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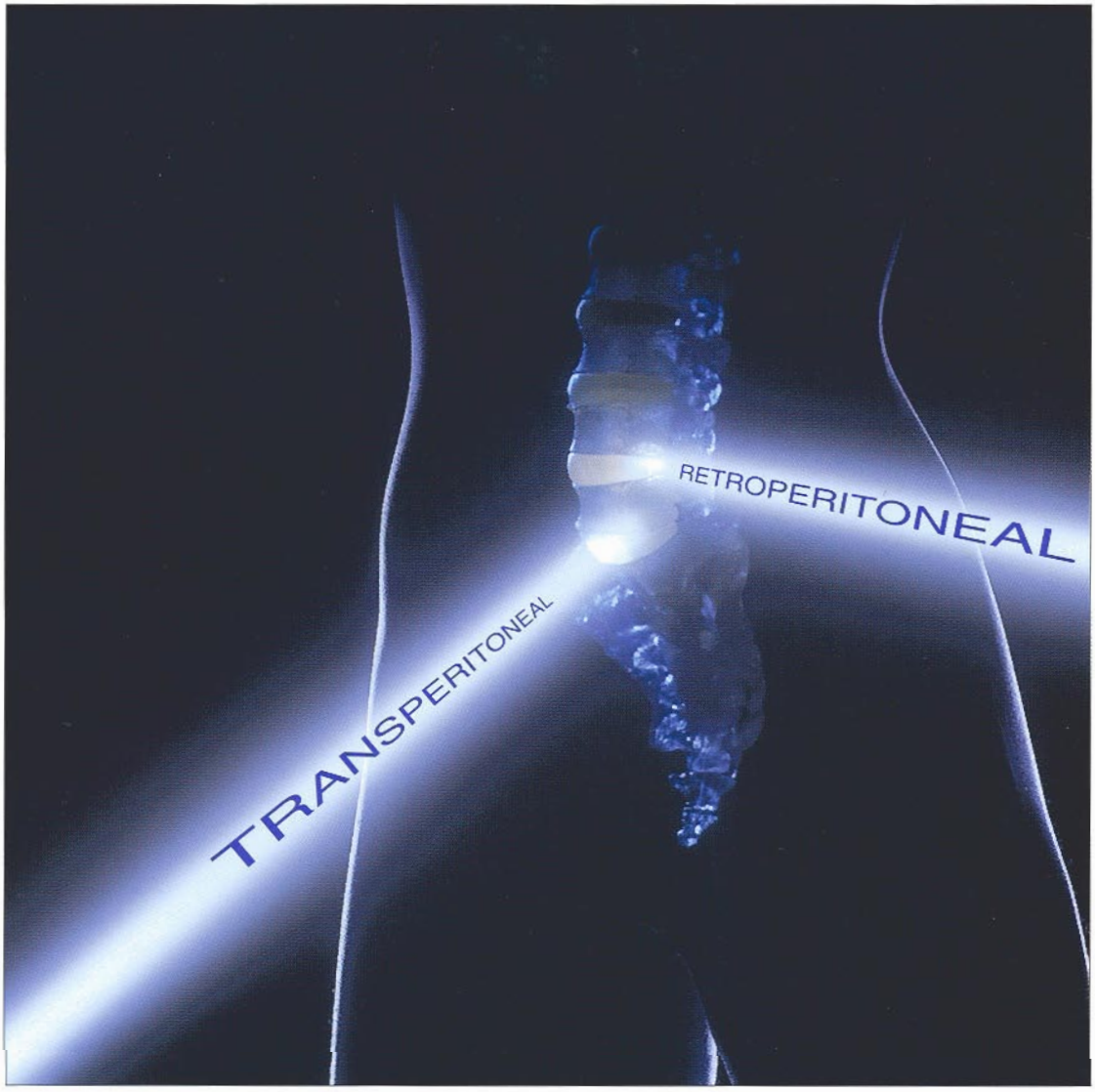

miaspas ALIF

Microsurgical Anterior Lumbar Interbody Fusion

B|BRAUN

miaspas mini ALIF

Microsurgical Anterior Lumbar Interbody Fusion System

* miaspas mini ALIF comprises two different microsurgical approaches to the lumbar segments L2/3, L3/4, L4/5 and L5/S1 based on well known surgical approaches
* miaspas mini ALIF consists of a retractor system and special instruments for approach and fusion
* the main advantages of the system are:
  - ➢ microsurgical (non-endoscopic) technique
  - ➢ independence from laparoscopic/vascular surgeons
  - ➢ blunt muscle dissection with preservation of abdominal muscles
  - ➢ fusion of surgeon's choice
  - ➢ open exposure can be achieved rapidly in case of emergency
  - ➢ laparoscopic equipment unnecessary

Developed in cooperation with:
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Content


RETROPERITONEAL
TRANSPERITONEAL

Foreword

Anterior lumbar interbody fusion was first described in the 30's and has been used since then for the treatment of a variety of pathologies such as spinal deformity, spinal instability due to trauma tumors, infection as well as chronic disabling low back pain incl. failed spinal surgery. Whereas in the early 70's Stauffer and Coventry condemned this approach because in their eyes it meant: "too much surgical trauma to the patient", other authors have reported satisfactory results. Irrespective of the surgical indications, the surgical trauma to the patient is undeniably associated with a considerable complication rate as well as peri- and postoperative morbidity. Recently a laparoscopic approach for anterior interbody fusion of the lumbosacral level has been described. Although this endoscopic, transperitoneal approach can also be applied to the L4/5 level, it seems to be associated with considerable technical difficulties as well as with a higher complication rate due to the necessity of preparation and dissection of the major abdominal vessels. For the spine surgeon, the application of laparoscopic surgical techniques to the anterior lumbar spine implies several real as well as potential difficulties:

The technical aspects: The spine surgeon is mostly not familiar with laparoscopic surgery. He must learn and train a completely new surgical technique with surgical equipment he is not familiar with. He has to operate in an anatomical region which endoscopic anatomy is not well known to him. Laparoscopic surgery implies the risk of technique - and / or equipment - related potential complications. It must be performed with at least two assistants also trained in this technique. In case of vascular complications, a quick exposure (within 1 - 2 minutes) of the situs is not possible. The laparoscopic approaches described up to now (April 1997) seem to be only reasonable for interbody fusion of the level L5/S1.

The medical-legal aspects: As a consequence of this technical aspects, the spine surgeon will be dependent on the collaboration of a surgeon trained in laparoscopic surgery as well as on a vascular surgeon. This will be required not only in the learning phase or in case of intra-operative complications. As long as laparoscopic surgical approaches will not be included in the educational program for orthopaedic surgery, a laparoscopic and / or vascular surgeon at least in stand-by is mandatory during laparoscopic anterior spine surgery.

There is general agreement on the fact, that a surgical technique can only be termed a 'routine procedure' if it is performed in at least 50 cases a year by the same surgeon. There is no general agreement on the indications for anterior lumbar interbody fusion, as well as on the indications for laparoscopic interbody fusion. This means, that 50 cases per year will be hard to reach for the majority of the orthopaedic departments not exclusively specialized in spinal surgery.

These considerations were challenging the author to develop two new, standardized surgical approaches for **mini**mal invasive **a**nterior **l**umbar **i**nterbody **f**usion. These approaches are applicable for the lumbar motion segments L2 - S1 and represent a microsurgical modification of the retroperitoneal (L2 - L5) and transperitoneal (L5/S1) surgical approaches which are well known to every spine surgeon. The surgical techniques, their application, as well as the preliminary results will be described in the following paper.

H. Michael Mayer, M.D.

1. The retroperitoneal approach to L2/3, L3/4 and L4/5

1.1 Pre-op planning and preparation of the patient

The lumbar segments L2/3, L3/4 und L4/5 are reached by a retroperitoneal approach from the left side. Preoperative conventional x-rays of the lumbar spine in two planes are mandatory in order to get enough information on the spine curvature as well as the height of the intervertebral space to be approached. Additional information on the shape of the inferior borders of the ribcage, which is important for the approach to L2/3, can also be obtained. In addition, a MRI of the lumbar spine is recommended to enhance the information on the underlying pathology, as well as on anatomical details which facilitates the operation: The size, shape and localization of the psoas muscle in relation to the anterolateral border of the lumbar spine can be assessed. The size and course of the retroperitoneal vessels are also determined. Especially for the approach to L 4/5, MRI-examination should be focused on the presence and size of an ascending lumbar vein or iliolumbar vein on the left side.

Although the approach is retroperitoneal, the patients are treated with routine mechanical large-bowel preps to empty the colon. Once the patient is anesthetized, a FOLEY catheter and a nasogastric tube are inserted. Arterial and central venous pressure-lines are placed because hemodynamic monitoring is important.

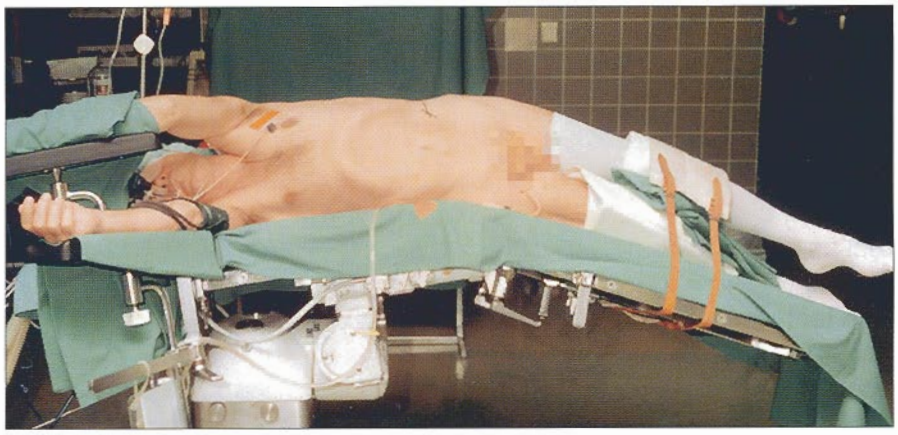


Fig. 1.01

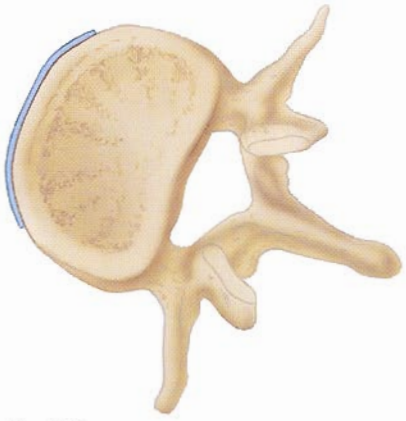


Fig. 1.02

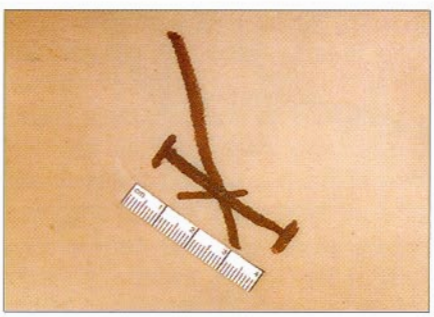
Level	Tilt
L2/3	40°
L3/4	30°
L4/5	20°

Fig. 1.03

1.2 Anatomical considerations

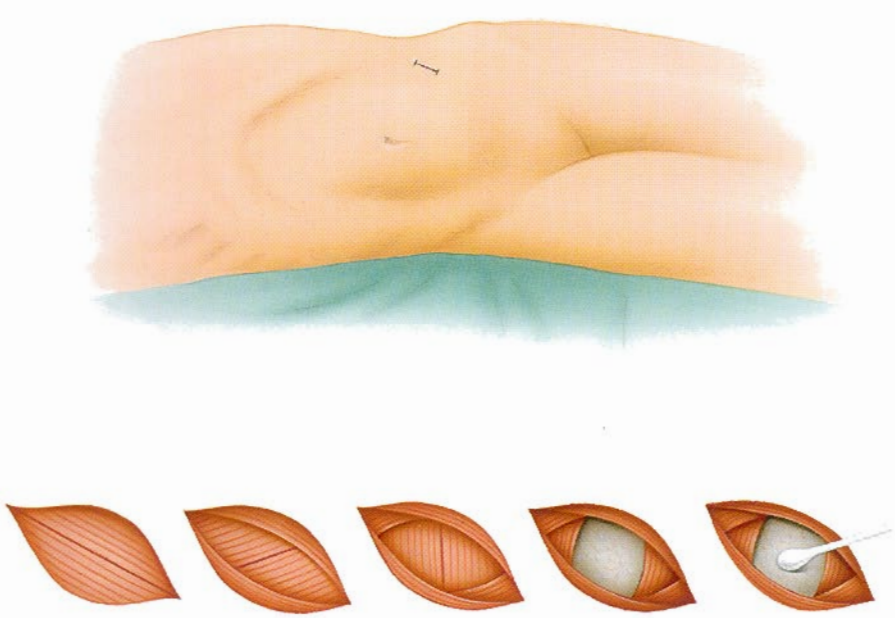
The disc spaces L 2/3, L 3/4 and L 4/5 are reached through a left-sided retroperitoneal approach. For this purpose, the patient is placed obliquely in a right lateral decubitus position (see 1.03). Except for the microsurgical technique, this approach is similar to the conventional retroperitoneal approach to the lumbar spine. In contrary to the conventional approach, segmental lumbar arteries and veins are not routinely exposed. At L 4/5, the ascending lumbar vein must sometimes be dissected, clipped and cut, in order to achieve a safe retraction of the common iliac vein from the intervertebral space. Since the operation is performed through a 4 cm skin-incision, it should be performed with the aid of a surgical microscope. It can as well be performed with the help of loupes and a headlamp.

