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# Complications of Anterior Cervical Discectomy Without Fusion in 450 Consecutive Patients

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## Summary

The complications of anterior discectomy without fusion were analyzed on the basis of 450 consecutive cases treated surgically for degenerative disc disease. There was no death related to the procedure. The most common complication was a worsening of the preexisting myelopathy. This occurred in 3.3%, including one case with severe medullary contusion. Wound infection developed in 1.6%. Additional radicular symptoms and wound haematoma, respectively, occurred in 1.3%; recurrent nerve palsy, Horner's syndrome, and respiratory insufficiency, respectively, in 1.1% of the cases. Epidural haematoma and instability of the cervical spine, respectively, occurred in 0.9%, nerve root lesion and aseptic spondylodiscitis, respectively, in 0.4%. There was one case each (0.2%) with a pharyngeal lesion, meningitis due to dural perforation, transient additional myelopathy, and epidural abscess.

The results and the management of complications are discussed in relation to numerous previously published reports, including posterior procedures and anterior fusion techniques. Precise knowledge of all potential accidents and pitfalls related to the surgical procedure and of their aetiology may contribute to preventing failures. The rate of complications in this series has been reduced in the past years by better patient selection, by paying more attention to correct positioning of the patient during the operation, and by meticulous removal of all offending structures. Discectomy without interbody fusion is now considered to be a reasonably safe procedure with an acceptable operative morbidity and lack of mortality.

*Keywords:* Anterior approach; cervical spine; complications; discectomy without fusion.

## Introduction

Cervical discopathy frequently requires surgical treatment. Simple anterior discectomy has the advantage that there are no complications related to any kind of grafts or to the iliac crest graft donor site.

A number of authors, who mainly have analyzed the surgical outcome after simple anterior discectomy, have reported no major complications in their series[3, 7, 23, 32, 34, 40, 46, 55, 60, 64, 67, 79]. In other published reports the complications were only briefly mentioned[20, 29, 31, 36, 42, 59, 85]. The surgeon dealing with this disease must have, apart from sufficient experience with the operative technique and instrumentation, detailed knowledge of all possible accidents and pitfalls associated with the procedure. Complications which have occurred must be recognized early and managed effectively.

In the present paper the authors analyze and discuss the complications associated with anterior cervical discectomy without interbody fusion which were encountered in 450 consecutive cases. A review of the pertinent literature is given.

## Material and Methods

Over a period of twelve years (January 1976 to December 1987), discectomy without interbody fusion was carried out in 450 patients suffering from cervical degenerative disc disease. A thorough chart review was done for each individual. Of the patients 72% were men and 28% women. Age ranged from 25 to 87 years (mean 50 years). Sixty-one percent of the patients presented with the clinical picture of radiculopathy, 16% with pure myelopathy, and 23% had a combined myeloradiculopathy.

Preoperative findings and clinical long-term results in this series were previously published[4–6]. Seeger gives a detailed description of the operative technique as it is performed in our institution[69].

All procedures were carried out with the patient in the supine position under general anaesthesia. The operations were performed by a total of 14 neurosurgeons having different degrees of experience. Complications were defined as problems, accidents, or other abnormalities related to the operative procedure and to the postoperative course. Those patients were recorded who sustained a soft tissue injury, who experienced a transient or permanent deterioration of pain and/or neurological symptoms and signs, and who underwent secondary operation or major intervention, in which anaesthesia-related problems occurred and in whom infection developed at the operative site.

## Results

There was no death in this series. There was no serious accident related to the general anaesthesia, with the exception of one accidental extubation due to repeated replacement of the muscle retractor in a three level operation, which was immediately followed by reintubation and later by an uneventful postoperative course.

In eight patients the dura mater was perforated accidentally with the rongeur or high speed drill. However, this did not result in a spinal fluid fistula or any additional pain or neurological deficit with the exception of one patient who sustained an intraoperative dura laceration and cord contusion and another one who developed meningitis. Thirty-five percent of the patients complained postoperatively of varying degrees of dysphagia, 15% suffered mild hoarseness. These complaints disappeared within 3 days in half of the cases and only rarely (5%) lasted longer than 3 weeks. Seventeen percent of the patients complained of more or less severe neck pain.

