupta DK: Laparoscopic approach to L4-L5 for interbody fusion using BAK cages: Experience in the first 58 cases. *Spine* 24(20):2171-2174,1999.