Fig. 1.04



The characteristics of the minimal invasive approach are the muscle-splitting technique and the temporary fixation of the spreader-system by screws which are inserted into the adjacent vertebrae.

Fig. 1.05



1.3 Positioning

The patient is placed in a right lateral decubitus position on an adjustable surgical table (Fig.1.01). The table is tilted to create a left convex bending of the lumbar spine. According to the level to be approached, the table is then tilted backwards in the axial plane for 20 degrees (L4/5), 30 degrees (L3/4) or 40 degrees (L2/3). Due to the convergent course of the anterior longitudinal ligament in the caudad-cranial direction, this adjustment leads to a positioning of the lateral border of the anterior longitudinal ligament on top (Fig.1.02). It thus serves as a landmark for the introduction of the anchoring screws (see below). The whole table is then tilted under fluoroscopic control in order to achieve a parallel projection of the vertebral endplates of the level to be approached (Fig.1.03). The cranio-caudad as well as anteroposterior projection of the center of the disc space onto the skin-level is marked (Fig.1.04).

1.4 Surgical steps

The author prefers the use of a surgical microscope during the whole procedure.

Skin - retroperitoneal space:

A 4 cm skin-incision is centered above the projection of the center of the disc space in an oblique direction parallel to the fibers of the external oblique abdominal muscle (Fig. 1.05). The retroperitoneal space is reached by a blunt, muscle splitting approach. Each muscular layer (external oblique, internal oblique, transverse abdominal muscle) is dissected in the direction of their fiber orientation (Fig. 1.05). Care is taken to preserve the branches of the intercostal nerves 10 - 12 as well as the iliohypogastric/ilioinguinal nerves which occasionally cross the surgical field between the layers of the internal oblique and transverse abdominal mucles. Thus innervation of the rectus abdominis is preserved. The splitting of the transverse abdominal muscle should be performed as far lateral as possible to avoid opening of the peritoneum. There is more retroperitoneal fat tissue beneath the lateral part of the transverse muscle. Moreover, the peritoneum is more adherent to the inner wall of the medial part of this muscle.

Retroperitoneal Space - Intervertebral Region:

The retroperitoneal space is enlarged by careful, blunt dissection with cottonoids and modified LANGENBECK retractors. Small bridging veins between the fat tissue and the inner wall of the lateral abdomen are closed with bipolar coagulation and dissected. The psoas muscle is identified as a first anatomical landmark (Fig. 1.06). The prevertebral tissue including the urether and the vascular bundle are gently retracted towards the midline using the blunt hooks. The anterolateral attachments of the psoas muscle to the lumbar spine are identified. They are incised and sharply dissected from the lateral circumference of the disc space (Fig.1.07). Dissection should be performed very carefully from the ventrolateral aspect of the vertebral bodies. The segmental vessels of the vertebral body inferior to the disc space can be exposed (Fig.1.08). In rare occasions, the segmental vessels of the inferior vertebral body need to be ligated with endoclips, cut and dissected from the vertebral surface. However, dissection is rarely necessary at the levels L3/4 or L2/3. At L4/5, the ascending lumbar vein may obstruct the inferior lateral angle of the surgical field and needs to be ligated with endoclips and dissected (Fig. 1.09). Usually the lateral border of the left common iliac vein can be identified (Fig. 1.07). Dissection should not be extended posterior to the pedicle entrance in order to avoid irritation of the lumbar nerve roots. The branches of the sympathetic chain are identified. They can occasionally be mobilized and preserved, however, in the majority of cases they need to be cauterized and dissected. Thus the lateral border as well as the anterior and lateral circumference of the anterior longitudinal ligament can be exposed (Fig. 1.07, 1.08, 1.09 and 1.10). The blunt dissection is then completed to expose between 5 and 10 mm of the adjacent vertebral bodies. The disc space level is then verified under fluoroscopic control. The spatial orientation of the disc space is then identified by cutting the annulus fibrosis parallel to the vertebral endplates (Fig. 1.11).

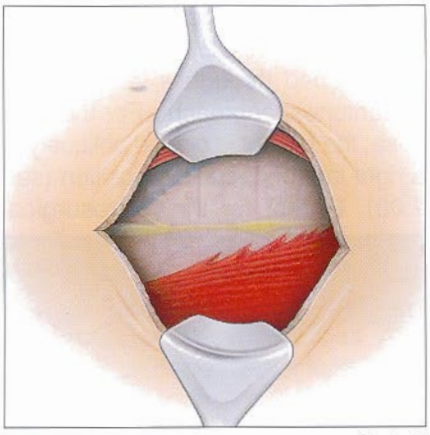


Fig. 1.06

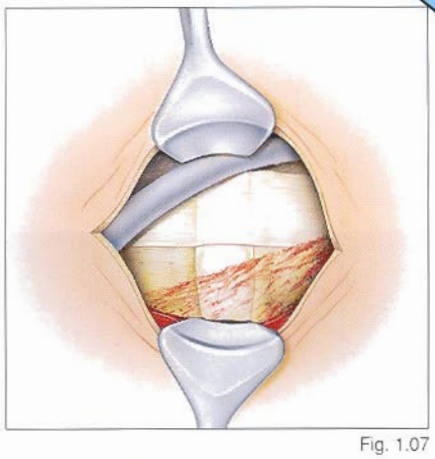


Fig. 1.07

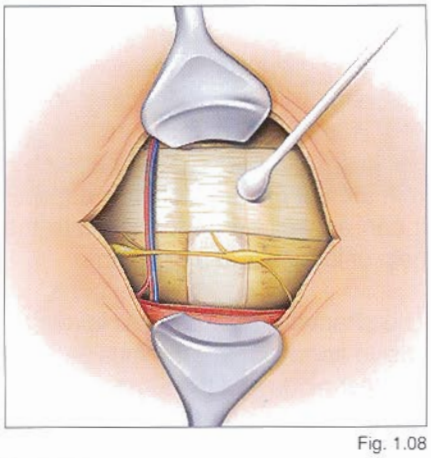


Fig. 1.08

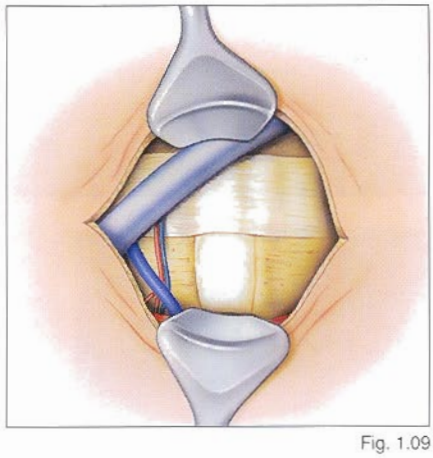


Fig. 1.09

Fig. 1.10

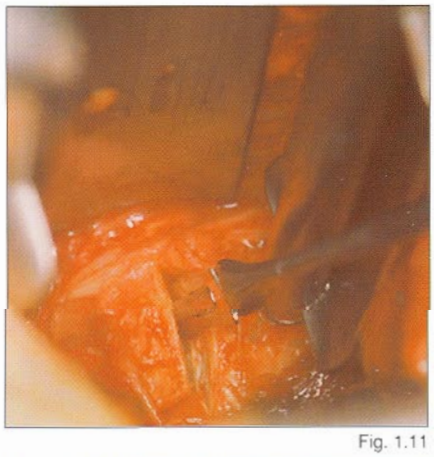


Fig. 1.11

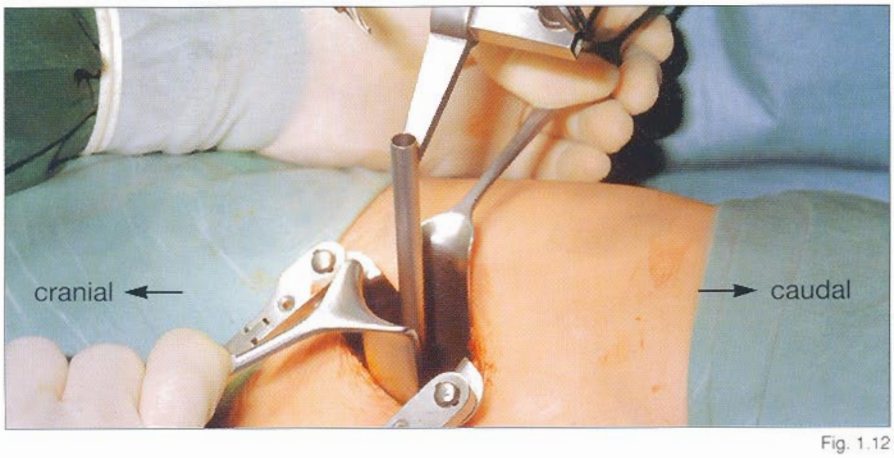


Fig. 1.12

Placement of the self-retaining retractor frame:

With a drill guide, the anterolateral cortex of the adjacent vertebral bodies is drilled in a strictly vertical direction to create the hole for the distraction screws. The entry point is about 5 - 8 mm from the intervertebral space at the lateral border of the anterior longitudinal ligament (Fig.1.12). The drill has a safety range of 10 mm and penetrates only the anterolateral cortex of the vertebral body. It is directed vertically and parallel to the vertebral endplates.Then specially designed anchoring screws are inserted (Fig. 1.13). These screws serve as an anchor for the cranial and caudal retractor blades which are then inserted (Fig. 1.14, 1.15 and 1.16). A retractor frame is then attached to the blades with a ball snap closure (Fig. 1.17 and Fig. 1.18). A sharp muscular blade is attached laterally to deflect the psoas muscle whereas a blunt vascular blade is inserted medially to retract the retroperitoneal vessels. Both blades are independently adjustable (Fig. 1.19). In cases in which a mere anterior approach is performed, a slight distraction of the intervertebral space can be achieved by adjusting the anchoring screws of the cranial-caudal blades. The anterolateral circumference of the segment to be fused is now exposed (Fig. 1.20).

Interbody fusion:

Anterior lumbar interbody fusion with an autologous iliac bone grafts is now described. However, any other type of anterior interbody fusion including the use of homografts or allografts (e.g. fusion cages) should be possible with this approach.

