Access-related complications in anterior lumbar surgery in patients over 60 years of age

Dominique A. Rothenfluh · Matthias Koenig ·
Oliver M. Stokes · Eyal Behrbalk ·
Bronek M. Boszczyk

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Abstract

Purpose The anterior approach is widely used for access to the lumbar spine in the setting of adult deformity either as a stand-alone procedure or in combined anterior–posterior procedures. Access-related complication rates have so far not been reported in an elderly patient population, in which it has been suggested that anterior lumbar surgery is indicated with caution. Here, the complication rates in patients over 60 years of age are reported.

Methods A retrospective chart review in a consecutive series of 31 patients over 60 years of age and in which a retroperitoneal access to the lumbar spine was performed. All charts including anaesthetic charts were reviewed and the patients' demographics, exact surgical procedure, comorbidities, and potential risk factors, as well as intra-operative and vascular complications noted. Patients who had revision anterior surgery, anterior surgery for tumour resection, trauma or infection were excluded.

Results The average age of patients was 64.9 years, ranging 60–81. Eighteen patients were female and 13 male. The average body mass index was 26.7 ranging 18.5–44.0. The indications for surgery were degenerative scoliosis (12 patients), degenerative spondylosis (7 patients), degenerative spondylolisthesis (5 patients), iatrogenic

spondylolisthesis following prior posterior decompression (5 patients), and pseudarthrosis following posterolateral instrumented fusion (2 patients). In 10 patients, a single-level anterior lumbar interbody fusion (ALIF) was carried out (1 L3/4, 5 L4/5, 4 L5/S1) and in 11 patients ALIF was performed on two levels (1 L2–4, 1 L3–5, 9 L4–S1). In three patients, 3 levels from L3 to S1 were approached and in seven patients 4 levels from L2 to S1. Patients with three- and four-level anterior lumbar surgery had higher blood loss than two- and one-level surgery (616 ± 340 vs 439 ± 238 , $p = 0.036$). The overall complication rate was 29 % (9/31), which included four vascular injuries and one pulmonary embolism. The vascular complication rate was 13 % (4/31) with two arterial and two venous injuries requiring repair. No major blood loss over 2,000 ml occurred.

Conclusions Anterior lumbar surgery in an elderly population does not necessarily have higher overall complication rates than in a younger population. The risk of vascular injury requiring repair was higher, but has not resulted in major blood loss and the procedure therefore can be carried out safely. The overall complication rate and blood loss compare favourably to complication rates in posterior adult deformity procedures.

Keywords Anterior lumbar interbody fusion (ALIF) · Vascular complication · Access-related complication · Deformity

Introduction

The anterior approach is widely accepted for access to the lumbar spine as it allows excellent exposure and access to the intervertebral space. The advantages of anterior lumbar interbody fusion over posterior access to the intervertebral

D. A. Rothenfluh · M. Koenig · O. M. Stokes · E. Behrbalk ·
B. M. Boszczyk (✉)
The Centre for Spinal Studies and Surgery, Queens Medical
Centre, Nottingham University Hospitals NHS Trust, Derby
Road, Nottingham NG7 2UH, UK
e-mail: b.boszczyk@gmx.net

D. A. Rothenfluh
Nuffield Orthopaedic Centre, Oxford University Hospitals NHS
Trust, Oxford, UK
e-mail: dominique.rothenfluh@mac.com

Fig. 1 This shows an example of four-level ALIF and second-stage posterior instrumentation for a sagittal deformity. The restoration of lumbar lordosis was largely achieved by anterior release and cage placement

space include release of the anterior longitudinal ligament and total discectomy with thorough removal of the cartilaginous endplates. This provides a large footprint for fusion to take place and has been reported to yield fusion rates over 90 % [1]. In addition, the anterior approach avoids damage to the paravertebral muscles and it has been suggested that stand-alone anterior lumbar interbody fusion (ALIF) leads to better clinical outcome and higher patient satisfaction than combined anterior–posterior fusion [2].

The extensive release resulting from a total discectomy with removal and release of the annulus fibrosus allows for

more restoration of lordosis [3] in the respective segment with better support due to the ability to insert a larger cage compared to the posterior access. This makes anterior access to the lumbar spine interesting for adult deformity correction, particularly restoration of the sagittal profile as illustrated in Fig. 1. Furthermore, anterior lumbar interbody fusion has been widely used to support the caudal ends of long spinal deformity constructs [4] as they are prone to non-union and 360° fusions offer higher union rates [5].

