Brief Review

Epidural anaesthesia and spinal haematoma

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***Purpose**: Haematoma formation in the spinal canal due to epidural anaesthesia is a very rare but serious complication. This paper presents a comprehensive review of case reports.*

***Source**: Sampling of case reports over a 10 yr period, medline® -research (1966–1995) and cross-check with former reviews.*

***Findings**: Fifty-one confirmed spinal haematomas associated with epidural anaesthesia were found. Most were related to the insertion of a catheter, a procedure that was graded as difficult or traumatic in 21 patients. Other risk factors were: fibrinolytic therapy (n = 2), previously unknown spinal pathology (n = 2), low molecular weight heparin (n = 2), aspirin or other NSAID (n = 3), epidural catheter inserted during general anaesthesia (n = 3), thrombocytopenia (n = 5), ankylosing spondylitis (n = 5), preexisting coagulopathy (n = 14), and intravenous heparin therapy (n = 18).*

***Conclusion**: Coagulopathies or anticoagulant therapy (e.g., full heparinization) were the predominant risk factors, whereas low-dose heparin thromboprophylaxis or NSAID treatment was rarely associated with spinal bleeding complications. Ankylosing spondylitis was identified as a new, previously unreported risk factor. Analysis of reported clinical practice suggests an incidence of haematoma of 1:190,000 epidurals.*

***Objectif**: L'hématome du canal rachidien provoqué par l'anesthésie épidurale constitue une complication très rare tout en étant très grave. Cet article présente une revue détaillée des cas rapportés.*

***Source**: Les observations rapportées sur une période de dix ans, une recherche dans Medline® (1966–1995) et un recoupement avec les articles de revue antérieurs.*

***Constatations**: Cinquante et une observations d'hématomes rachidiens prouvés associés à l'anesthésie épidurale ont été trouvées. La plupart des hématomes étaient liés à l'insertion d'un cathéter, technique ayant été jugée difficile ou traumatique chez 21 patients : la thérapie fibrinolytique (n = 2), l'aspirine ou un autre AINS (n = 3), un cathéter épidural inséré pendant une anesthésie générale (n = 3), la thrombocytopénie (n = 5), la spondylite ankylosante (n = 5), la coagulopathie préexistante (n = 14) et l'héparinothérapie intraveineuse (n = 18).*

***Conclusion**: La coagulothérapie et l'anticoagulothérapie (i.e., l'héparinisation complète) ont été les facteurs de risque prédominants alors que la thromboprophylaxie à l'héparine à faible dose et les traitement aux AINS ont été rarement associés à des complications hémorragiques rachidiennes. La spondylite ankylosante a été identifiée comme un nouveau facteur de risque jusque là non signalé. L'analyse des observations suggère que l'incidence de l'hématome est de 1:190,000.*

Key words

ANAESTHETIC TECHNIQUE: epidural;
ANALGESICS: NSAID;
COMPLICATIONS: haematoma, spinal, coagulopathy, anticoagulation.

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A haematoma in the spinal canal is a rare event. Spinal haematomas can occur as a complication of epidural or subarachnoid anaesthesia alone, anticoagulation therapy alone, or as a complication of the two in combination. Most, however, occur spontaneously without these risk factors.

The introduction of low molecular weight heparins (LMWH) for the prevention of deep venous thrombosis and pulmonary embolism has reopened the discussion concerning the risk/benefit ratio of the combination of epidural or subarachnoidal anaesthesia and anticoagulants. Since the incidence of haematoma formation in the spinal canal due to epidural anaesthesia is very low, prospective studies are difficult to accomplish. Nevertheless, an analysis of case reports may help to identify risk factors and lead to improved clinical strategies. This paper presents a comprehensive review of case reports of spinal (and cranial) haematomas related to epidural

anaesthesia. Vandermeulen *et al.* reviewed the problem of anticoagulants and spinal-epidural anaesthesia in 1994.[4] The present review is an update and reports 16 additional cases of spinal haematomas either missed by the former report or published after 1994.