Fig. 1.13

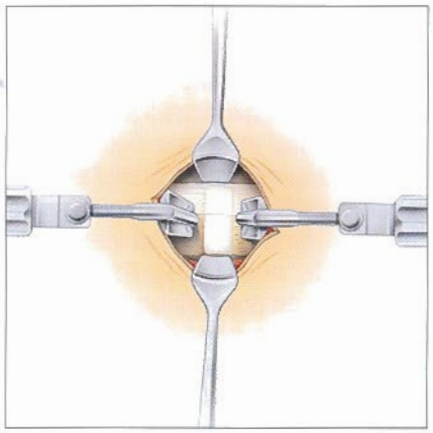


Fig. 1.14

Fig. 1.15

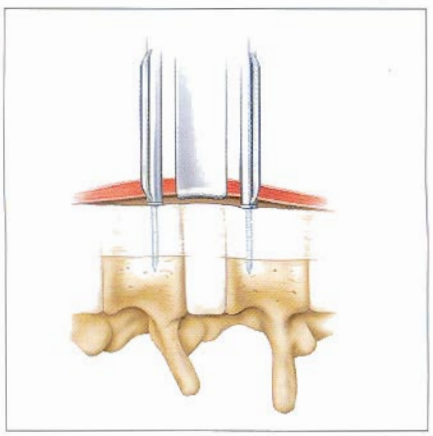


Fig. 1 16

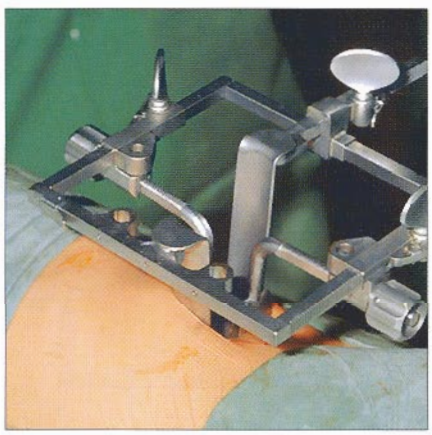


Fig 1.17

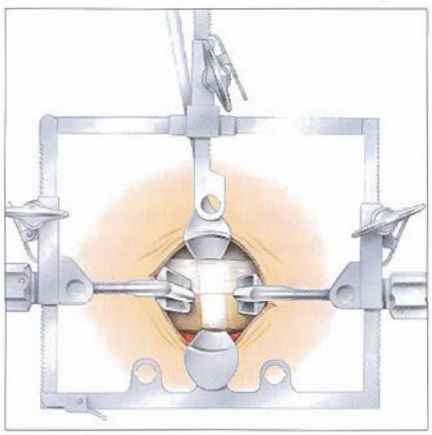


Fig. 1.18

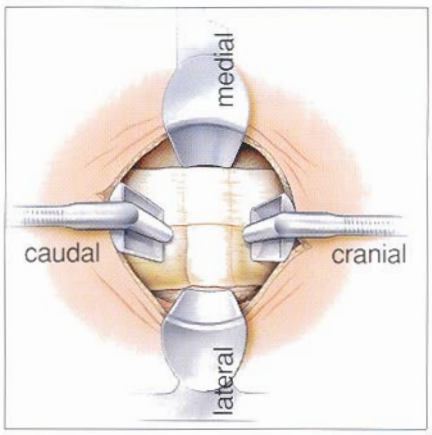


Fig. 1.19

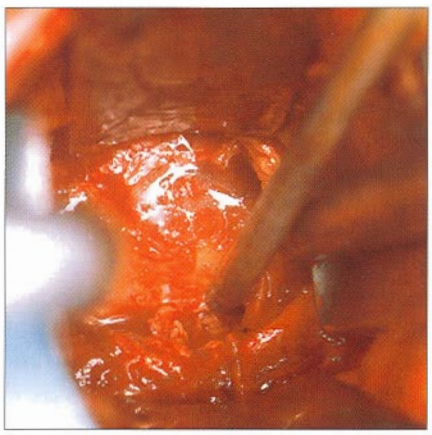


Fig. 1.20

Discectomy and Preparation of graft - bed:

Starting from the anatomical midline of the anterior longitudinal ligament, the anulus fibrosis is incised in its antero-lateral circumference and the disc space is cleaned. The endplates are carefully removed with chisels (Fig. 1.21, 1.22, and 1.23). To achieve parallel fusion planes, removal of the endplates is started with a specially designed parallel bladed osteotome. The subchondral bone is then smoothed with a high-speed drill (Fig.1.24 and 1.25).

In case, an anterior decompression of the spinal canal is necessary, this can also be performed by removal of the redlined parts of the vertebral bodies shown in figure 1.23. The height and depth of the iliac crest graft needed is measured with sliding callipers (Fig.1.26 and Fig.1.27).

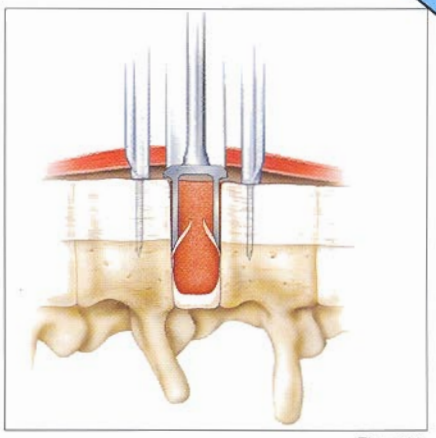
Graft - harvesting:

A tricortical iliac bone graft is harvested through a separate small incision over the lateral iliac crest on the same side. The skin incision is placed at least 3 cm lateral to the spina iliaca anterior superior in order to prevent dissection of the lateral femoral cutaneous nerve. The bone graft is also taken from the middle part of the iliac crest. It is removed using a double saw blade which can be adjusted to the size of the bone graft needed (Fig. 1.28). The graft is removed with the help of a graft cutter. In addition, as much cancellous bone as possible is harvested from the ilium. The bone defect is sealed with bonewax and covered with gelfoam, a drainage is inserted and the wound closed in layers.

Grafting:

A small hole is drilled into the graft which is then mounted onto a graft holder (Fig. 1.29) and impacted into the intervertebral space (Fig. 1.30 and Fig. 1.31). Additional cancellous bone from the iliac crest as well as from the removed parts of the vertebral bodies are impacted into the intervertebral space in front as well as behind the impacted tricortical graft.

Fig. 1.21



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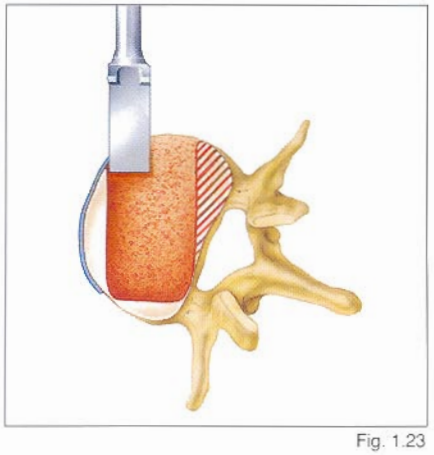

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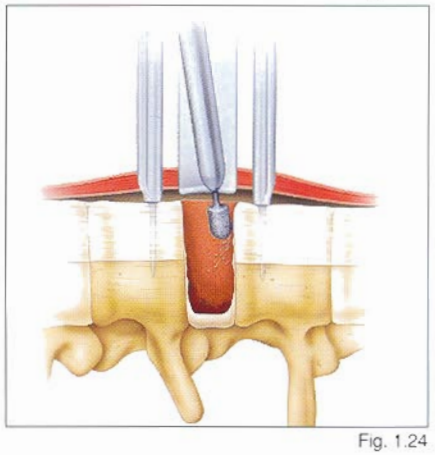

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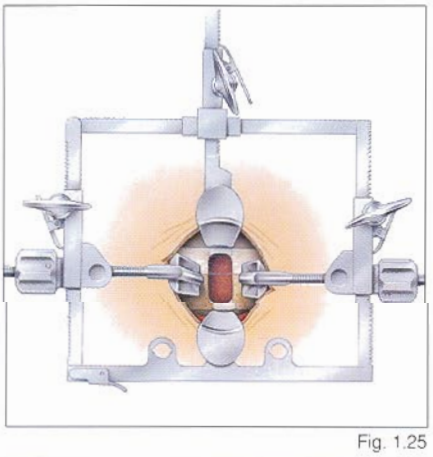

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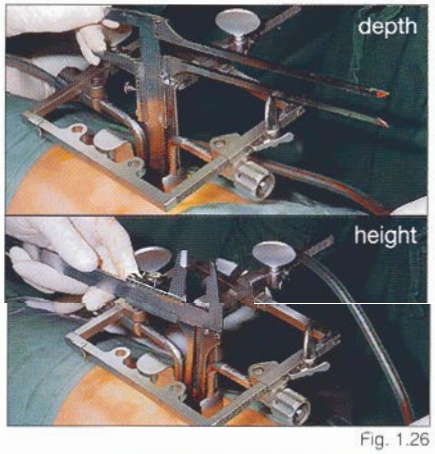

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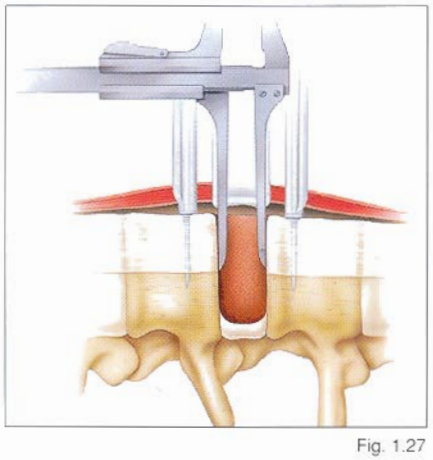


Fig. 1.27

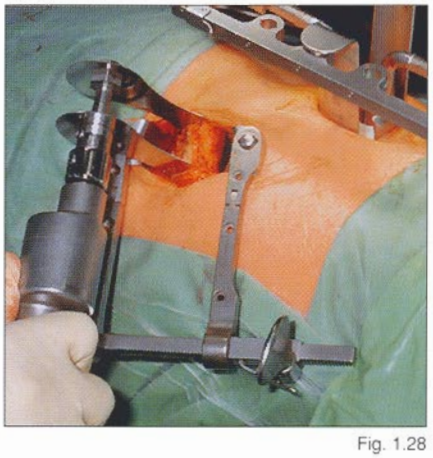


Fig. 1.28

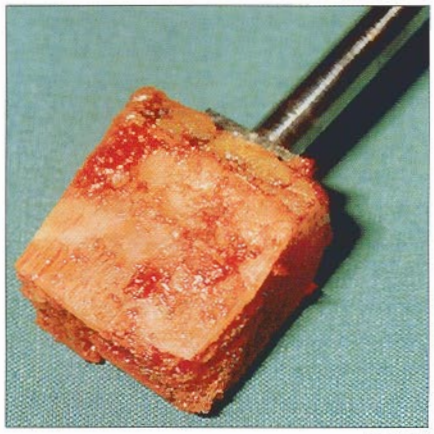


Fig 1.29

Fig. 1.30

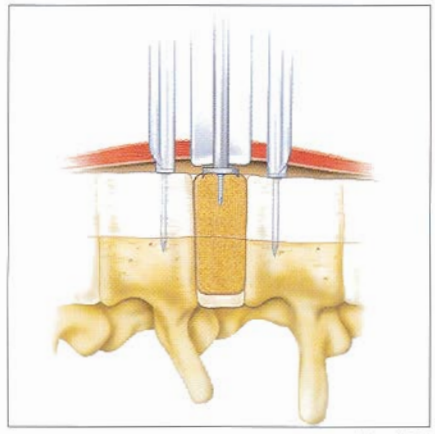


Fig. 1.31

Retreat:
The retractor frame is removed, the holes for the anchoring screws are sealed with bonewax and the fusion area is covered with Surgicell. The muscle layers are closed with absorbable sutures, the skin is closed with an intracutaneous suture.

1.5 Postoperative treatment

Usually there are no drains placed at the fusion site. The wound-drainage at the donor site of the iliac crest bone-graft is removed on the second post-op day. Since most of the patients have had an additional posterior stabilization by an internal fixator, they are allowed to get out of bed between the third and fifth postoperative day. However, our preliminary experience shows that an earlier mobilisation may be possible. From the first postoperative day, patients receive the usual physiotherapy program starting with isometric exercises. Thromboembolic prophylaxis is performed with a colloidal solution starting with 500 ml intraoperatively, on the first postoperative day, as well as on the third postoperative day. From the fourth postoperative day, low-dose Heparin 3 x 5,000 I.U. is given in case the patient is not yet mobilized at that time. If there are no complications, the patients usually leave the hospital between the seventh and fourteenth postoperative day.

2. The transperitoneal approach to L5/S1

2.1 Pre-op planning and preparation of the patient

Meticulous preoperative planning is paramount for the successful performance of a transperitoneal minimal invasive approach to L5/S1. Conventional x-rays of the lumbar spine give information on the anterior height of the intervertebral space L5/S1, on the sacral inclination as well as on the orientation of the intervertebral disc space plane (Fig. 2.01). The level of the bifurcation of the aorta and vena cava must be determined preoperatively. The prevertebral space of the lumbosacral junction must be evaluated very carefully on MRI. Especially the course of the common iliac artery and vein on both sides must be determined. In addition, MRI gives information on the thickness of the retroperitoneal fatpad in front of the L5/S1 disc space (Fig. 2.02 and 2.03). When previous abdominal operations have been performed, the indication for a minimal invasive transperitoneal approach must be evaluated individually. It is possible to start with a microsurgical approach. In case of larger intraabdominal scar tissue or fibrous bands, it is possible to enlarge the approach; however, starting with this new surgical technique, the author advises the use of the conventional approach with a larger skin incision in previously operated cases. The L5/S1 interspace is reached through a mini-laparotomy in the midline. Since the surgeon stands between the spreaded legs of the patient, abduction of the hip-joints should be determined preoperatively. The patients are treated with routine mechanical large-bowel preps as well as purgatives starting 24-hours before the operation. This, as well as complete relaxation, are necessary to manipulate the small bowel as well as the sigmoid colon intraoperatively in order to expose the parietal peritoneum in front of the promontory. Anesthesia is performed in the same manner as described for the retroperitoneal approach.

Fig. 2.01

Fig. 2.02

Fig. 2.03

2.2 Anatomical considerations

The L5/S1 disc space is reached from a midline approach. The visual plane of the surgeon is in parallel to the orientation of the L5/S1 disc space (Fig. 2.04). It is absolutely necessary to know the level of the bifurcation of the major retroperitoneal vessels in order to have free access to the L5/S1 interspace. Before entering the retroperitoneal space, it is necessary to palpate the course of the common iliac arteries and, in most of the cases, it is possible to identify the course of the ureter crossing the common iliac artery on the right side. The peritoneum parietale is opened by a longitudinal incision about 1.5 cm medial and parallel to the course of the right common iliac artery; thus, injury to the ureter as well as to the superior hypogastric plexus is avoided. In the prevertebral space, only blunt dissection is performed. One of the major advantages of the microsurgical approach is the fact that the superior hypogastric plexus can be identified and carefully pushed to the left side thus avoiding its injury.

