Eur Spine J (2012) 21:2626–2632
DOI 10.1007/s00586-012-2321-0

ORIGINAL ARTICLE

Posterior lumbar spinal fusion and instrumentation in morbidly obese patients using the Synframe retractor system: technical note

Rahul Vaidya · Anil Sethi · Adrienne Lee · Steve Bartol · Ndidi Onwudiwe · Max Aebi

Received: 11 April 2012 / Accepted: 13 April 2012 / Published online: 24 April 2012
© Springer-Verlag 2012

Abstract
Purpose Lumbar spine surgery in morbidly obese patients is a challenge to the operating surgeon. The aim of the study was to evaluate the surgical experience in this group of patients using the Synframe retractor system (Synthes, Paoli, PA, USA) as a tool for improved surgical access.
Methods An Institutional Review Board approved retrospective study was conducted on 43 morbidly obese patients undergoing posterior lumbar decompression instrumentation and fusion. Patient selection was based on a BMI of >40. Information acquired included BMI, set up time, procedure time, ASA, intraoperative blood loss and the number of preoperative co-morbidities of each patient. Postoperative complications, length of stay, and pre-operative and postoperative Oswestry disability index (ODI) and visual analogue scale (VAS) were recorded at each postoperative visit. They were compared to 45 age matched controls from our spine database.
Results The average set-up time (73.5 min), amount of blood loss (average 1,040 mL), length of incision (10.3–14.5 cm) and length of hospital stay (5.4 days) were recorded. The average surgical time was dependent on the procedure and number of levels fused and ranged from 164 to 245 min. These parameters were compared with normal weight patients and noted to be higher.
Conclusion The surgical experience determined that the Synframe retractor system provided a stable and well-illuminated operative field. It minimized the number of personnel required for assistance and improved surgical access. As may be expected, all the above recorded parameters were greater in the morbidly obese group.

Keywords Obesity · Lumbar fusion · Synframe

R. Vaidya (✉) · A. Sethi · A. Lee · N. Onwudiwe
Department of Orthopaedic Surgery, Detriot Medical Center, Detroit Receiving Hospital, 4D-4 UHC, 4201 St. Antoine Street, Detroit, MI 48201, USA
e-mail: RahVaidya@hotmail.com

S. Bartol
Department of Orthopedic Surgery, Henry Ford Health System, Sentio, LLC, 21520 Bridge Street, Southfield, MI 48033, USA

M. Aebi
Orthopaedic Surgery, University of Bern, Bern, Switzerland

Introduction

Obesity has become an epidemic condition in the United States and world wide [1]. The definition of obesity is a body weight that is 20 % greater than the desirable body weight and having an excess of body fat that frequently results in the significant impairment of health [2]. Morbid obesity or severe obesity is described as a Body Mass Index (BMI) of >40 [3]. Morbidly obese individuals have a variety of co-morbid conditions which classically include hypertension, diabetes, coagulation disorders, asthma/bronchitis, hyperlipidemia, thyroid disease, psychiatric disorders, angina, and alcohol consumption, shortness of breath, sleep apnea, and myocardial infarction [2, 4].

In the western world, spine surgeons encounter many morbidly obese patients with spinal disorders that require surgical treatment following the failure of conservative measures [5]. Anesthetic delivery, patient positioning, surgical access, imaging, and the placement of spinal instrumentation are major difficulties confronting the surgeon performing lumbar spine fusion in obese patients [5]. Anesthetic risks are greater in the obese patients due to

difficulty in: airway management from short thick necks; arterial and venous access; dosing of anesthetic agents [6]. Many anesthesiologists in the modern world are familiar with the care of these patients, especially in hospitals where bariatric surgery is now commonplace.

The use of the Synframe (Synthes Spine, Paoli, PA, USA) retractor system fixed to the operating table for spinal surgery was first reported in 2000 [7]. Its versatility and ease of use have made it a popular tool. It can be used at all levels of the vertebral column both anteriorly and posteriorly. We have used this system in our patients undergoing lumbar spinal fusion and have found it to be especially useful in morbidly obese patients. This report describes our experience of lumbar spine fusion using the Synframe retractor in patients with a BMI of 40 or more with a single surgeon and one assistant.