In 46 patients (10%) at least one of the complications listed in Table 1 occurred. Six (13%) were women and forty (87%) men, the mean age was 56 years. Sixteen of these patients (35%) presented preoperatively with radicular, 30 (65%) with medullary symptoms. In these 46 patients a total number of 74 discs were removed. Of the 14 neurosurgeons who performed the discectomies, 13 were involved in at least one of these cases with complications. However, 20 of the 46 patients with complications (43%) were operated on by only two of the neurosurgeons.

Transient vocal cord paresis and Horner's syndrome were observed postoperatively in five cases respectively.

Perforation of the hypopharynx occurred in one patient during approach to the second-third interspace. In another, dural perforation led postoperatively to meningitis.

The pre-existing myelopathy worsened in 15 cases (3.3%). Of these, iatrogenic contusion of the cervical cord in one male was followed by persistent quadriparesis. Cord damage with transient myelopathy occurred in one patient without preoperative medullary involvement. Six individuals experienced additional radicular symptoms. The nerve root was injured in two patients. A wound haematoma developed in six cases, an epidural haematoma in four. Due to respiratory insufficiency following the procedure, five patients required reintubation between two hours and three days after surgery. An instability of the cervical spine occurred in four patients and required secondary stabilization in each case.

Table 1. *Complications in 450 Consecutive Patients Following Anterior Discectomy Without Fusion*

| Complications | No. | % |
|---|---|---|
| Recurrent nerve palsy | 5 | 1.1 |
| Horner's syndrome | 5 | 1.1 |
| Pharyngeal lesion | 1 | 0.2 |
| Dural perforation, meningitis | 1 | 0.2 |
| Worsening of myelopathy | 15 | 3.3 |
| Severe medullary contusion | 1 | 0.2 |
| Additional, transient myelopathy | 1 | 0.2 |
| Additional radicular symptoms | 6 | 1.3 |
| Nerve root lesion | 2 | 0.4 |
| Wound haematoma | 6 | 1.3 |
| Epidural haematoma | 4 | 0.9 |
| Respiratory insufficiency | 5 | 1.1 |
| Instability | 4 | 0.9 |
| Superficial wound infection | 4 | 0.9 |
| Deep wound infection | 3 | 0.7 |
| Epidural abscess | 1 | 0.2 |
| Aseptic spondylodiscitis | 2 | 0.4 |
| Mortality | 0 | |

Wound infection developed in seven patients. Two had an aseptic spondylodiscitis, one an epidural abscess.

## Discussion

A review of the literature reveals a formidable list of various problems encountered in anterior spinal surgery. Several publications describe the most common complications and their aetiology[12, 13, 52, 70, 71, 76, 77]. Suggestions are made about how to avoid them and how to treat them. Even in the most careful operation, accidents may occur, regardless of the surgeon's experience. Many of these complications, however, are extremely rare and in most cases avoidable.

Carotid artery injury[51], injury of an atypical vertebral artery[9], pneumothorax[13, 16, 49, 83], glossopharyngeal lesion and facial nerve paresis[37], paresis of hypoglossal nerve, and lesion of the cervical plexus[66] have been reported. Cosgrove and Théron mentioned two cases with a fistulous communication between the vertebral artery and its surrounding venous plexus[17], Goymann and co-workers noted on case with cerebral infarction after Smith-Robinson's fusion procedure[30]. Circulatory complications include cardio-pulmonary failure[22, 26], pneumonia[43, 85], pulmonary infarction, and

phlebitis of the leg[1, 75]. None of these complications were encountered in the present series.

Temporary dysphagia and hoarseness, which result from oedema of the pharynx, oesophagus, and trachea[76], should not be necessarily regarded as complications, but as inevitable conditions related to the approach, similar to wound pain experienced after any operation.