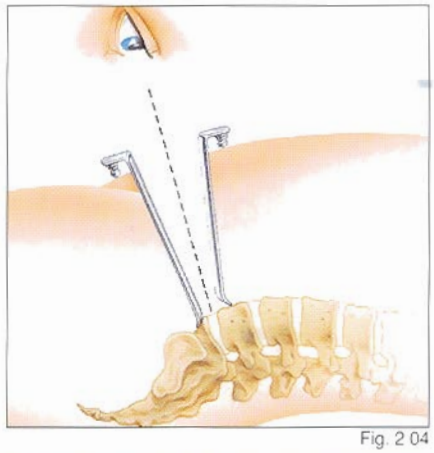


Fig. 2.04

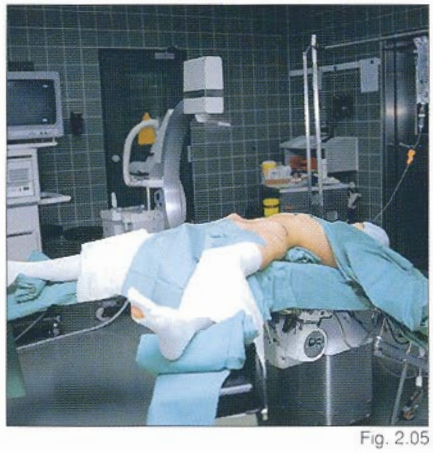


Fig. 2.05

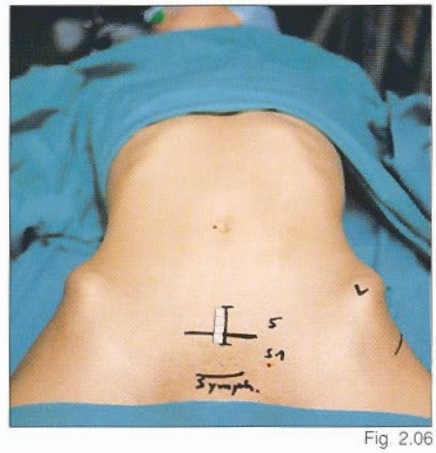


Fig. 2.06

2.3 Positioning

The patients are placed in a supine Trendelenburg position (trunk tilted 20 - 30°) with the lumbar spine hyperextended and legs in maximum abduction (Fig. 2.05 and 2.06). The table is tilted head-down. The legs of the patient must be supported by soft cushions and fixed onto the leg holders. The surgeon is standing between the legs of the patient and is thus working in the plane of the L5/S1 disc space. The level of the L5/S1 disc space is marked onto the skin after a lateral x-ray projection as well as the anterior border of the promontory (Fig. 2.07). The incision for harvesting the autogenous iliac bone-graft is marked on the left iliac crest. The operation is performed with a surgical micro- scope. However, it can also be done with headlamp and loupes (Fig. 2.08).

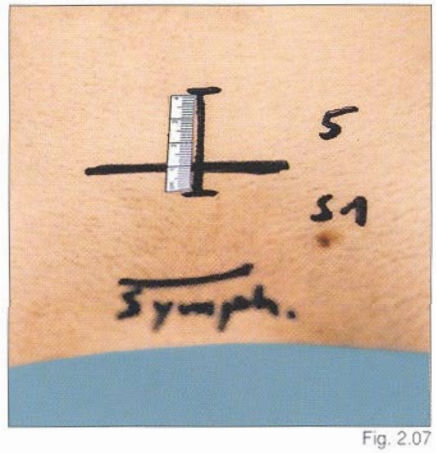


Fig. 2.07

Fig. 2.08

2.4 Surgical steps

Skin - intraperitoneal cavity:
A 4 cm - skin-incision is placed in the midline of the abdomen centered over L5/S1 which is usually the transition zone between the lower and middle third of the umbilical-symphyseal distance. The skin incision can be placed transverse or longitudinal. In females, a transverse incision should be preferred. The peritoneum is reached by sharp dissection of the linea alba in the midline (Fig. 2.09). A muscle retractor allows the exposure of the peritoneum viscerale (Fig. 2.10). It is dissected in the midline and armed with sutures. The mesenterium with the ileum is carefully pushed into the upper left abdominal cavity using small towels. The same is done to the colon sigmoideum which is carefully retracted to the left (Fig. 2.11 and 2.12). The transperitoneal retractor is inserted which exposes the promotorium. Two transverse blades serve to expose the anterior circumference of L5/S1, the right common iliac artery as well as the retroperitoneal course of the urether on the right side. The cranial blade ist placed onto the inferior border of the L5 vertebral body, the inferior blade is placed into the pre-sacral space. Now, the peritoneum parietale is shown (Fig 2.13).

Retroperitoneal Space - Intervertebral Region:
The peritoneum parietale is incised with microscissors in a craniocaudal direction (Fig.2.14). The incision is made about 15 mm medial to the right common iliac artery. The retroperitoneal fat tissue is exposed and carefully retracted to the left side including the superior hypogastric plexus. This is done very gently using cottonoid pads and avoiding damage to the plexus. Bi-polar coagulation should be avoided or at least restricted to a minimum. Thus, the anterior circumference of L5/S1 is exposed. The middle sacral artery/vein are exposed, closed with a clip and dissected (Fig. 2.15). The transperitoneal retractor is now reinserted underneath the peritoneum in order to expose the anterior intervertebral circumference (Fig. 2.16).

Interbody fusion:
Anterior lumbar interbody fusion with an autologous iliac bone graft will be described. However any other type of anterior interbody fusion including the use of homografts or allografts (e.g. fusion cages) should be possible with this approach.

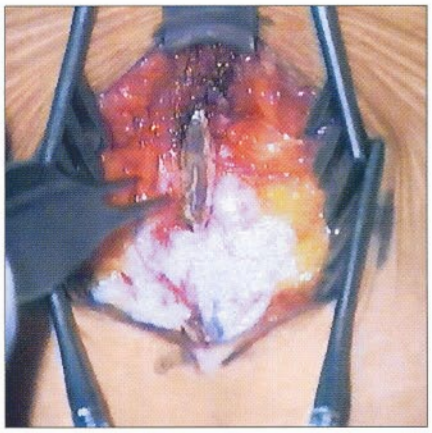


Fig. 2.09

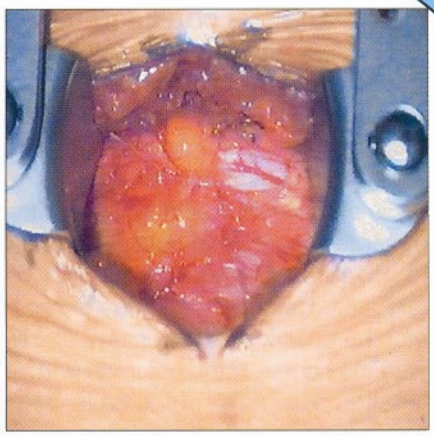


Fig. 2.10

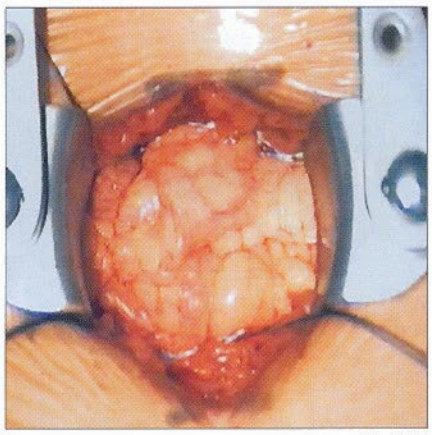


Fig. 2.11

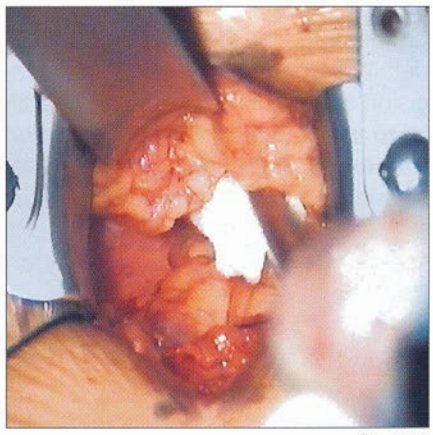


Fig. 2.12

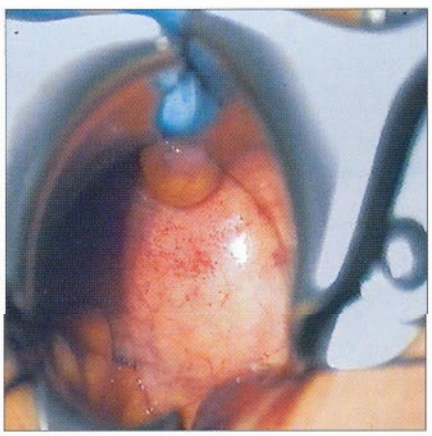


Fig. 2.13

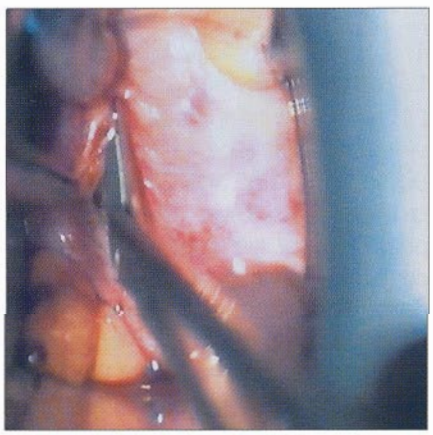


Fig. 2.14

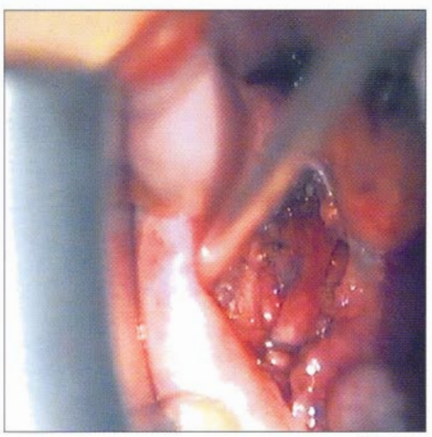


Fig. 2.15


Fig. 2.16

Discectomy and Preparation of Graft Bed:
The anterior longitudinal ligament and the anulus fibrosis are incised in a rectangular shape (Fig. 2.18). The disc space is emptied with rongeurs (Fig. 2.19). The endplates are curetted and carefully removed with chisels and the subchondral bone is smoothed with a high-speed drill (Fig. 2.20 and 2.21). If necessary, the endplates can be removed as far posterior until the posterior longitudinal ligament is exposed. Thus, decompression of the anterior part of the spinal canal at L5/S1 can also be performed. The height and depth of the iliac crest graft needed is measured with sliding callipers.

Graft harvesting:
A tricortical iliac bone graft is harvested and impacted in the same manner as described above.

Grafting:
The graft is prepared and inserted the same way as has been described for the retroperitoneal approach (Fig 2.22 and 2.23). However, the orientation of the graft ist strictly in the midline in parallel to the sagittal plane. Additional cancellous bone from the iliac crest as well as from the removed parts of the vertebral bodies is impacted into the intervertebral space on both sides of the graft as well as anterior to it (Fig. 2.24). The fusion area is then covered with Surgicell.

Retreat:
The retractor is partly removed in order to expose the peritoneum for suture. The peritoneum parietale is closed with a running resorbable suture and the abdominal towels are removed. No drainage is necessary. The peritoneum viscerale is closed with a running, resorbable suture and the linea alba with resorbable single sutures. The skin is closed with an intracutaneous suture.

2.5 Post-op treatment
The postoperative treatment is identical to the retroperitoneal appraoch; however, mobilization of the patient is not performed before complete bowel function has returned.