Materials and methods

An IRB approved retrospective study was conducted on consecutive morbidly obese patients who underwent posterior lumbar decompression and fusion. Patient selection was based on BMI values $\geq$40. The study population consisted of 43 consecutive patients (25 females and 18 males) from 28 to 81 years of age with an average age of 56 years. The BMI in the group ranged from 40 to 58 with an average of 44 kg/m^2. The average ASA score was 3.1 and the average number of co-morbidities was 6.4. Patient follow-up ranged from 16 to 30 months with an average of 23 months. One patient had two surgeries at different times with different data and was counted as two patients. The average number of levels fused was two. The indications for surgery were: lumbar canal stenosis in 24 patients, degenerative disc disease in 10 patients, revision surgery in 4 patients for postl-aminectomy instability, spondylolisthesis in 3 patients, and degenerative scoliosis in 2 patients. Medical records were obtained for each patient from hospital charts. Information acquired from the intra-operative notes of the attending nurse included age, weight, height, gender, time in surgery, procedure start time, procedure end time, and departure. Anesthesia preoperative patient evaluation tool sheets were used to determine ASA scores and the number of preoperative co-morbidities of each patient. Anesthesia notes were also used to determine intraoperative blood loss.

Clinical evaluation included a pre-operative examination and follow up at 2 (43 pts), 6 (39 pts), 12 (40 pts) and 24 (43 pts) weeks following surgery and at 1 (41 pts) and 2 years (36 pts). The Oswestry disability index (ODI), visual analogue scale (VAS) for back and leg pain and a pain diagram were recorded at every visit and kept in our spine database. Patients were also evaluated with plain radiographs and a CT scan was done when indicated.

Surgical technique

Positioning is a key component of any lumbar spine surgery and operating tables that are suitable for patients with weights up to 500 pounds are required. We use the flat OSI table with a special metal frame (Fig. 1), or a Kambin frame, which helps to place the lumbar spine in relative kyphosis. Any position which causes lumbar lordosis can make access to the spine extremely deep and difficult. The head is secured in the prone view apparatus. Once the patient is positioned, we place the table in reverse trendelenburg, raising the head to decrease facial edema which can occur when surgery is prolonged.

Synframe

The Synframe (Synthes Spine, Paoli, PA, USA) is a retractor system which consists of a ring placed around the surgical site (Fig. 2). It is fixed to both sides of the operating table with arms. Using retractor blades the ring allows a 360° access to the surgical exposure from any point. It can also carry Hohmann levers, a fiber optic light source, and endoscopes of varying size. Hohmann levers can be clicked to the ring or secured with sponges and function as a unilateral lever system that does not depend on counterbalance to keep the system in place. Its high degree of versatility in providing a stable operating field allows spine surgery to be performed with minimal assistance. The light source provides stable illumination in the depth of the wound. Attachment of endoscopes facilitates the surgery to be seen on a video screen [7].

Fig. 1 The patient is positioned on the OSI table on a metal padded frame with the head elevated (reverse trendelenburg). The belly is free and head is placed in a prone view device