It has been reported that the retroperitoneal approach can be safely carried out by spinal surgeons with

acceptable complication rates [6, 7]. Anecdotally, however, it has been suggested that the risk for intraoperative complications is higher in an elderly population in whom anterior access should be indicated with caution. As the anterior access offers advantages and may be particularly useful in the setting of adult deformity correction either as a stand-alone or combined anterior–posterior procedure, we investigated the complication rates of a consecutive series of patients over 60 years of age.

Methods

A review of the case notes of a consecutive series of patients having had anterior lumbar surgery from L2 to S1 over a 5-year period from 2007 to 2012 by a single surgeon (BMB) was carried out. For this review, patients who had stand-alone anterior lumbar surgery or anterior surgery as an adjunct to a posterior deformity correction or revision surgery were included if they were at least 60 years of age at the time of surgery. Patients who required anterior surgery for anything other than a degenerative spinal disorder, such as surgery for tumour resection, infection, or revision anterior surgery were excluded from this study.

The case notes including surgical records and anaesthetic protocol were reviewed and the patients' demographics, indications for anterior surgery, levels treated, and exact procedure carried out was recorded. Comorbidities such as cardiac and pulmonary disease and potential risk factors for anterior surgery, such as vascular risk factors like hypertension, atherosclerosis, calcification of vascular structures, or risk factors such as anterior osteophytes and previous abdominal surgery were recorded based on a retrospective review of the case notes and review of imaging. The duration of surgery, documented blood loss and leg ischaemia time (loss of pulsatile signal on the pulsoxymeter) were prospectively noted in the anaesthetic charts. The duration of surgery in our charts includes the anaesthetic time from positioning to extubation and is, therefore, longer than the time skin to skin. Particular attention was given to document all access-related intraoperative complications such as vascular injury, injury to ureter or kidney, bowel injury, and incidental opening of peritoneum, neurological injury, dural tear as well as anaesthetic complications such as problems with airway management or intraoperative circulatory problems. Vascular injury was defined as major if it required repair or reconstruction as previously defined [6, 7]. Minor vascular injuries such as bleeding while mobilizing the vessels or ligating the iliolumbar vein that were treated with pressure or a haemostatic agent were not recorded in this study. Blood loss was defined as major when it exceeded 2,000 ml. Finally, other postoperative

complications such as wound infection, abdominal hernia, lymphoedema, injury to the sympathetic trunk, and sepsis were also looked for.

In all patients, the anterior lumbar spine was accessed via a retroperitoneal approach with a median longitudinal incision and paramedian incision of the rectus sheath as described before [8, 9]. In all cases where the common iliac vessels needed to be mobilized to access L4/5 or above, the iliolumbar vein was ligated if present. Anterior access was carried out by the operating spinal surgeon in all cases and a vascular surgeon was on standby and only present in the operating theatre if a major vascular injury occurred that required a suture or reconstruction. Preoperative bowel preparation was not used in any of the patients reported here. Intraoperatively, hypotension was used and normothermia maintained. Prophylactic anticoagulation was not used intraoperatively and is started for deep venous thrombosis prophylaxis on the first postoperative day.

This retrospective review was exempt from approval by the institutional review board according to the guidelines on service evaluation. All data were analysed using the JMP v.11 statistics package for Mac (SAS Institute Inc., Cary, NC, USA). *P* values below 0.05 were considered significant and the respective test used based on the distribution of data is given throughout the manuscript.

Results

A total of 31 patients met the inclusion and exclusion criteria and therefore could be included. The average age of patients was 64.9 years, ranging 60–81. Eighteen patients were female and 13 male. The average body mass index (BMI) was 26.7 ranging 18.5–44.0 (Table 1). The indications for surgery were degenerative scoliosis (12 patients), degenerative spondylosis (7 patients), degenerative spondylolisthesis (5 patients), iatrogenic spondylolisthesis following prior posterior decompression (5 patients), and pseudarthrosis following posterolateral instrumented fusion (2 patients) and are summarized in Table 2. The potential risk factors and comorbidities (Table 3) included coronary heart disease in 6 patients, 12 patients were diagnosed with hypertension, 16 with atherosclerosis, and 1 venous insufficiency. Six patients had a history of smoking and eight diagnosed COPD, one of which together with asthma and another two patients had asthma. Osteophytes at the levels to be operated on could be seen in 23 patients in the