Transient exacerbation of cervical pain is often considered a major disadvantage of simple discectomy. The 17% incidence in the present series is consistent with the 19 to 20% rate of transient postoperative neck and interscapular pain noted by others[34, 41], but is much less than the 60% incidence mentioned by Kadoya and his co-workers[46]. However, lower rates were also reported by some authors who used the same procedure (4%[53], 9.6%[36], 12%[42]).

According to Wilson and Campbell[85], the postoperative neck pain is directly proportional to the extent the vertebrae are spread during disc removal. Follow-up of our patients by means of questionnaires has shown that postoperative neck pain in most cases subsided within one week[6].

Due to the anatomical features, there is a lower risk of soft tissue injury and serious accidents in posterior procedures (laminectomy, foraminotomy) than in the anterior approach to the cervical spine. Accordingly, no unusual morbidity was mentioned by Epstein and associates in 57 patients[25]. A low complication rate following postero-lateral foraminotomy (1.5%) without air embolism, despite the sitting position, was reported in a series comprising 736 cases[39]. Air embolism in posterior procedures is a very rare but serious complication and may occur without being accompanied by a drop in blood pressure[10, 68]. Lesoin and co-workers[51] mentioned three cases of air embolism in 800 patients, two of whom had a fatal outcome.

The range of complications encountered in posterior procedures further includes neurological deterioration (between 4%[51, 61] and 12 to 14%[18, 27]), wound infection (2.5 to 4%[18, 27, 51]), pseudomeningocoele (1.5%[18]), cerebrospinal fluid leakage (3%[18]), aseptic meningitis (1.8%[61]), lesion of nerve roots (1.8%[58]), epidural haematoma[38, 51] and paralysis of the shoulder girdle[68].

One of the main reasons why discectomy without fusion was adopted in our institution in 1976 and has remained the method of choice in the surgical management of cervical degenerative disc disease is the lack of problems associated with interbody grafts (extrusion, fracture or infection, pseudarthrosis, aseptic necrosis) or with the donor site (haematoma, seroma, infection, painful hip, meralgia), encountered in anterior fusion techniques (Cloward, Smith-Robinson or modified procedures). Although the incidence of such complications is low[2, 14, 65, 72], their occurrence may cause significant postoperative morbidity and even require reoperation. The rate of graft extrusions or graft fractures varies between 0.4% and 3%[1, 21, 63, 77]. Infection of the graft occurred in less than 1%[26, 76]. Graft collapse or aseptic necrosis was observed in less than 2%[57] up to 7%[21]. Failure of fusion can account for 1%[75], 7%[21] up to 21% of cases[16]. Infection at the donor site developed in less than 1%[22, 26, 53, 57, 63], but may also occur more frequently (2%[44], 2.8%[1], 4.8%[16]). A wound haematoma or seroma appeared in 6 to 9%[21, 43, 44, 83, 84]. A persistent painful hip was manifest in 0.5 to 1%[26, 53] and even in up to 25% of cases[16].

These problems were eliminated when fusion procedures with Kiel bone grafts[75], bone bank bone[15] or bone cement (polymethylmethacrylate) were used[33, 66].

*Mortality:* The majority of articles reviewed reported no mortality. Fortunately, no fatal accident occurred in our series. Cervical spine surgery, however, carries a certain risk of death related to the operation. Mortality rates between 0.7%[35] and 1.1%[51] from posterior operations are mentioned.

From anterior procedures (Cloward technique, antero-lateral approach, discectomy without fusion), a 0.5% incidence[22, 26], a 3 to 4% incidence[29, 54, 81], and an up to 6.1% incidence[78] were reported. Causes of death included air embolism[51], cardio-pulmonary failure[22, 26, 49], bilateral broncho-pneumonia[35], laryngeal oedema[26], severe medullary contusion with tetraplegia[26, 47, 51], epidural haematoma due to lesion of an atypical vertebral artery[9] and lesion of the carotid artery[51].

To identify high-risk patients and to be able to initiate specific therapeutic measures, a careful medical examination is mandatory prior to operation. This justifies delaying the operation for several days, which will pose no serious problems in almost every case.