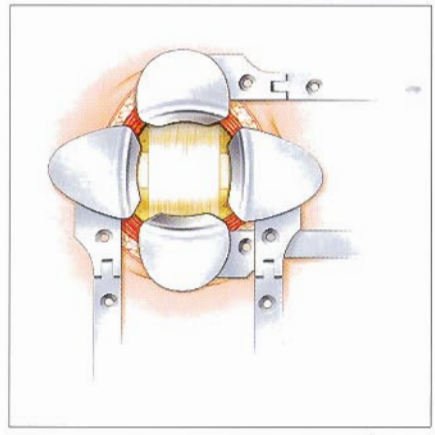


Fig. 2.17


Fig. 2.18

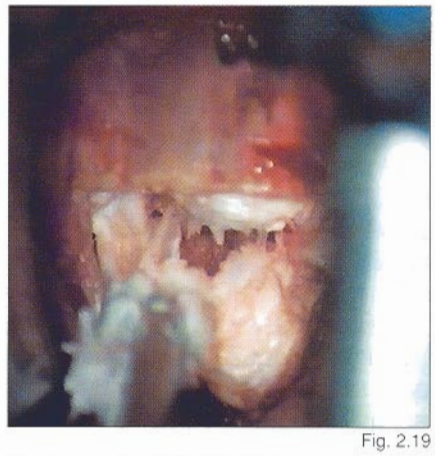


Fig. 2.19

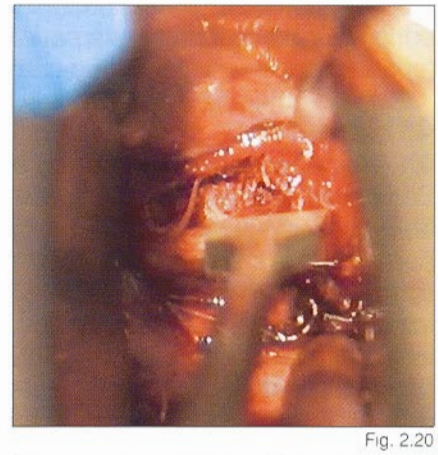


Fig. 2.20


Fig. 2.21

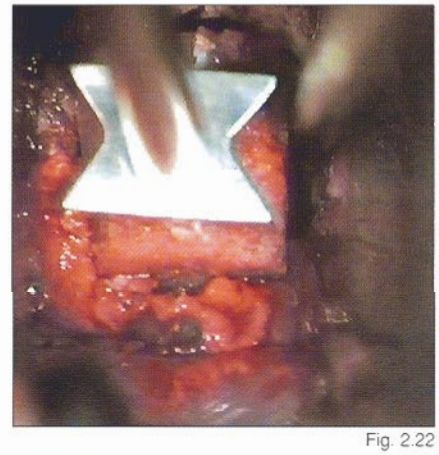


Fig. 2.22

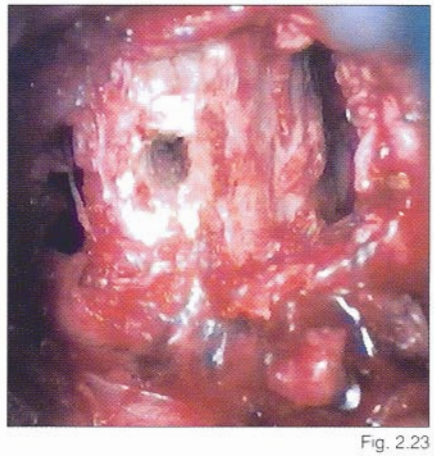


Fig. 2.23

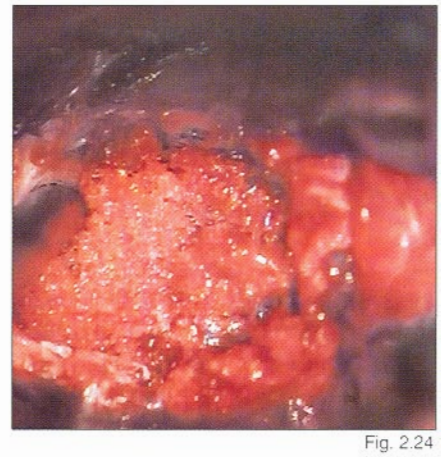


Fig. 2.24

3. Selection of Patients

3.1 Indications

The two microsurgical approaches described are basically indicated in all cases in which mono- or bisegmental anterior interbody fusion is required. The main indications in our series were degenerative or isthmic spondylolisthesis, unstable spinal stenosis, failed back surgery syndrome, and painful degenerative disc disease. Up to now, we do not yet have experience with this approach for the anterior stabilization of lumbar fractures, tumors or spondylitis. However, these approaches might also be feasable in these kinds of pathology in individual cases.

3.2 Contraindications

Previous abdominal operations might be a relative contraindication because of intraabdominal adhesions. If such adhesions are located in the surgical route to L5/S1 they can be dissected quite easily. However vision of the adjacent parts of the abdominal cavity is limited. It is our practice to start with the microsurgical technique in these cases. If there are intraoperative difficulties appearing, the approach can be quickly enlarged to a conventional surgical exposure. There are no other specific contraindications for this approach. It is our experience that, even in obese patients (which were more than 60% in our own series (see 4)), microsurgical anterior lumbar interbody fusion can be performed.

4. Results

4.1. Retroperitoneal approach to the levels L2/3, L3/4 and L4/5

Between January 31st, 1995 and April 16th, 1997 a total of 73 patients received microsurgical anterior lumbar interbody fusion (MINIALIF). The underlying diseases were degenerative or isthmic spondylolisthesis, degenerative instable disc disease, unstable spinal stenosis, fracture, pseudoarthrosis or failed back surgery syndrome. 61 patients had single level (Th12/L1 : n = 2; L2/3 : n = 2; L3/4 : n = 8; L4/5 : n = 49) and 12 double level (L2/3/4 : n = 2; L3/4/5 : n = 10) fusions. Mean operating time was 112 min (range 60 - 165 min). The intraoperative blood loss was 61.9 ml (range: 20 - 120 ml) at the fusion site and 62.4 ml (50 - 180 ml) at the donor site. No drainage was necessary at the fusion site, no patient required blood transfusions. Except for 2 patient all patients with a follow up of six months showed solid interbody fusion. Fig. 4.1 and 4.2 show a lateral X-ray and a CT scan of L4/5 after **MINIALIF.**

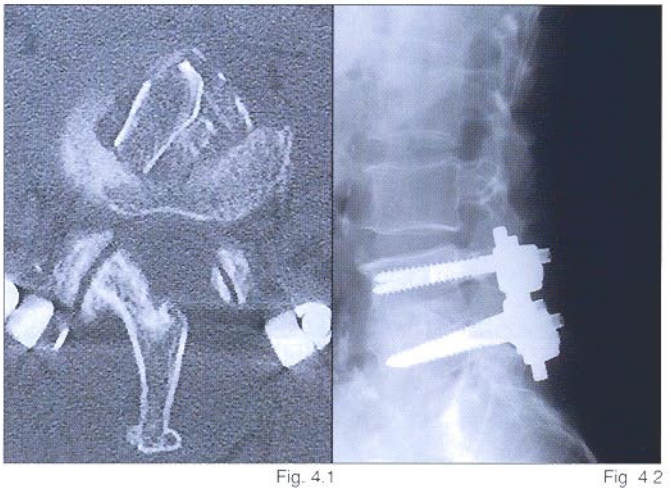


Fig. 4.1 Fig 4.2

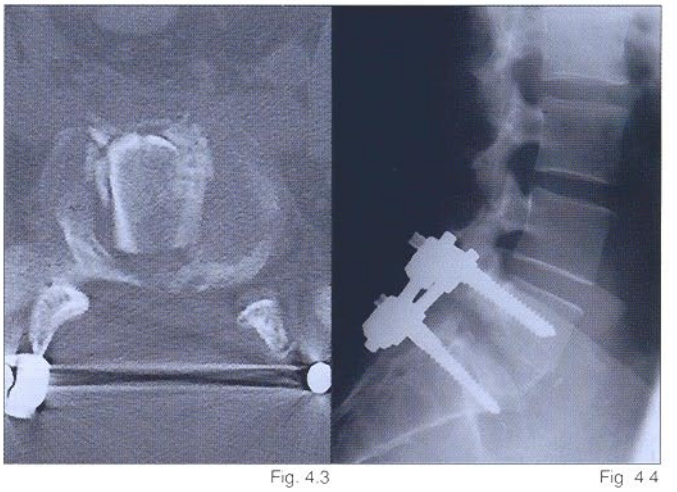


Fig. 4.3 Fig 4.4

4.2. Transperitoneal approach to L5/S1

In the same time span a total of 34 patients received microsurgical anterior lumbar interbody fusion of L5/S1. The underlying diseases were degenerative or isthmic spondylolisthesis failed back surgery, degenerative instabilities, pseudoarthrosis or spondylitis. All patients had single level fusions (L5/S1 : n = 32; L5/6 : n = 2). Mean operating time was 129.4 min (range 65 - 205 min). The intraoperative blood loss was 65.9 ml (range: 20 - 300 ml) at the fusion site and 70.6 ml (30 - 250 ml) at the donor site. No drainage was necessary at the fusion site, no patient required blood transfusions. All patients followed up for 6 months or more show solid fusion. Fig. 4.3 and 4.4 show graft placement at L5/S1 after **MINIALIF.**

5. Complications

We had 1 pseudarthrosis in our series due to resorption of the bone-graft as well as one irritation at the lateral femoral cutaneous nerve at the donor site. We have had no other approach-specific complications in our series.

6. Potential complications and hazards

There are some specific potential complications and hazards, due to the microsurgical technique as well as due to the instruments, which should be mentioned here, although none of these possible complications have occurred up until now. Microsurgical dissection of the retroperitoneal space allows an excellent exposure of the anterolateral surface of the motion segment. However, dissection, especially of the retroperitoneal vessels, must be performed very gently and carefully since the segmental arteries and veins are rarely seen. This bears the potential hazard of rupture of these vessels by forcible distraction. Especially at L4/5, the common iliac vein of the left side, which sometimes crosses the anterior part of the intervertebral space, must be mobilized very carefully and an ascending lumbar vein must be identified before mobilization of the larger vessel. Exposure is much better when the ascending lumbar vein is ligated with endo-clips and dissected.
The insertion of the distraction screws must follow the guidelines described here, which again points out the importance of the exact positioning of the patient. Although, there is a theoretical chance of perforation of the screw-tip into the spinal canal; this can be avoided by exact positioning and preoperative planning.

In case the lateral border of the anterior longitudinal ligament cannot be identified, the distraction screw can be placed about 1 to 1.5 cm anterior to the medial border of the psoas muscle to be on the safe side. The distance of the insertion of the distraction screws to the endplate border must be at least 5 mm in order to avoid exposure of the screw tip after removal of the endplates.
At L5/S1, opening of the retractor frame in the retroperitoneal space must be performed very carefully in order to avoid over-distraction of the venous bifurcation. Especially at L5/S1, there is sometimes bleeding from large intraosseous veins. This bleeding can be controlled by small amounts of bone-wax, which are distributed on the bony surfaces with the high-speed diamond drill.

7. Conclusions

Minimal Invasive **A**nterior **L**umbar **I**nterbody **F**usion comprises two different microsurgical approaches to the lumbar segments L2/3, L3/4, L4/5 and L5/S1.

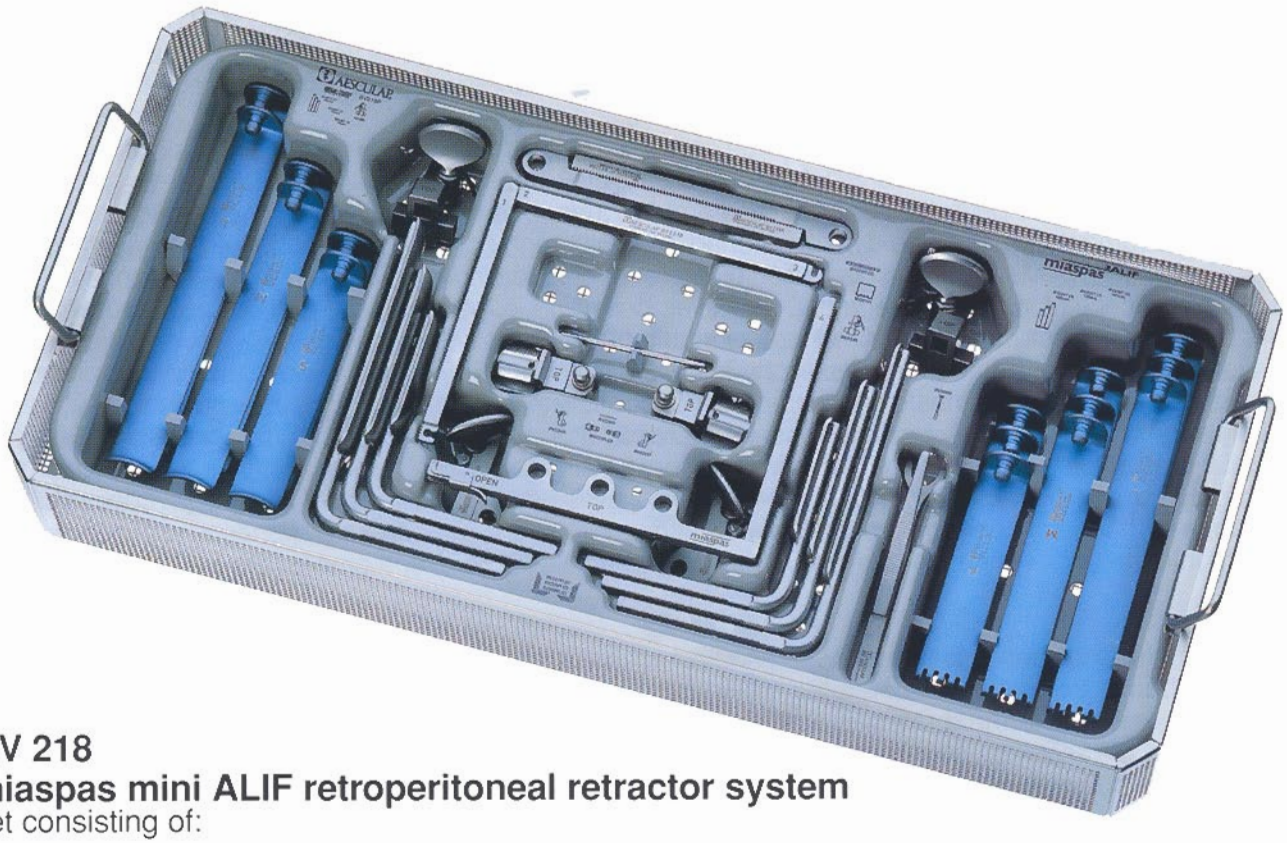
I. The retroperitoneal approach to L2/3, L3/4 and L4/5