Methods

A search for case reports in the literature using three different, overlapping approaches was performed. The author gathered, prospectively, over 10 yr, case reports of complications from continuous reading of relevant anaesthesia journals. Furthermore, a medline®-research covering 1966–1995 was performed for the following terms: Epidural*, Ana(e)sthesia, Haematoma; Epidural*, Ana(e)sthesia, Complication.

Previous reviews were examined for additional cases.[1–4] Only case reports with definite haematomas (e.g., confirmed at neurosurgical intervention or autopsy) and only cases following (attempted) epidural but not subarachnoidal anaesthesia were included (Table I, Part A). Case reports with uncertain aetiology, in which epidural haematoma was discussed as one of the possible causes of paraplegia, are listed separately (Table I, Part B).

In addition, clinical reports of epidural anaesthetic practice are given in order to evaluate the incidence of spinal or cranial heamatomas.

Results

Case reports of complications

Fifty-one cases of confirmed spinal haematomas in conjunction with epidural anaesthesia were identified in the literature (Table I, part A).[5–53,98–99] The haematomas were located in the spinal epidural space with two exceptions: one subdural and one combined subarachnoid-subdural haematoma.[18,34] Three cases of cranial subdural haematomas were documented after epidural anaesthesia, all occured during obstetric anaesthesia.[19,20,51] In all cases of spinal or cranial subdural haematoma formation following (attempted) epidural anaesthesia, an inadvertant perforation of the dura (wet tap) was verified or assumed by the reporting author. In three cases, spinal epidural haematoma was an incidental finding at autopsy without preceding clinical symptoms of cord compression. In 14 reports the pathology of the neurological sequelae was not evident, but cord compression due to epidural haematoma was one option discussed by the authors. These case reports are listed separately (Table I, part B).[49, 53–62,100,101]

RISK FACTORS

Spinal haematomas were reported in 23 male and 20 female patients (in eight cases sex was not mentioned) with a median age of 68 yr (neonate – 86 yr). In 38 cases, a catheter was introduced into the epidural space, in five a single shot epidural was performed, in three epidural anaesthesia was "attempted" and in five patients no information was given on the technique used. Especially in older case reports, clinical details were often sparse. Therefore, the identification of risk factors was not always possible. Two haematomas occurred following cervical, nine after thoracic and 36 following a lumbar approach to the epidural space (four cases without information). In 13 cases the clinical symptoms of cord compression developed following removal of an epidural catheter. The procedure was graded as difficult, traumatic or associated with an epidural vein trauma (bloody tap) in 22 patients.

A list of concomitant therapy or pathological states associated with spinal haematomas in confirmed case reports is given in Table III. Coagulopathies or anticoagulant therapy were the predominant risk factors for spinal haematoma formation. In many of these cases one could argue that central neural blockade was inapproproate, especially in the presence of fibrinolytic therapy (urokinase) or full therapeutic anticoagulation (warfarin).

On the other hand, low-dose heparin prophylaxis or NSAID treatment was rarely associated with spinal bleeding complications, although both conditions are often found in combination with epidural anaesthesia in clinical practice. However, the rate of spinal haematomas associated with various risk factors has to be weighed against the incidence of those risk factors in the whole population treated with epidural anaesthesia, e.g., two case reports associated with urokinase therapy may indicate a high risk, since this combination is rarely used. On the other hand, many patients receive perioperative low dose heparin prophylaxis or will have taken aspirin during the previous week without mentioning it and will be operated upon with epidural anaesthesia. A combination of NSAID with epidural anaesthesia, frequently found in clinical practice, was associated with haematomas in three cases probably indicating no increased risk. This conclusion is in accordance with an analysis performed by Horlocker *et al.* and Weale *et al.*,[63,64] who found no correlation between antiplatelet therapy and bloody needle or catheter placement.