Table 1 Patients (*n* = 31)

Age (range)	64.9 years (60–81)
Sex	18 female, 13 male
BMI (range)	26.7 (18.5–44.0)

Table 2 Indications for anterior surgery ($n = 31$)

	No. of patients
Degenerative scoliosis	12
Degenerative spondylosis	7
Degenerative spondylolisthesis	5
Iatrogenic spondylolisthesis	5
Pseudarthrosis	2

Table 3 Risk factors/comorbidities ($n = 31$)

	No. of patients
Cardiac	
Coronary heart disease	6
Valvular disease	0
Low output	0
Vascular	
Hypertension	12
Atherosclerosis	16
Venous insufficiency	1
Calcification on X-ray	17
Pulmonary	
Smoker	6
Fibrosis	0
COPD	8
Asthma	3
Osteophytes	23
Previous abdominal surgery	
Bowel/abdominal	4
Gynaecological	6
Great vessels/retroperitoneal	0

preoperative X-ray. A total of ten patients had previous abdominal surgery, six out of which were gynaecological and the remaining four patients had intra-abdominal surgery. No patient had a retroperitoneal approach or surgery at the great vessels, in which cases anterior lumbar surgery would most likely not have been considered.

In 27 patients, an ALIF was carried out (in total 54 levels), 4 patients had combined ALIF (8 levels) and total disc replacement (TDR) (7 levels). In six cases, the anterior procedure was part of an anterior–posterior deformity correction. In 10 patients, a single-level ALIF was carried out (1 L3/4, 5 L4/5, 4 L5/S1) and in 11 patients ALIF was performed on two levels (1 L2–4, 1 L3–5, 9 L4–S1). In three patients, three levels from L3 to S1 were approached and in seven patients four levels from L2 to S1 (Table 4).

The duration of surgery differed between the levels and showed significant differences between one and two levels, but not two and three levels (respectively, 170 ± 58 vs 263 ± 88 min, $p = 0.002$, t test, two-tailed; and 263 ± 88

vs 295 ± 51 min, $p = 0.416$, t test, two-tailed). Anterior surgery on four levels did not take significantly longer than treating three levels (375 ± 79 vs 295 ± 51 min, $p = 0.397$, t test, two-tailed). Blood loss was significantly more in two-level anterior surgery compared to one level (439 ± 238 vs 252 ± 131 ml, $p = 0.018$, t test, two-tailed). As expected, patients with three- and four-level anterior lumbar surgery had highest blood loss, which was significantly higher than two-level surgery (616 ± 340 vs 439 ± 238 ml, $p = 0.036$, t test, two-tailed), whereas the blood loss in three- and four-level surgery was largely the same (616 ± 340 vs 616 ± 401 ml, $p = 0.760$, t test, two-tailed). In line with the longer duration of surgery, three- and four-level anterior surgery had the longest leg ischaemia time as a result of retraction of the common iliac vessels which was significantly different from two- and one-level ischaemia time (two level 28 ± 28 vs four level 39 ± 32 min, $p = 0.029$, t test, two-tailed and one level 19 ± 27 vs four level 39 ± 32 min, $p = 0.011$, t test, two-tailed, respectively), while not being significant when three and four levels are compared (three level 45 ± 40 vs four level 39 ± 32 min, $p = 0.128$, t test, two-tailed). There are not enough cases to give a meaningful comparison between patients who had anterior–posterior surgery to patients with anterior surgery only and between patients who had TDR and ALIF to ALIF only.