- the segments L2/3 - L4/5 are reached through a retroperitoneal microsurgical approach through one 4 cm skin - incision
- the operation is carried out with the aid of a surgical microscope or a headlamp and loupes
- a special retractor system exposes the anterolateral surface of the intervertebral space through which ALIF can be performed in different manners (autografts, homografts, allografts)
- the operation is performed with one assistant
- mean operating time is below 2 hours
- mean blood loss below 100 ml
- good results in first 23 patients

II. The transperitoneal approach to L5/S1

- the lumbosacral junction is reached through a 4 cm midline incision between the umbilicus and the symphysis
- with a special retractor system, the segment L5/S1 is approached using a microscope or a headlamp and loupes
- the operation is performed with one / two assistants
- mean operating time is 130 min
- mean blood loss is below 200 ml
- good results in first 13 patients

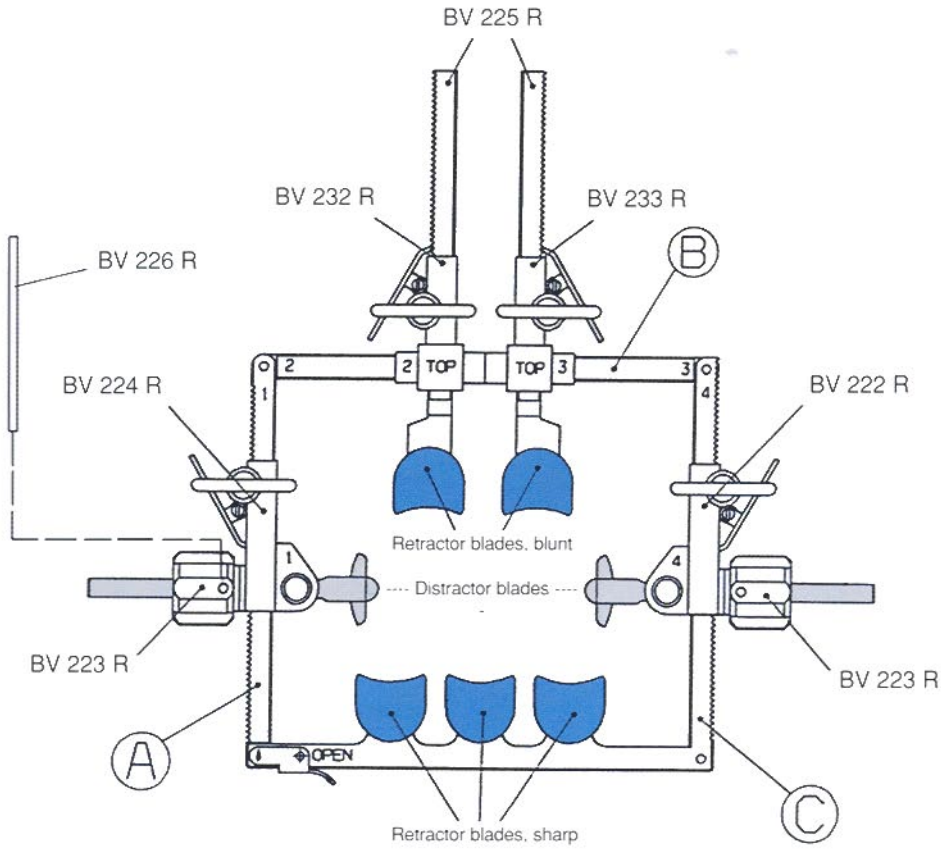
RETROPERITONEAL



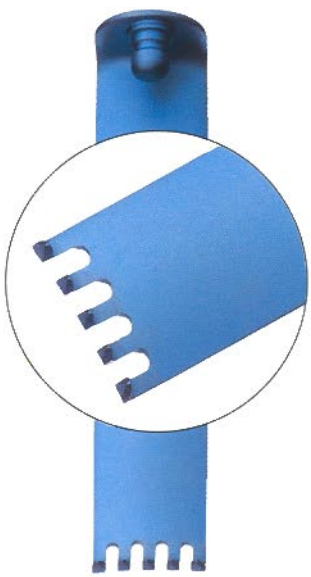
BV 218
miaspas mini ALIF retroperitoneal retractor system
set consisting of:

1 Piece	BV	219	P	orga-tray®, only
1 Piece	BV	221	R	Retractor frame, consisting of: (A) frame bar, toothed, (B) frame bar, (C) frame corner segment
1 Piece	BV	222	R	Sliding piece for cranial distractor blades
2 Pieces	BV	223	R	Retractor holding bracket for caudal and cranial distractor blades with adjusting screw
1 Piece	BV	224	R	Sliding piece for caudal distractor blades
2 Pieces	BV	225	R	Toothed rack with retractor blade attachment
1 Piece	BV	226	R	Spanner
2 Pieces	BV	227	R	Distractor blade, 95 mm, size "S"
2 Pieces	BV	228	R	Distractor blade, 125 mm, size "M"
2 Pieces	BV	229	R	Distractor blade, 155 mm, size "L"
1 Piece	BV	232	R	Toothed rack holding block, left
1 Piece	BV	233	R	Toothed rack holding block, right
3 Pieces	BV	234	T	Muscular retractor blade, sharp, 105 mm, Titanium, size "S"
3 Pieces	BV	235	T	Muscular retractor blade, sharp, 135 mm, Titanium, size "M"
3 Pieces	BV	236	T	Muscular retractor blade, sharp, 165 mm, Titanium, size "L"
2 Pieces	BV	239	T	Vascular retractor blade, blunt, 110 mm, Titanium, size "S"
2 Pieces	BV	240	T	Vascular retractor blade, blunt, 140 mm, Titanium, size "M"
2 Pieces	BV	241	T	Vascular retractor blade, blunt, 170 mm, Titanium, size "L"
1 Piece	BV	399	R	Forceps for press out of blades with ball snap closure
1 Piece	JF	223	R	Perforated basket, 540 x 254 x 70 mm
1 Piece	JF	511		Wrapping drape, 140 x 100 cm
1 Piece	JG	785	B	Identification label, red

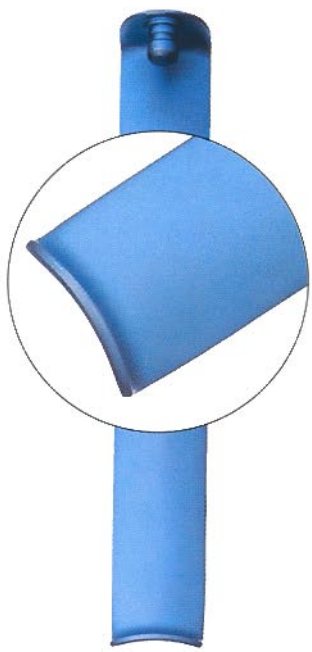
BV 220 R
miaspas mini ALIF retroperitoneal retractor system
= set with same content like BV 218 but without orga-tray® and perforated basket



BV 234 T - BV 236 T
Muscular retractor blade, sharp, titanium, semi-radiolucent, with ball snap closure



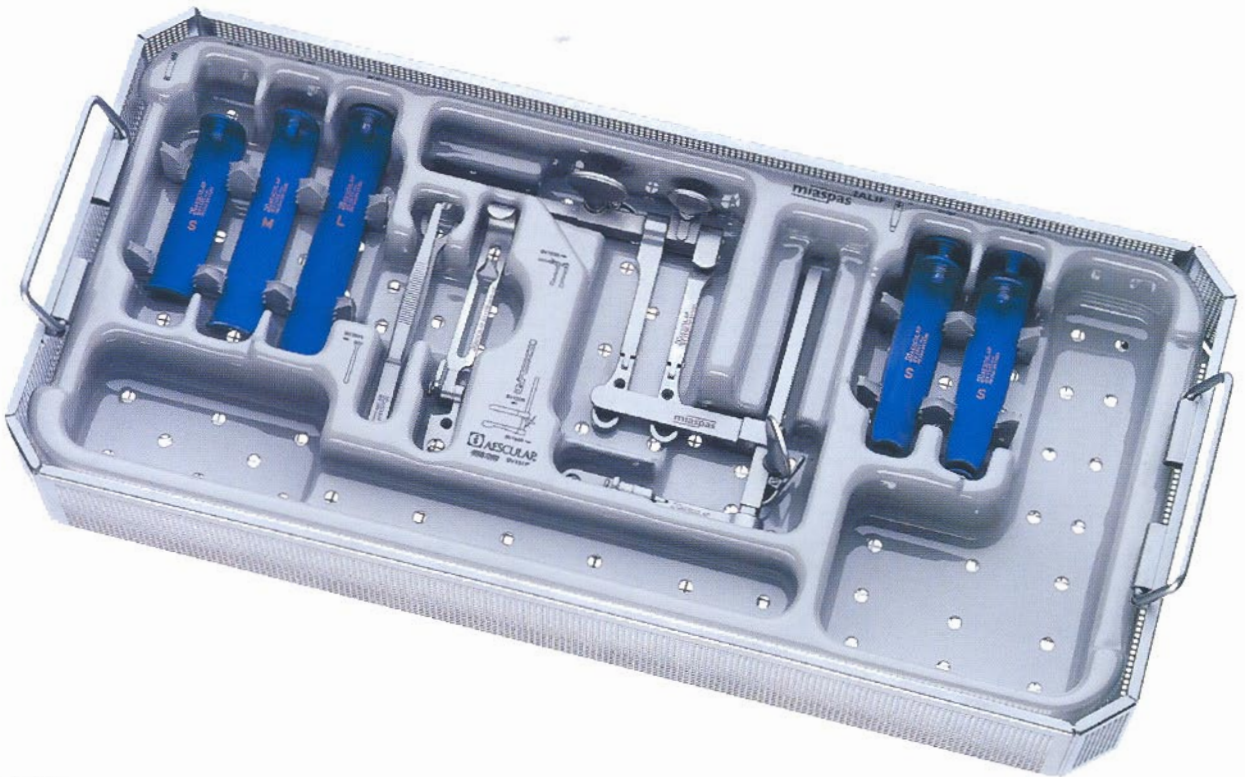
BV 239 T - BV 241 T
Vascular retractor blade, blunt, titanium, semi-radiolucent, with ball snap closure



BV 227 R - BV 229 R
Distractor blade

FF 880 S
Anchoring screw
4 x 25 mm
(unit = pair)