*Worsening of myelopathy:* The major problem in the present series was the worsening of pre-existing myelopathy in a total of 15 individuals (8.5% of patients with myelopathy), who were between 47 and 76 years of age (mean 61 years). Causes of myelopathy were bisegmental or trisegmental hard disc lesions in nine patients, monosegmental hard discs in two patients, and monosegmental soft disc lesions in four patients.

One patient who sustained intraoperative spinal cord contusion deserves special mention. Discectomy and removal of large dorsal osteophytes at C4–5 and

C5–6 interspace was performed in this 65 year old man. Myelopathic symptoms (spastic gait disturbance, sensory loss, beginning of quadriparesis) rapidly worsened preoperatively. During the procedure, dura perforation with CSF leakage and jerking of the limbs occurred. On awaking, paraplegia and severe spastic paresis in the upper extremities were discovered. Repeat myelography showed cord swelling and a high doses of dexamethasone were administered. Decompressive laminectomy on the third postoperative day led only to minimal improvement in the patient's condition. Three days later the course was once again complicated by a gastro-intestinal haemorrhage and peritonitis due to perforation of a duodenal ulcer, most likely induced by the use of corticosteroids. Abdominal surgery had to be carried out. The patient made a partial recovery, with marked residual neurological deficit and reactive depression characterized the later course. In view of the immediate onset of extreme neurological deterioration following the procedure, iatrogenic cord trauma was the suspected as the chief aetiologic factor responsible for this complication. On the other hand, the pre-existing spinal canal stenosis and the myelopathic changes in the spinal cord associated with rapid preoperative neurological impairment were additional factors which increased the vulnerability of the spinal cord.

Some authors feel that in such cases with spinal cord oedema, laminectomy should be performed immediately, combined with opening the dura and sectioning the dentate ligaments[74]. Cord damage was reported from posterior procedures[38, 51, 58, 61], as well as from anterior fusion techniques[15, 21, 54], sometimes without demonstrable technical error[48, 74], and also from simple discectomy when a pre-existing spinal canal stenosis was present[29].

Less severe cord damage occurred in a 55 year old male suffering from radiculopathy due to a hard disc lesions at two cervical levels (C5–6 and C6–7). Marked gait disturbance and ataxia, observed immediately after the procedure, resolved within 24 hours. Subsequently, the radicular symptoms gradually subsided.

Worsening of myelopathic signs and symptoms without evident trauma to the spinal cord was observed postoperatively in 14 patients. Certainly, it is not always possible to clearly distinguish between poor operative outcome and complication, because often there is a gradual transition from one to the other[26]. Nevertheless, marked neurological deterioration following the procedure should be considered a complication and discussed as such.

Ventral re-exploration in eight of these 14 patients and decompressive laminectomy in two of them was carried out between one and ten days after the first procedure.

In the majority of cases, reoperation disclosed marked swelling of the posterior longitudinal ligament or its residual edges when it was resected, which was associated with persistent osteophytes and/or small clots. Two patients had additional discectomy at adjacent levels with removal of soft herniations.

In one patient a retropharyngeal infection was found after five days, (the posterior longitudinal ligament had not initially been resected). In another patient the finding was an epidural abscess combined with haematoma (the posterior ligament had been completely resected at the first operation).

Three individuals did not undergo early reoperation because their neurological disorders were gradually improving. Due to residual myelopathic signs in one case, delayed re-exploration was performed after nine weeks, which disclosed an organized epidural haematoma that could be evacuated. One patient was submitted to secondary spinal fusion because of severe kyphotic angulation in the segment of discectomy. Finally, another patient had a previously undetected meningioma of the foramen magnum. The myelopathic signs and symptoms subsided after tumour removal. We conclude that neurological deterioration could have been avoided in most of these foregoing cases.