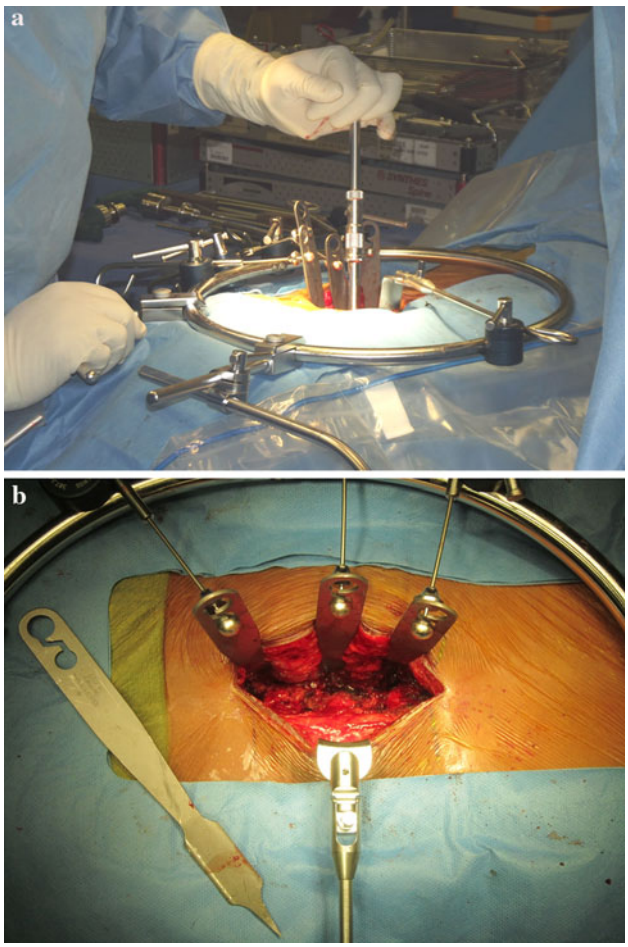

Fig. 2 **a**, **b** The Synframe retractor system placed at the operative site

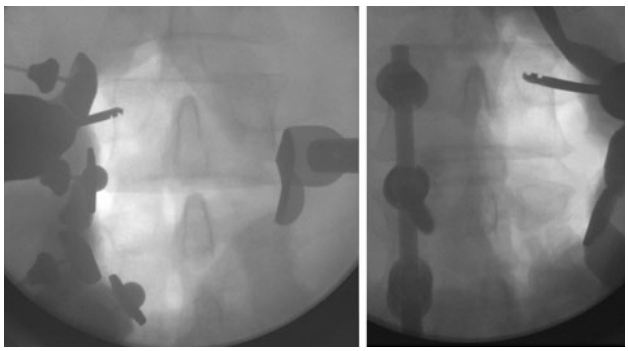

Fig. 3 C-arm image used to determine the pedicle screw trajectory in very deep wounds. Here, left side instrumented and then retractors moved to right side

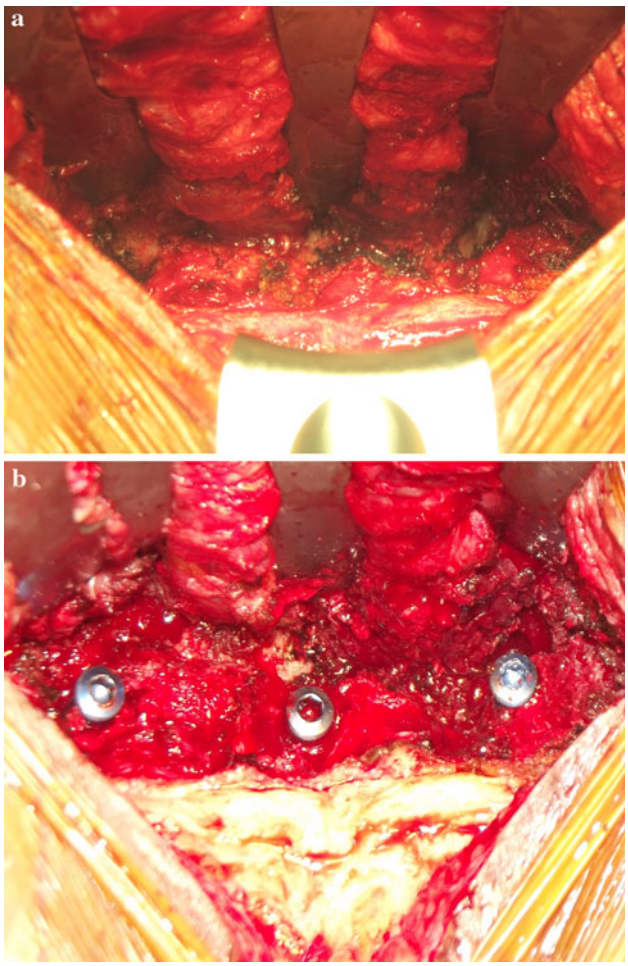

Fig. 4 **a** Hohmann retractors secured with sponges placed at the tip of the transverse processes. **b** Pedicle screws in place with Hohmann retraction