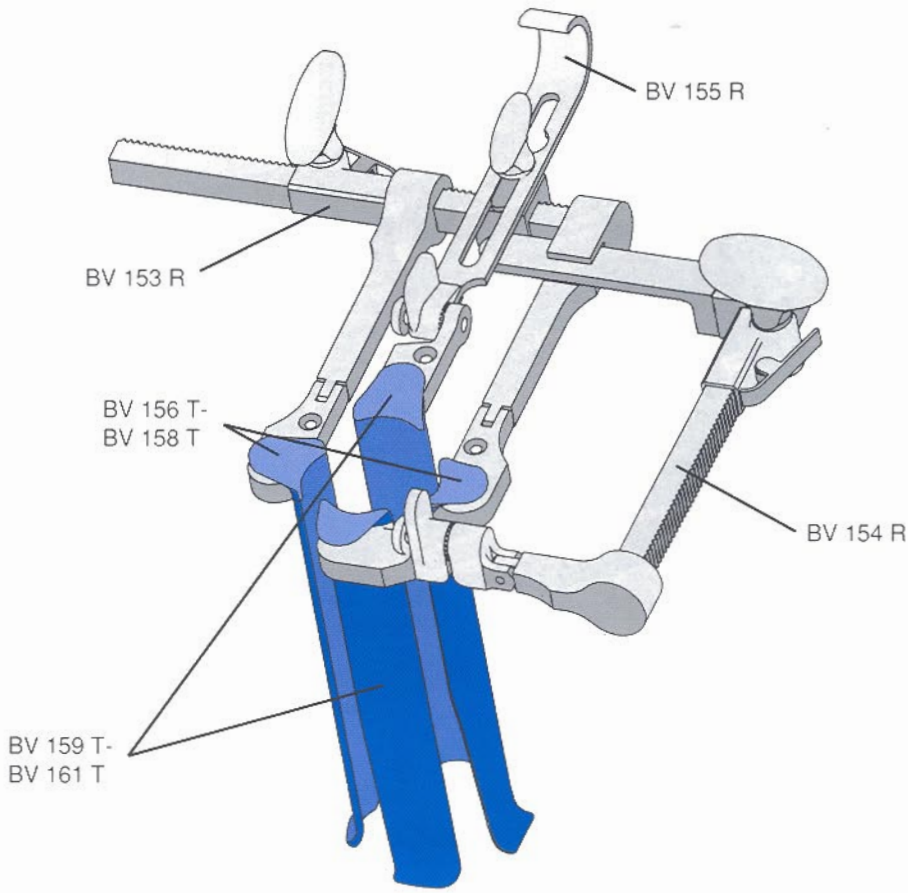
TRANSPERITONEAL



BV 150
miaspas mini ALIF transperitoneal retractor system
set consisting of:

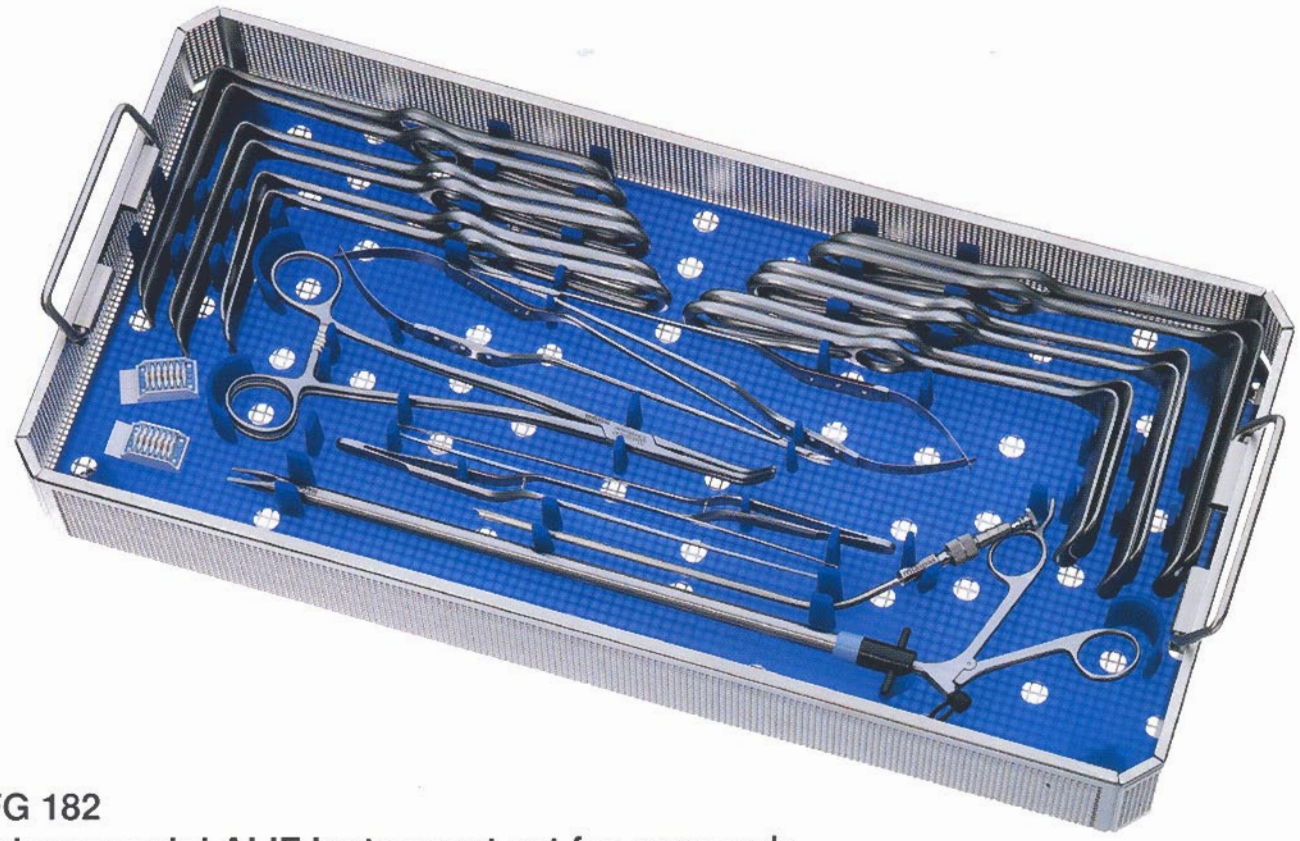
1 Piece	BV 151 P	orga-tray", only
1 Piece	BV 153 R	Retractor
1 Piece	BV 154 R	Counter retractor
1 Piece	BV 155 R	Counter retractor attachment
2 Pieces	BV 156 T	Delta-shaped retractor blade, size "S" (95 mm), titanium
2 Pieces	BV 158 T	Delta-shaped retractor blade, size "L" (115 mm) titanium
1 Piece	BV 159 T	Caudo-cranial blade, size "S" (95 mm), titanium
1 Piece	BV 160 T	Caudo-cranial blade, size "M" (115 mm), titanium
1 Piece	BV 161 T	Caudo-cranial blade, size "L" (135 mm), titanium
1 Piece	BV 399 R	Forceps for press out of blades with ball snap closure
1 Piece	JF 223 R	Perforated basket 540 x 254 x 70 mm
1 Piece	JF 511	Wrapping drape, 140 x 100 cm
1 Piece	JG 785 B	Identification label, red

BV 152 R
miaspas mini ALIF transperitoneal retractor system
= set with same content like BV 150 but without orga-tray" and perforated basket



BV 156 T - BV 158 T
Delta-shaped retractor blade, blunt
titanium, semi-radiolucent,
with ball snap closure

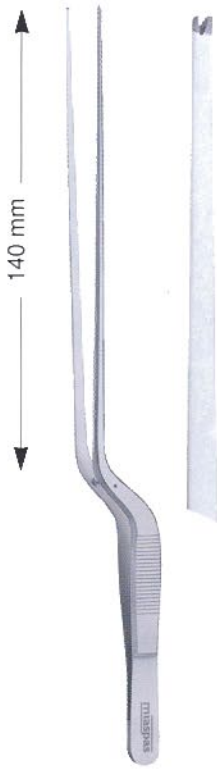
BV 159 T - BV 161 T
Caudo-cranial retractor blade, blunt
titanium, semi-radiolucent,
with ball snap closure



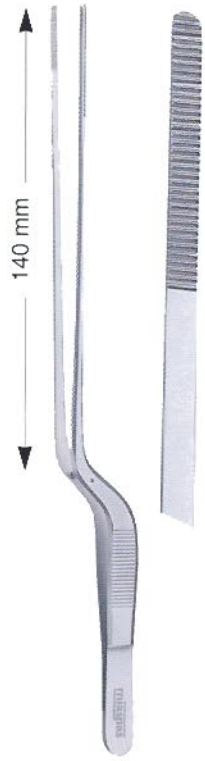
FG 182
miaspas mini ALIF Instrument set for approach

consisting of:

1 Piece	BD 896 R	Forceps, 1 x 2 toothed, bayonet shaped
1 Piece	BD 884 R	Dissecting forceps, bayonet shaped
2 Pieces	BJ 066 R	Dissecting/ligatur forceps
2 Pieces	BT 466 R	Retractor, 80 x 20 mm
2 Pieces	BT 467 R	Retractor, 110 x 20 mm
2 Pieces	BT 450 R	Retractor, 125 x 20 mm
2 Pieces	BT 468 R	Retractor, 80 x 35 mm
2 Pieces	BT 469 R	Retractor, 110 x 35 mm
2 Pieces	BT 451 R	Retractor, 125 x 35 mm
1 Piece	FD 085 R	Micro scissors, spring type, bayonet shaped, straight
1 Piece	FD 086 R	Micro scissors, spring type, bayonet shaped, curved
1 Piece	GF 934 R	Suction cannula, diam. 4.0 mm, working length 160 mm
1 Piece	PL 504 R	Clip applicator for medium sized clips PL 567 T
1 Package	PL 567 T	Titanium ligature clip, medium, 30 x 6 clips, sterile
1 Piece	FG 183 R	Perforated basket with storage, 540 x 254 x 70 mm
1 Piece	JF 511	Wrapping drape, 140 x 100 cm
1 Piece	JG 785 B	Identification label, red



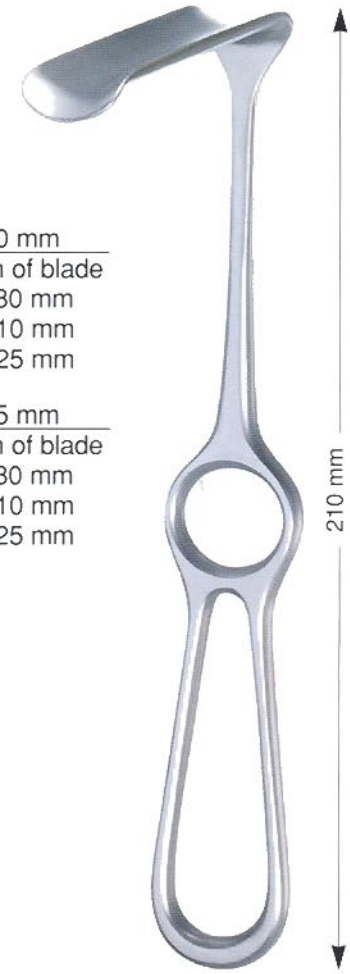
BD 896 R
Forceps, 1 x 2 toothed
total length 240 mm



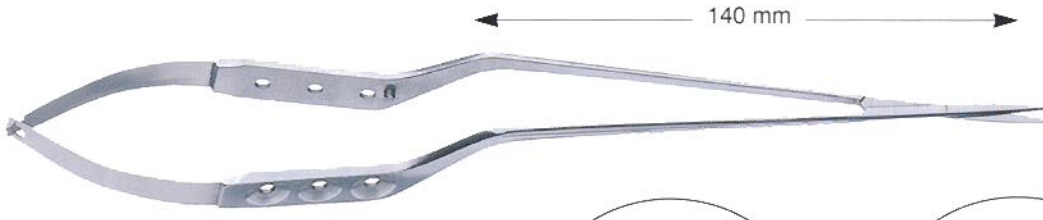
BD 884 R
Dissecting forceps,
total length 240 mm

Retractors, width 20 mm	
Ref.No	Length of blade
BT 466 R	80 mm
BT 467 R	110 mm
BT 450 R	125 mm

Retractors, width 35 mm	
Ref.No	Length of blade
BT 468 R	80 mm
BT 469 R	110 mm
BT 451 R	125 mm