Particularly in anterior discectomy without fusion, incomplete as well as inappropriate removal of osteophytes might be one important cause of the poor surgical result. Special care is advised in patients with a narrow spinal canal[29]. Sugar recommends using smaller instruments like curettes, punches, or air drill instead of rongeurs[74]. It is remarkable that in the present series only two neurosurgeons (14%) were involved in nine instances of worsening myelopathy (60%). This point is mentioned to emphasize that the occurrence of such complications is also related to the surgeon's skill or experience. However, there is also evidence that worsening myelopathy can often be ascribed to mechanisms other than haematoma or spinal cord trauma[28].

Diagnostic error (for instance, spinal cord tumours), incorrect surgical indication (in cases with multisegmental discopathy, excluding from discectomy the segments with less pronounced, but radiologically demonstrable narrowing of the spinal canal), kyphotic angulation, and postoperative infections were the causes for the poor result in the present series and constitute avoidable aetiological factors for postoperative myelopathic deterioration.

Other possible causes of failure which must be considered are mechanical factors, such as manipulation of the neck during intubation[8, 25, 70, 74] and hyperextension of the neck in the anaesthetized patient, which can be dangerous as it can cause infolding of the ligamenta flava, anulus fibrosus, and posterior dura[73, 82]. Therefore, some authors recommend testing the tolerable range of neck motion before surgery and not exceeding this level[56, 74, 76]. A drop in blood pressure during the operation[56] or local vascular factors, for instance damage to a radicular artery[45], are also involved in the aetiology of cord compromise.

The knowledge of these potentially troublesome factors, and the policy of paying more attention to patient selection, to positioning during operation, and to careful and sufficient removal of osteophytes, have clearly reduced the number of poor results or devastating complications at our institution in the last few years. For example, worsening of pre-existing myelopathy, which had been observed in twelve cases between 1976 and 1982, occurred in only three patients after that period.

*Epidural haematoma:* This rare but serious complication may cause severe cord compression and tetraplegia. It is mentioned occasionally from posterior procedures[38, 51]. Busch reported one case with a fatal outcome[9]. U and Wilson analyzed three cases of acute epidural haematoma following anterior discectomy without fusion from a series of 100 patients and emphasized the necessity of early re-operation and evacuation if tetraplegia occurs postoperatively[80].

The source of bleeding are small arteries supplying the posterior ligament, which are injured when the ligament is resected. Therefore, there is controversy over whether or not to resect it. Some authors recommend coagulating the residual edges of the resected ligament to control the bleeding and to improve exposure[62, 80]. In our series the ligament was resected at least partly in the majority of cases. Soft disc herniations with penetration of the ligament, as well as thickened ligament with space-occupying effect, were frequent findings[4].

Another possible source of haemorrhage might be the radicular artery if the root is injured during operation. This was the suspected cause in one of four cases in the present series with an epidural haematoma. The patient, operated on at C5–6 and C6–7 interspace, postoperatively experienced increased radicular pain, but no additional neurological impairment. Re-exploration was performed after three days.

Another patient who suffered myelopathy due to a hard disc lesion at C5–6 interspace initially improved after the operation. Five days later, gait disturbance suddenly recurred. Myelography revealed a block at the previous level. Evacuation of an epidural haematoma led to resolution of symptoms. We wonder if the anticoagulant therapy with low-dose heparin applied in this patient from the second postoperative day for repeat deep venous thrombosis might have been involved in the aetiology of the haemorrhage. Despite postoperative worsening of myelopathy, (and neurogenic respiratory arrest in one case), reoperation was not performed immediately in two patients because of partial recovery. Secondary worsening required re-exploration in one patient after ten days, which disclosed an epidural haematoma combined with an epidural abscess. This was treated with antibiotics. In the other case, re-operation was carried out after nine weeks. As was already mentioned, the finding was an organized epidural haematoma.

Direct compression of the spinal cord is the pathogenetic mechanism causing intermittent ischaemia of medullary tissues, which is sufficient to impair function without destroying it[8]. Immediate intervention, however, is essential as treatable complications may be missed by delay. In retrospect, re-exploration should have been carried out immediately in view of the unequivocal postoperative deterioration.