In nine patients, an intraoperative complication was noted as shown in Table 5, which yields an overall complication rate of 29 %. There was no significant difference in BMI between patients with or without complications (no complications 26.6 ± 4.76 vs 28.1 ± 6.3 kg/m², $p = 0.49$, t test, two-tailed). One patient had an acute pulmonary embolism intraoperatively and three patients incidental opening of the peritoneum. In four patients (13 %) a major vascular injury occurred, defined as a laceration requiring repair. In two cases there was a laceration of the left common iliac vein and in two cases injury of the artery. One of the arterial injuries was an intimal dissection resulting in intraarterial thromboembolism with leg ischaemia and required endovascular thromboembolism. No patient had a blood loss over 2,000 ml. In relation to the risk factors, all vascular complications occurred in patients with a history of atherosclerosis, calcification and osteophytes on lumbar spine X-rays (Table 6). Of patients with atherosclerosis or calcification, 25 % had a vascular injury and 17 % with visible osteophytes on the preoperative X-ray. The two arterial injuries occurred in a single-level L4/5 ALIF and a two-level L3–L5 ALIF and resulted in an average blood loss of 270 ml (Table 7), which is still in the same range as would be expected in a single- or two-level ALIF as shown in Table 4. On the other hand, the two venous injuries occurring in a two-level L4–S1 and four-level L2–S1 ALIF showed an average

Table 4 Anterior levels treated and intraoperative data, complications given per patient ($n = 31$)

	<i>n</i>	Duration (min)	Blood loss (ml)	Leg ischaemia (min)	Intraop compl	Vascular compl
1 Level	10	170 ± 58	252 ± 131	19 ± 27	2 (6.5 %)	1 (3.2 %)
L3/4	1	135	100	0	0	0
L4/5	5	196 ± 69	330 ± 140	38 ± 27	1	0
L5/S1	4	140 ± 17	193 ± 54	0	1	1
2 Level	11	263 ± 88	439 ± 238	28 ± 28	3 (9.7 %)	2 (6.5 %)
L2–L4	1	435	600	50	0	0
L3–L5	1	235	340	15	1	1
L4–S1	9	247 ± 75	432 ± 257	27 ± 30	2	1
3 Level	3	295 ± 51	616 ± 340	45 ± 40	2 (6.5 %)	0
4 Level	7	375 ± 79	614 ± 401	39 ± 32	2 (6.5 %)	1 (3.2 %)
Total	31	260 ± 103	435 ± 293	29 ± 30	9 (29.1 %)	4 (12.9 %)

Table 5 Total complications as total number of incidents ($n = 31$)

	No. of incidents
All intraoperative complications	
None	21
Arterial bleeding	2
Venous bleeding	2
Ureter/kidney injury	0
Opening of peritoneum	3
Bowel injury	0
Neurological	0
Circulatory	1
Airway management	0
Dural tear	1
Acute pulmonary embolism	1
Major vascular complications	
Arterial bleeding	2
Venous bleeding	2
Blood loss >2,000 ml	0
Other complications	
Superficial wound infection	1
Deep wound infection	0
Deep venous thrombosis	0
Abdominal hernia	1
Lymphoedema	1
Sympathetic trunk injury	0
Sepsis	0

blood loss of 1,050 ml (Table 7), which particularly for the four-level ALIF (1,400 ml) is more than double than what has been measured on average when approaching four levels (Table 4), indicating that venous injuries result in more overall blood loss than arterial injuries. No patient in this series, however, had a major blood loss of over 2,000 ml as a result of either the procedure carried out or of a major vascular injury requiring repair.

Table 6 Complications in relation to risk factors

Risk factors/comorbidities	Patients	Intraop compl	Vascular compl
Cardiac			
Coronary heart disease	6	2	3
Valvular disease	0		
Low output	0		
Vascular			
Hypertension	12	7	3
Atherosclerosis	16	3	4
Venous insufficiency	1	2	1
Calcification on X-ray	17	8	4
Pulmonary			
Smoker	6	1	1
Fibrosis	0		
COPD	8	4	4
Asthma	3	2	1
Osteophytes	23	10	4
Previous abdominal surgery			
Bowel/abdominal	4	1	2
Gynaecological	6	3	1
Great vessels/retroperitoneal	0		

Discussion

In the present series of consecutive patients over 60 years of age, the percentage of overall intraoperative complications was relatively high at 29 %; however, this includes incidental peritoneal openings. It is debatable to what extent this represents an intraoperative complication. If this is removed, the intraoperative complication rate is 19 %. Furthermore, a drop in blood pressure is also noted as an intraoperative complication. Apart from the vascular injuries, the only complication with a potential harm to the patient was a pulmonary embolism in a patient who had a

Table 7 Patients with vascular injuries ($n = 4$)

		Duration (min)	Blood loss (ml)	Leg ischaemia (min)
Arterial	L4/5	150	200	0
Arterial	L3–5	235	340	15
		193 $\pm$ 60	270 $\pm$ 99	7.5 $\pm$ 11
Venous	L4–S1	420	700	90
Venous	L2–S1	480	1,400	70
Total		450 $\pm$ 42	1,050 $\pm$ 494	80 $\pm$ 14

venous injury, which was postoperatively managed with anticoagulation. In a recently published study, the overall complication rate in a younger patient population was 20 % [7].