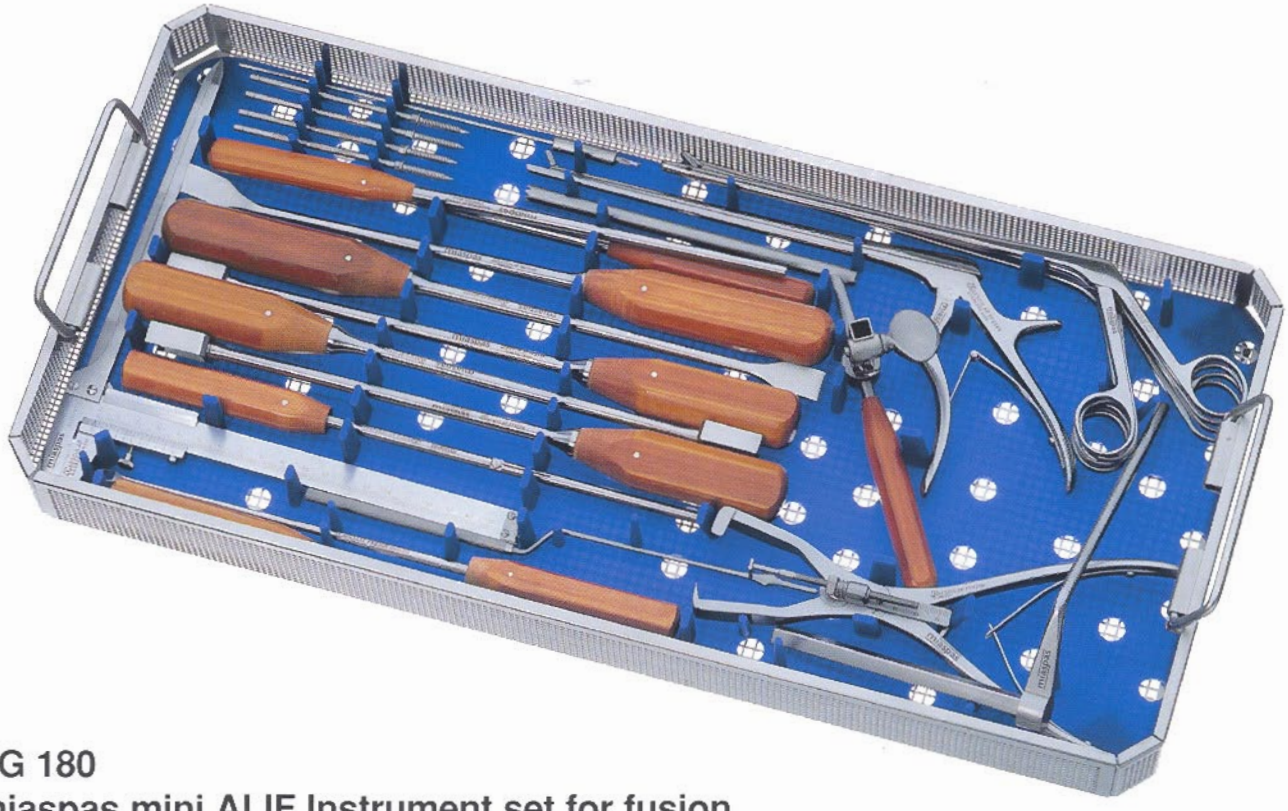
Retractor
BT 450 R - BT 469 R



FD 085 R / FD 086 R
Micro scissors, spring type
total length 260 mm

FD 085 R

FD 086 R

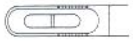
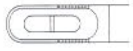
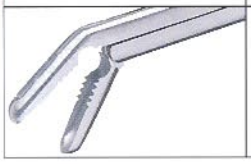


FG 180
miaspas mini ALIF Instrument set for fusion

consisting of:

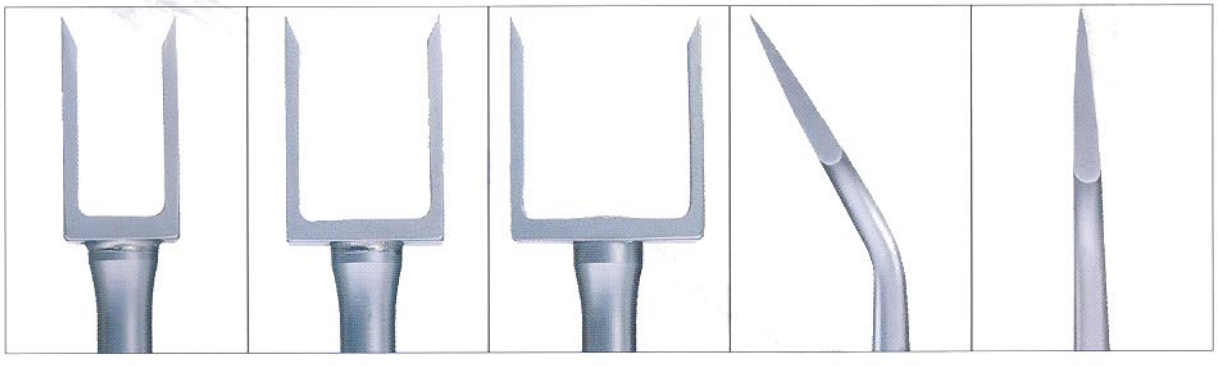
1 Piece	AA 852 R	Vernier calliper, for measurement of bone graft and bone graft site
1 Piece	BB 069 R	Scalpel handle no. 3, bayonet shaped, working length 130 mm
1 Piece	FF 569 R	Rongeur straight, 4 x 14 mm, 220 mm
1 Piece	FF 571 R	Rongeur straight, 6 x 16 mm, 220 mm
1 Piece	FF 578 R	Rongeur 150° up bite, 5 x 14 mm, 220 mm
1 Piece	FF 586 R	Rongeur 150° down bite, 4 x 14 mm, 220 mm
1 Piece	FF 825 R	Parallel osteotome, 25 x 15 mm, working length 200 mm
1 Piece	FF 826 R	Parallel osteotome, 25 x 20 mm, working length 200 mm
1 Piece	FF 827 R	Parallel osteotome, 25 x 25 mm, working length 200 mm
1 Piece	FF 858 R	Heavy duty rongeur, 4 mm, 220 mm
1 Piece	FF 877 R	Drill guide for anchoring screws, working length 120 mm
1 Piece	FF 878 R	Drill, 2.8 mm, length 225 mm, for anchoring screws
2 Paires	FF 880 S	Anchoring screws, diam. 4 mm, base plate diam. 6 mm, 25 mm
1 Piece	FF 881 R	Bone graft holder, 260 mm
1 Piece	FF 883 R	Parallel drill guide, to be used together with FF 877 R
1 Piece	FF 894 R	Impactor, diam. 5 mm, 280 mm
1 Piece	FF 895 R	Impactor, diam. 8 mm, 280 mm
1 Piece	FF 896 R	Screw driver for anchoring screws, total length 280 mm
1 Piece	FF 929 R	Graft cutter, width 15 mm
1 Piece	FK 830 R	Curette, sharp, 6 mm, total length 280 mm
1 Piece	ND 106 R	Osteotome, curved, width 15 mm, working length 200 mm
1 Piece	ND 107 R	Osteotome, straight, width 15 mm, working length 200 mm
1 Piece	FG 181 R	Perforated basket with storage, 540 x 254 x 50 mm
1 Piece	JF 511	Wrapping drape, 140 x 100 cm
1 Piece	JG 785 B	Identification label

Rongeurs, toothed
220 mm

		4 x 14 mm	straight	FF 569 R
		6 x 16 mm	straight	FF 571 R
		5 x 14 mm	150° up bite	FF 578 R
		4 x 14 mm	150° down bite	FF 586 R

Heavy Duty Rongeur
220 mm

		4 mm	straight	FF 858 R



FF 825 R
25 x 15 mm

FF 826 R
25 x 20 mm

Parallel osteotome
working length 200 mm

FF 827 R
25 x 25 mm

ND 106 R

ND 107 R

Osteotome
width 15 mm
working length 200 mm

Approach / general instruments:

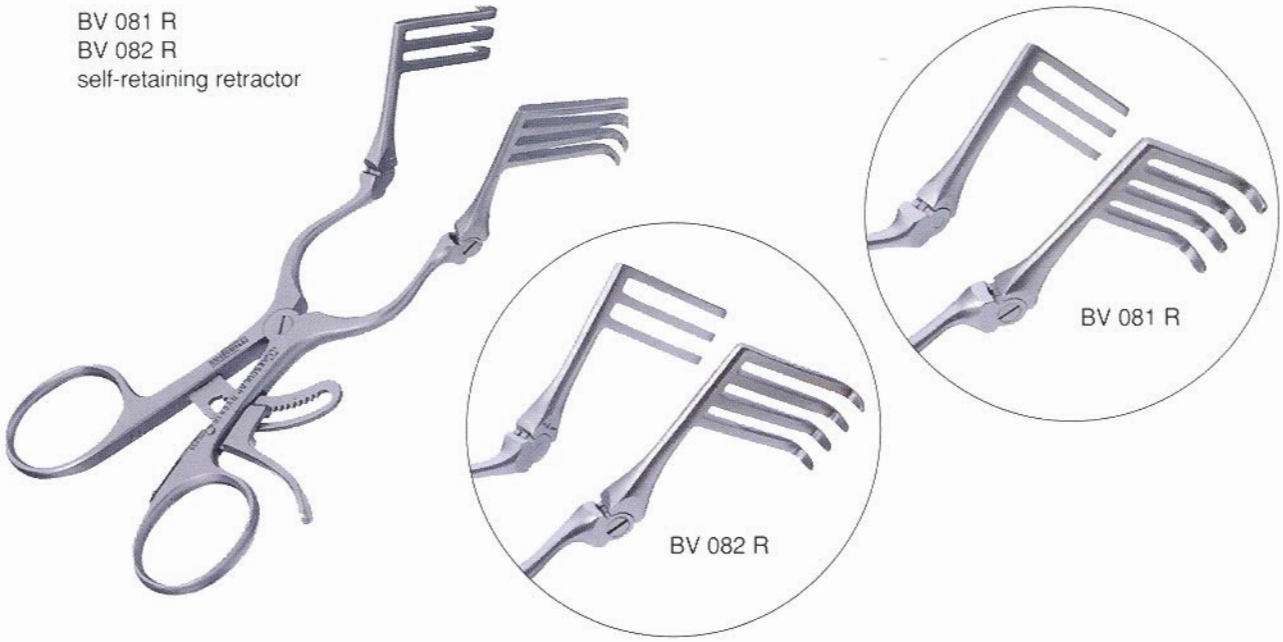
BC 281 R	NELSON-METZENBAUM dissection scissors, DUROTIP®, total length 280 mm
BC 282 R	METZENBAUM dissection scissors, DUROTIP®, total length 285 mm
BD 520 R	MICRO-ADSON dissecting forceps, 1 x 2 toothed, 150 mm, delicate
BD 521 R	ADSON dissecting forceps, 1 x 2 toothed, 150 mm
BV 081 R	Self-retaining retractor, teeth 30 mm long, sharp
BV 082 R	Self-retaining retractor, teeth 30 mm long, blunt
FF 305 R	CASPAR micro dissector, downwards curved, 230 mm
GK 970 R	Bipolar forceps, bayonet shaped, insulated, tips straight 1.0 mm, 220 mm, with flat plug
GK 980 R	Bipolar forceps, bayonet shaped, insulated, tips straight 2.0 mm, 220 mm with flat plug
GK 299	Wire brush for cleaning bipolar forceps and electrodes
PL 503 R	Clip applicator for medium-large titanium clips PL 568 T
PL 568 T	Titanium ligature clip, medium-large, 20 x 6 clips, to be used with PL 503 R

Graft harvesting and preparation of graft site:

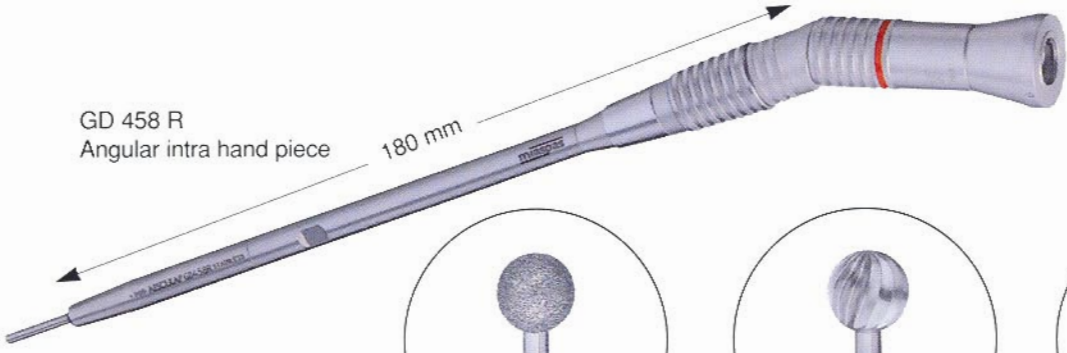
GD 458 R	Angular intra hand piece, 1 : 2
GD 463 R	Spray nozzle for hand piece GD 458 R
GD 265 R	Diamond burr, size 24, ISO 070, diam. 7.0 mm, length 180 mm
GD 275 R	Rose burr, size 24, ISO 070, diam. 7.0 mm, length 180 mm
GD 295 R	Cylindrical burr, diam. 8.0 mm, length 180 mm
BV 439 R	Spreader acc. CASPAR (2 Pieces)
BV 796 R	Blade acc. CASPAR, 23 x 60 mm (4 Pieces)
FK 358 R	Raspatory acc. LAMBOTTE, width 20 mm, length 215 mm
FK 365 R	Raspatory acc. SCHNEIDER, width 13 mm, length 175 mm
GB 128 R	Small oscillating saw hand piece
GC 660 R	Double saw blade, adjustable 16 - 26 mm

ALSO AVAILABLE:
HiLAN High Speed Motor hand piece with drills and burrs.
Please ask for the detailled brochure (leaflet-No. O-134).

BV 081 R
BV 082 R
self-retaining retractor



GD 458 R
Angular intra hand piece



GD 265 R
Diamond burr
size 24
diam. 7.0 mm

GD 275 R
Rose burr
size 24
diam. 7.0 mm

GD 295 R
Cylindrical burr
diam. 8.0 mm

GB 128 R
Small oscillating saw hand piece
without saw blades,
with key GB 20

GC 660 R
Double saw blade
adjustable 16 - 26 mm

B|BRAUN
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Brochure No. O 118 02

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