*Additional radicular symptoms.* Additional radicular symptoms were seen in six patients. Three of them suffered cervical radiculopathy, the other three myelopathy.

In two instances the dural pouch was accidentally opened and the root was partly injured, leading postoperatively to increased radicular pain. One patient who underwent re-exploration on the third postoperative day, revealing an epidural haematoma, has already been mentioned. The other one improved without additional surgery. Of the remaining four patients, reoperation was performed in only one, who developed extreme C7 radicular motor weakness with a latency of nine days. Swelling of the posterior ligament and residual osteophytes were the intraoperative findings. The reason for the late recurrence remained unclarified. The other three patients subsequently improved. Incomplete foraminotomy was the obvious reason for the worsening of the radicular symptoms. This again underscores the importance of anterior foraminotomy in discectomy without fusion. Similar reports were made by authors using the same method. Giombini and Solero mentioned four cases (4%) with contralateral radicular pain and two (2%) with contralateral radicular motor deficit[29]. Goymann and co-workers reported

four transient and one permanent radicular impairments in 212 fused cervical segments[30]. Hankinson and Wilson noted two patients out of 52 with new radicular pain[36], Husag and Probst had one patient with brachialgia and three with sensory deficit[42]. Lunsford and co-workers reported radicular pain in 8.4%, radicular motor deficit in 0.8%, and sensory deficit in 2.5%[53].

*Wound haematoma.* Despite the closed drainage system applied in each patient for 48 hours after discectomy, a wound haematoma associated with swelling of the retropharyngeal space formed in six patients of our series (1.3%). All of them complained postoperatively of major difficulty in swallowing, two had additionally serious airway difficulty which required reintubation for 24 hours to 3 days.

Re-exploration and evacuation of the haematoma was performed in two cases (one of these patients developed a retropharyngeal abscess two weeks later, which had to be drained). Four patients needed no surgical intervention, as the haematoma resolved spontaneously. This complication has not been encountered again since 1981.

Wound haematoma secondary to anterior spinal surgery associated with dysphagia has frequently been reported in the literature. The incidence varies between 1 and 2%[26, 36, 43, 53, 57, 84, 85], however, it may also occur more frequently (3.8%[22], 11%[54]). Dysphagia may even remain persistent in 0.8 to 5%[26, 54].

Management focuses on early detection and reintubation in cases with pronounced tracheal obstruction; surgical evacuation may also be necessary. Recognition may be obscured by delayed onset and by the fact that the haematoma is usually neither palpable nor externally visible.

*Respiratory insufficiency.* Observed in five patients of our series (1.1%) respiratory insufficiency may occur as a result of either compression of the upper cervical cord or direct tracheal compression and/or laryngeal oedema. In addition, a very rare cause of this uncommon complication is worth mentioning. On awakening after discectomy, the 57 year old female, who was operated on at three levels (C4–5 to C6–7), was tetraplegic. Previous unexplained progressive rspiratory insufficiency made emergency reintubation necessary after two hours. By the first postoperative day, the motor and respiratory function had fully recovered. Neurological examination and electromyography performed several weeks later furnished evidence of a neuromuscular disorder (Lambert-Eaton's syndrome[24]). The delayed effect of the muscle relaxant drugs administered during anaesthesia was the cause of the postoperative motor weakness and respiratory insufficiency. This rare disease was unknown to the patient before discectomy.

Two patients with respiratory insufficiency after the procedure as a result of wound haematoma have been already mentioned. One of the patients with worsening of myelopathy due to an epidural haematoma who underwent delayed re-exploration developed neurogenic respiratory arrest and was reintubated for 24 hours. Respiratory function returned to normal on the first postoperative day.

In the fifth patient respiratory insufficiency was attributed to a marked local soft tissue swelling in combination with a pre-existing tracheal compression due to a hypertrophic thyroid gland, which extended into the retrosternal space. No surgical treatment was necessary in this case. This kind of complication has not been encountered in our department since 1982. Neurogenic respiratory insufficiency was reported by Esperson and co-workers in 0.4% of cases[26]. These authors mentioned one patient with laryngeal oedema who died. Tew and Mayfield noted one patient requiring tracheostoma and another one with an enlarging haematoma and respiratory arrest, which was unrecognized under the collar[77].