Imaging

A standard C-arm has difficulty with lateral images in these patients, so we used AP images exclusively to locate levels and place spinal instrumentation. Presence of congenital anomalies at the lumbosacral junction should be carefully noted on preoperative studies, as on the AP image alone it is more difficult to count levels from the sacrum. Often the spine is very deep in the wound, so we employed the AP X-ray to locate the correct starting point and trajectory for the pedicle screw, as is done in the vertebroplasty or kyphoplasty technique (Fig. 3). The radiolucent Hohmann retractors do not interfere with AP imaging or Lateral imaging. However, with really big patients lateral images are virtually impossible to read even with the fluoroscope on maximum power.

Procedure

After positioning and applying the Synframe retractor we use the c-arm to mark the top and bottom of the levels to be operated. The incision does not need to be any longer than from the superior endplate of the proximal vertebra to just below the pedicles of the lower vertebrae to be operated. A standard posterior approach is made through the skin and fat down to the fascial layer. The muscles are then stripped

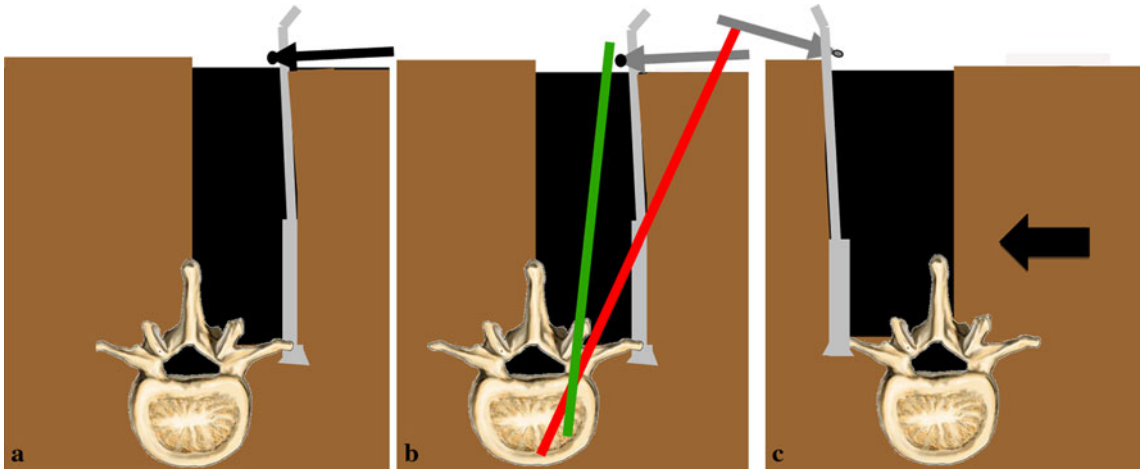

Fig. 5 **a** Diagrammatic representation of the placement of Hohmann retractors at the tip of the transverse process. **b** Straight (*green*) screw trajectory allows the placement of pedicle screws without enlargement of the skin incision. **c** Once implants are placed on one side, retractors are then placed on the other side for pedicle screw placement