While it has been reported that anterior access to the lumbar spine is associated with a risk of vascular injury, the reported rates of injury are reasonably low with or without a vascular access surgeon [6, 7]. Systematic reviews by Inamasu and Guiot and Wood et al. [10, 11] reported vascular complications rates ranging 0–18 %. The vascular complication rate in the present series is 13 % and, therefore, twice as high as a recently published larger series of a younger cohort of patients [7]. These were injuries requiring a suture or clips for repair and were not associated with a major blood loss. Although it has been reported that lacerations up to 4 mm can be managed without suture using haemostatic agents [12], injuries of this size are repaired with a suture or clips in this series and are therefore included as vascular complications, while other reports may not have included them. The arterial injuries did not result in more blood loss than the respective patient group without vascular injury. On the other hand, there seems to be a higher risk for blood loss in injuries to the vein which in this series resulted in higher blood loss than the respective controls without vascular injuries, which has been reported previously [7]. One of the arterial injuries was an intimal dissection following retraction of the vessels, which has to be looked for in this age population. It has been published before that intraoperative pulse oximetry is critical for picking up intraarterial thromboembolic events resulting from intimal dissections [13].

In patients with aortic calcification visible on the preoperative X-rays, the rate of vascular injury was 25 % and therefore twice as high as in the whole series. In patients with osteophytes shown on the preoperative X-ray, 17 % had vascular injuries. It has been reported before that the presence of osteophytes may predispose to vascular injury in anterior access to the lumbar spine [14]. All patients with a vascular injury had a cardiac or vascular risk factor; however, the series is too small to do meaningful further analyses.

Anterior lumbar surgery in patients over 60 years of age may be particularly appealing as either a stand-alone procedure or in a combined anterior–posterior procedure in the setting of adult deformity. While one study has suggested that a combined anterior–posterior procedure may have higher complication rates [15], the published overall complication rates and blood loss for long posterior instrumentation and osteotomies for example are higher than what has been observed in the present series. Blood loss has been reported to be as high as 1.6–2.4 l [16] and 1.8 l [17] which is 3 to 4 times as high as on average in a three- and four-level anterior access procedure reported here. The overall complication rates have been reported to range from 8.4 % [16] to 38 % [17]. One recent study reported on complication rates of three-column osteotomies in patients over 60 years of age and found major complications in 18 % and minor complications in 39 % of patients [18]. It, therefore, appears that an anterior procedure in this patient group does not necessarily have a higher risk for complications and may even be lower in the case of a multi-level stand-alone anterior procedure compared to posterior three-column osteotomies for example. It is demonstrated here that three- and four-level anterior access results in higher blood loss than one or two levels, which still compares favourably to three-column osteotomies. However, the overall complication rates in three- and four-level anterior access combined of 13 % were not higher compared to one and two levels combined (16 %).

Our patient group cannot exactly be compared to what has already been published in the literature as the age distribution and potential comorbidities and vascular pathologies may not be comparable to younger patient groups and exact numbers on the age distribution are not provided in many studies reporting anterior access-related complications [10–12, 19–21]. The present series, therefore, seems unique in that it only included patients over 60 years of age and particularly the vascular complication rate does not necessarily seem to be higher compared to what has been reported in other series. Most importantly, none of the patients had a major blood loss over 2,000 ml as a result of a vascular injury or the surgical procedure itself. The limitation of the present study is clearly the relatively low number of patients, but to our knowledge it is the only case series reporting anterior access-related complications of patients over 60 years of age also including three- and four-level access.

We, therefore, conclude that anterior lumbar surgery in an elderly population does not necessarily have higher overall complication rates than in a younger population or when compared to posterior spinal procedures for adult deformity. The risk of vascular injury requiring repair seems to be higher, but has not resulted in major blood loss and the procedure therefore can be carried out safely.

Particularly, if it is used either as a stand-alone or combined procedure in adult deformity surgery, it compares favourably to the published complication rates.

Conflict of interest None.

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