*Instability:* Instability of the cervical spine following anterior surgery for degenerative disc disease is a rare occurrence. Anterior angulation deformity may develop after anterior fusion techniques as well as after simple discectomy, especially if there has been excessive resection of the margins of the adjacent vertebral bodies[77]. Murphy and Gado reported one case in a series of 26 patients who experienced contralateral radicular symptoms three days after simple discectomy at C5–6 and C6–7 interspace[59]. This aggravation of complaints was caused by anterior kyphosis of 25° and required subsequent anterior interbody fusion at both levels.

There were four patients in our series who developed postoperative cervical spine instability. Partial osteolysis of the fifth and sixth vertebral body following discectomy at C5–6 and C6–7 interspace in a 72 year old male was responsible for angular kyphosis of 35° at C5–6, associated with pronounced radicular pain and motor weakness of upper extremities. These signs appeared secondary to initial resolution of pain and neurological deficits, and gradually improved after application of a Halo cast for four months with re-establishment of the normal alignment. Early re-exploration in this individual revealed no bacterial infection as cause of the spondylodiscitis.

Similarly, kyphotic angulation of 28° occurred in a 42 year old man at level C5–6 following operation at

C5–6 and C6–7 interspace. Although radicular motor deficits returned to normal several days postoperatively, additional interscapular and severe neck pain made reoperation with interbody fusion necessary (Smith-Robinson procedure). Subsequently, this patient made a full recovery.

Instability in these two cases may be attributed to excessive bone resection during operation. On the other hand, an angular kyphosis of 17° at level C5–6 had already been present in the second case before discectomy, but without abnormal movement in this segment. Nevertheless, it appeared to constitute an additional factor responsible for this avoidable postoperative complication.

Improper patient selection was another reason for instability in the third case. The patient, a 63 year old woman, presented with incomplete quadriparesis and spasticity due to multisegmental hard disc lesions associated with a Klippel-Feil deformity at the level C2–3. Discectomy at the C3–4 and C4–5 interspace was followed by worsening of myelopathy on the third postoperative day. Decompressive laminectomy between C3 and C6 was carried out and led to a certain amount of improvement. However, secondary deterioration of myelopathy with increased quadriparesis developed after several weeks. Plain radiographs revealed angular kyphosis of 27° and subluxation at C4–5. Re-exploration with interbody fusion (Smith-Robinson technique) had to be performed and the cervical spine was additionally immobilized in a Halo cast for three months. This patient only made a partial recovery. In retrospect, we now see that discectomy without fusion in this case should not have been the method of choice.

In the fourth case, which was a 38 year old woman suffering from C6 radiculopathy due to a unilateral hard disc formation, plain radiographs performed on the second postoperative day revealed a subluxation at the level of discectomy C5–6. Severe radicular pain on the contralateral side required re-exploration, and the segment was fused using the technique described by Caspar[11]. Subsequently, the patient made a full recovery. This patient had had no previous traumatic injury to the cervical spine, and no abnormal movement at C5–6 interspace existed before discectomy. The aetiologic factor responsible for postoperative instability and subluxation with foraminal encroachment seemed to be excessive spreading of the vertebral bodies during the operation.

*Vocal cord paresis, Horner's syndrome and pharyngeal lesion:* The anatomical conditions surrounding the recurrent laryngeal nerve, the sympathetic chain, pharynx, and oesophagus are well known[13, 52, 76]. Blunt dissection and retraction as well as proper positioning of the muscle retractor are recommended by many authors to avoid lesions of these structures.

Transient recurrent nerve palsy occurred in five males of our series, four of whom have had discectomy between sixth and seventh interspace and one at level C7–T1. Apparently, traction injury on this nerve predominantly occurs when approaching the lower cervical spine. Vocal cord paresis, reported in most references as transient, may occasionally be permanent (1 to 2%)[20]. The incidence in our series (1.1%) is consistent with that cited in other reports[22, 26, 76]. Roosen and co-workers noted a 0.3% incidence[66], but rates of 3%[42, 53], 9%[29] up to 16%[54] have been mentioned.