back with cautery and a cob elevator over the facet joints on one side. Hohmann retractors are then placed over the facet joints and fixed to the ring. The muscle is then released on top of the facets and the Hohmann retractors moved to the tip of the transverse process (Fig. 4a, b). These retractors work like Taylor retractors and do not need any counterbalance. If postero-lateral fusion is to be performed then the transverse processes are exposed well and the bone decorticated. Bone graft from the iliac crest is laid into the gutter made here. Alternatively allograft bone is used. Instrumentation is then placed on this side. Due to the depth of the incision, we often use fluoroscopy to ensure the correct trajectory of pedicle screw insertion. The C-arm is positioned to get a straight AP shot of the vertebra with a sharp superior endplate, and pedicle screws are placed in the standard manner with starter awl and pedicle feeler or drill bit. Care is taken to ensure that a straight AP shot of the vertebrae is seen, as occasionally the synframe or the Hohmann retractor system will rotate the vertebrae (Fig. 3). In obese individuals pedicle screws must be placed in the Roy Camille [8] or straight (green) trajectory instead of axially down the pedicle (red), using Magerl method, as the soft tissue gets in the way and disallows the placement of pedicle screws without enlargement of the skin incision (Fig. 5). The length of the screw in the vertebra ends up being shorter, but their purchase is strong due to a 3 point fixation across the pedicle [9]. This is followed by the application of a suitable posterior construct. Once fixation is achieved on one side, the Hohmann retractors are released and the contralateral side is exposed and fixed in a similar manner. In cases where transforaminal lumbar interbody fusion (TLIF) is planned, the procedure is performed on the first side that is exposed. The muscle on both sides is retracted when using a Gelpie, cerebeller or other tensioning retractor system, but not with this system as the levers hinge on bony elements. Working on one side at a time minimizes the muscle ischemia, as each side is only retracted when it is being worked upon. A light fastened to the ring illuminates the depth of the incision eliminating the need for a headlight.

Results

Intraoperative evaluation

Set-up time, surgical time, blood loss during surgery and skin incision size were reviewed for all patients. The average set-up time (room in time to surgical incision) for the morbidly obese patients was 73.5 min. The average amount of blood loss was 650 ml for single level cases, 943 ml for two level cases, and 1,040 ml averaged over all

Table 1 Time of surgery in minutes

Group	1 LLDF1	2 LLDFI	1 Level TLIF	2 Level TLIF
Morbidly obese	164	124	194	245
Number of patients	8	10	6	5
Normal weighted	124	171	131	229
Number of patients	7	13	5	4

1 LLDFI I Level lumbar decompression and instrumentation, *2 LLDFI* 2 level lumbar decompression and instrumentation

Table 2 Incision length in millimeters

Group	1 Level	2 Levels
Morbidly obese	10.3	14.5
Normals	8.9	12.9

Table 3 Outcome scores morbidly obese patients

Morbid Obese	Preop	2 weeks	6 weeks	12 weeks	24 weeks	1 year	2 years
Oswestry	58	49	47	42	40	35	28
Back pain (VAS)	7.6	5.0	4.8	4.3	4.1	3.9	3.7
Leg pain (VAS)	7.4	5.4	4.5	3.7	3.4	2.8	2.6

cases. The surgical time and length of incision are shown in Tables 1 and 2, respectively. The average length of hospital stay for the morbidly obese patients was 5.4 days. This is compared to a group of normal weighted patients who were case matched, as reported previously [4].

Clinical evaluation morbidly obese group

Significant improvement in back and leg pain scores were observed in morbidly obese group. There was marginal improvement in the Oswestry scores (Table 3). The use of narcotics for pain decreased significantly in the morbidly obese patients as evidenced by decreased pain scores (Table 3). We did not compare this to our previously reported normal weighted group, as this a varied group of patients with small numbers in each diagnosis group.

Postoperative complications

Postoperative complications were seen in (18/43) 42 % of the morbidly obese patients. We classified these as major and minor complications. These are detailed in Tables 4 and 5.