Damage to the superior laryngeal nerve causes no vocal cord paresis, but may be followed by permanent change in the voice[12]. Horner's syndrome is practically without clinical significance. We encountered it in five males operated on at one or two of the levels C5–6, C6–7, and C7–T1. The 1.1% incidence of our series is similar to that of others[20, 22, 66]. Rates vary between 0.2%[76] and 4%[29, 36].

Dissection of soft tissues to approach the upper cervical spine is more difficult than in the lower part. Injury to the hypopharynx occurred in one patient with myelopathy due to a soft disc protrusion between the second and third interspace. Repair was performed by an otolaryngologist and discectomy was delayed six weeks to avoid deep wound infection. After an uneventful postoperative course discectomy was carried out without any further difficulties.

As the wall of the hypopharynx is much thinner and less muscular than the oesophagus, perforation of the hypopharynx is more likely[12]. Crock mentioned one case with pharyngeal laceration[19]. The incidence reported of pharyngeal lesions in anterior cervical spine operations has ranged from 0.2%[76], 1.2%[20], 3.9%[66], to 7%[72].

*Infections:* Wound infections after anterior cervical spine surgery are uncommon and usually occur within the early postoperative period. Rates vary between 0.1 to 0.3%[57, 66, 76] and 3%[54]. The 1% incidence reported by several authors[1, 20, 21, 26, 53, 75, 84] is lower than the overall 2% infection rate in both Hoff and Wilson's series[41] and in our own.

Retropharyngeal abscesses can also be a delayed consequence of anterior spinal surgery[50]. Bacterial infection between the subcutaneous fat tissue and platysma developed in four of our patients. They required no surgical treatment. In three other patients a pre-

vertebral abscess developed. In another patient, who has already been mentioned, an epidural abscess formed accompanied by an epidural haematoma. All of these patients were treated with broad spectrum antibiotics, but only two were re-explored. Organisms included staphylococcus aureus, staphylococcus epidermidis and streptococcus.

Meningitis occurred in a 63 year old woman after a dural injury and CSF leakage during discectomy. Spiking fever, increased number of cells in the CSF and nuchal rigidity on the first postoperative day led to the diagnosis of meningitis, despite negative cultures due to early antibiotic therapy. The patient subsequently made a full recovery. Finally, severe local pain six weeks after discectomy between the fifth and sixth interspace, with removal of a soft disc protrusion in a 41 year old man, was diagnosed by magnetic resonance imaging as spondylodiscitis. The local syndrome improved after conservative treatment and collar application. The other patient with partial osteolysis of vertebral bodies and angular kyphosis has already been mentioned.

Hankinson and Wilson reported a 2% incidence of postoperative discitis[36]. However, the frequency of postoperative aseptic discitis may even be higher. Magnetic resonance imaging can be particularly helpful in the future to assess this postoperative complication and to differentiate it from a poor surgical result.

## Conclusions

The potential number of accidents and pitfalls related to anterior spinal surgery should not be underestimated. Anterior discectomy without fusion carries the risk of all complications except those related to interbody grafts and to the iliac crest donor site. Analyses of our previous pitfalls and failures showed that the rate of complications may be clearly reduced by proper patient selection, correct positioning during the operation, and meticulous removal of all offending structures. Special care is advisable in elderly patients with multisegmental hard disc lesions and myelopathic symptoms. Increased knowledge about the aetiology of complications is a valuable contribution to the avoidance of all factors leading to such undesirable events.

In the past years, severe complications such as medullary contusion, permanent neurological deterioration, and instability of the cervical spine have become a rarity at our institution. For the patients suffering from cervical degenerative disc disease who need surgical treatment, discectomy without interbody fusion is now a reasonably safe alternative surgical method with an acceptable operative morbidity and virtually no mortality.

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