Discussion

Morbid Obesity is a significant health problem associated with multiple co-morbidities. These patients are at risk for developing serious complications; hence, modifications in the use of standard operative techniques may be required [10]. The use of the Synframe retractor in obese patients offers many advantages. It allows stable surgical access to the spine with minimal personnel making it possible for the operating surgeon to perform the surgery with a single scrub nurse [11]. The circular design of the retractor can be used to attach Hohmann retractors at any point in the ring, thereby providing an unrestricted approach to the vertebral column [7, 11]. A variety of retractor blades or levers may be used and this aspect is of importance in the obese patient, as each blade may be adjusted individually to retract tissue in the depth of the wound providing good visualization into the surgical field and also good illumination in the depth of the surgical wound with the fiber optic light attachment. Since the ring is held in place by two arms on either side of the operating table, it is not dependant on the retractor blades to maintain its position as in many other systems [12]. It is possible to use it as a unilateral lever system and does not need to be counterbalanced by the contra lateral musculature. This may prevent any prolonged pressure effect on the paraspinal muscles which could be a cause of persistent back pain postoperatively [13, 14]. Improved access to the facets and the transverse process is achieved with the Synframe, as the Hohman levers can be progressively advanced to the tip of the transverse process. This brings into view the entire posterior surface of the lamina, facets and transverse processes, facilitating the preparation of a bed for the bone graft especially in posterolateral fusion (Fig. 4a, b). The average blood loss during surgery for the morbid obese group was 1,040 mL. This volume is not significantly different than that of our previously reported series [4] in normal weight patients (1,000 mL) and is directly related to the number of levels operated upon.

Table 4 Major complications morbidly obese patients

Major complications	Number
Myocardial infarction	1
Cardiac arrythmia	2
Pneumonia	2
Postop ileus	2
Intraop hypotension	1
Hypovolemic ischemic optic neuropathy	1
Acute renal failure	1
Deep vein thrombosis (DVT)	2
Non-union	2
Adjacent level disease	2
Hematoma	1
Wound breakdown/infection	1

Table 5 Minor complications morbidly obese patients

Minor complications	Number
Urinary tract infection	4
Urinary retention	5
Cage migration from fall with no sequelae	1
Transient fever	6

We had previously reported a trend in morbidly obese patients requiring longer times for surgery when comparing them to normal weight individuals for single and two-level lumbar decompression instrumentation and fusion, as well as for one- and two-level TLIF surgery [4]. Due to the low number of individual surgeries, we are unable to show any significant time differences between this larger group of morbidly obese patients and our previously reported times (1 level LLDFI 124 min, 2 level LLDFI 171 min, 1 level TLIF 134 min, 2 level TLIF 229 min) for normal weighted individuals [4]. This group of morbidly obese patients required on an average 11 min more for set up when compared to normal weight individuals at our institution which included positioning and administration of anesthesia.

We compared the length of incision in morbidly obese and normal weight patients. The incisions were larger for 1 level (8.9 cm in normal vs. 10.3 cm in morbidly obese) and 2 level surgeries (12.9 cm in normal vs. 14.5 cm in morbidly obese) in the morbidly obese group. Though morbidly obese patients required larger incisions to accomplish the surgical procedure, it is our belief that with the use of Synframe the incision length was reduced considerably and the operation was much easier to perform.

In morbidly obese patients the surgeon is working on the posterior vertebral body at a greater depth. The anatomy of the pedicle warrants that the surgeon penetrates the bone at an angle so as to remain within the cortical confines of the pedicle. This further stresses the borders of the incision. We have used the Roy-Camille technique to insert the pedicle screw perpendicular to the vertebral body [8]. This minimizes the need for larger incisions. In a recent study we observed that straight pedicle screw (Roy-Camille technique) insertion results in a more stable posterior construct due to improved cyclic loading than angled pedicle screw (Magerl technique) [9]. The angled screw insertion technique resulted in more scattered values of damage indicating that the outcome from the angled screw fixation is less predictable.

Good positioning is a key component of spine surgery and may prevent neurologic complications and pressure problems which may occur with prolonged surgery. We use the flat OSI table (max 500 lbs) with a special metal frame (Fig. 1), or a Kambin frame, which helps to place the lumbar spine in relative kyphosis. Positioning which causes lordosis can make access to the lumbar spine extremely deep and difficult. We have tried to use the leg sling with the spinal attachment for the Jackson table, however, often the patient's legs are too big for the space provided and will get pressure on the sides. We have found the use of the Andrews table difficult in many of these patients, as their size makes it difficult to hold them in the 90/90 hip–knee position and have abandoned its use in these situations. It is also impossible to image in the AP plane with this table. In a few situations we have used 2 OSI tables side by side with supports in the middle for extreme cases.

We have previously reported that there is a significant complication rate of morbidly obese patients undergoing lumbar spine surgery [4] and this paper also shows a 42 % incidence. There was a steady improvement in Visual Analog Scale pain scores and Oswestry scores. However, improvement can take up to 2 years and long-term results still have to be noted. With the varied diagnosis of patients only the fact that there was improvement can be inferred. We did not compare these results to normal weighted patients, as the numbers for each diagnosis were small and this paper is focused on the operative experience with the Synframe in these individuals. This is still a large series of morbidly obese patients who have undergone lumbar fusion and instrumentation surgery. We use the Synframe retractor posteriorly in normal weighted patients and find it a useful tool for all posterior lumbar surgery. The lighting system eliminates the need for a headlight and an arthroscopy scope can be attached to be used as a teaching tool for students and residents.

In conclusion, the use of the Synframe retractor system provided a stable and well-illuminated operative field. It minimized the number of personnel required for assistance and improved surgical access and made the surgical times for these cases acceptable. Though longer incisions are required in morbidly obese patients, they were probably limited with the use of Synframe. We feel that this is an extremely valuable tool for posterior lumbar surgery, but especially in morbidly obese patients.

Conflict of interest None.

References

1. DeMaria EJ (2007) Bariatric surgery for morbid obesity. N Engl J Med 356(21):2176–2183
2. National Institutes of Health (1998) Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report. Obes Res 6(suppl 2):51S–209S
3. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM (2006) Prevalence of overweight and obesity in the United States, 1999–2004. JAMA 295:1549–1555
4. Vaidya R, Carp J, Bartol S, Ouellette N, Lee S, Sethi A (2009) Lumbar spine fusion in obese and morbidly obese patients. Spine (Phila Pa 1976) 34(5):495–500
5. Flancbaum L, Choban PS (1998) Surgical implications of obesity. Annu Rev Med 49:215–234
6. Passannante AN, Tielborg M (2009) Anesthetic management of patients with obesity with and without sleep apnea. Clin Chest Med 30(3):569–579
7. Aebi M, Steffen T (1998) Synframe: a preliminary report. Eur spine J 9(suppl.1) S44–S50

8. Sterba W, Do-Gyoon Kim, Fyhrie DP, Yeni YN, Vaidya R (2007) Biomechanical analysis of differing pedicle screw insertion angles. Clin Biomech 22(4):385–391
9. Telfeian AE, Reiter T, Durham SR, Marcotte P (2002) Spine surgery in morbidly obese patients. J Neurosurg Spine 97:20–24
10. Kossman T, Jacobi D, Trentz O (2001) The use of retractor system (Synframe) for open, minimal invasive reconstruction of the anterior column of the thoracic and lumbar spine. Eur Spine J 10:396–402
11. Mayer HM (2000) The ALIF concept. Eur Spine J 9(suppl.1): S35–S45
12. Kawaguchi Y, Matsui H, Tsuji H (1996) Back muscle injury after posterior lumbar spine surgery: a histologic and enzymatic analysis. Spine 21(8):941–944
13. Lehto M, Hurme M, Alaranta H, Einola S, Falck B, Jarvinen M, Kalimo H, Mattttila M, Paljarvi L (1989) Connective tissue changes of the multifidus muscle in patients with lumbar disc herniation. An immunohistologic study of collagen types I and III and fibronectin. Spine 14(3):302–309
14. Roy-Camille R, Saillant G, Mazel C (1986) Internal fixation of the lumbar spine with pedicle screw plating. Clin Orthop Relat Res 203:7–17