By analogy, since the proportion of lumbar to thoracic or cervical epidural anaesthesia is unknown, one cannot calculate the specific risk for these different segmental approaches. The median age of 68 yr is high and probably indicates an increased risk in elderly patients. Again, the data allow no clear cut conclusion, since the distribution of patients receiving epidural anaesthesia in the population is not known. Case reports have been

TABLE 1 Case reports of haematomas associated with epidural anaesthesia

Part A: Confirmed cases (References 5–53,98–99)

Author/Year	*sex/age*[1]	*Segm./Tech.*[2]		*Coag. Status*[3]	*Heparin*[4]	*Puncture*[5]	*outc*[6]	*Indication, risk factors, details*[7]
Frumin 1952	f ?	L?	C	?	+	-	-	Embolectomy, Symptoms following removal of EDC
Bromage 1954	m72	L?	C	?	+	-	--	Embolectomy, severe fatal haemorrhage, epidural haematoma as an incidental finding at autopsy
Grossiord 1959	f48	L?	C	?	?	+	+acute	Herniotomy, Spondylarthrosis, Diabetes mellitus
Ruston 1964	neonat	L?	C	?	?	+		Omphalocele, traumatic insertion of EDC, intraoperative asystole, epidural haematoma as an incidental finding at autopsy
Gingrich 1968	m73	$L_{3/4}$	C	?	+	?	+6h	Sympatholysis (Recovery of neurological function over a few months)
Dawkins 1969	?	?	?	+	?	?	--	Anticoagulant therapy (drug not specified)
Dawkins 1969	?	?	?	+	?	?	+	Anticoagulant therapy (drug not specified)
Butler 1970	m70	$L_{2/3}$	C	?	+	-	--4h	Embolectomy, sclerodermia, Symptoms following removal of EDC
Helperin 1971	m76	$L_{3/4}$	C	?	+	-	-6d	Embolectomy, 5000 IU Heparin intra- and postoperativly, EDC removed at end of surgery, restitution within 2 weeks
Janis 1972	m76	$L_{3/4}$	C	?	+	-	--	Hip surgery, postop. heparin, haemorrhage, EDC removed during coagulopathy, no surgical therapy due to poor patient condition
DiGiovanni 1973	?	?	C	+	?	?	--n.s.	Sympatholysis, paraplegia following removal of EDC under anticoagulation, no surgical therapy due to poor patient condition
Varkey 1974	m70	$L_{3/4}$	C	?	+	-	--11d	Sympatholysis, intravenous heparin 20 min following application of EDC
Usubiaga 1975	m80	L?	?	?	+	?	?	Laparotomy, postoperative anticoagulation (case 287 in Usubiagas report (Hellman, personal communication))
Gordh 1978	m52	$T_{2/3}$	S	?	?	+	-n.s.	Pain therapy (radicular pain cervical spine following trauma), ankylosing spondylitis, injection of$(NH_4)_2SO_4$, autopsy
Greensite 1980	m68	$L_{2/3}$	A	ASA-postop	?	+,Perf	--12h	Knee replacement, spinal subdural haematoma
Reinhold 1980	f36	$L_{1/2}$	S	?	?	Perf	++	Obstetrics, cranial subdural haematoma
Newrick 1982	f29	L?	A	?	?	Perf	-	Obstetrics, cranial subdural haematoma
Stephanov 1982	f68	$L_{3/4}$	C	+	?	?	++3d	Hysterectomy, Spondylosis (slow recovery)
Swerdlow 1982	f ?	L?	S	?	?	?	--24h	Chronic back pain, epidural steroids
Roscoe 1984	f24	$L_{2/3}$	C	?	?	-	-17h	Obstetrics, paresis 3 days after delivery, lumbal ependymoma found at surgical intervention
Bynke 1985	m50	$L_{2/3}$	C	-	?	-	-12h	Hip surgery, ankylosing spondylitis (M. Bechterew), Azapropazon-therapy

Author/Year	*sex/age*[1]	*Segm./Tech.*[2]		*Coag. Status*[3]	*Heparin*[4]	*Puncture*[5]	*outc*[6]	*Indication, risk factors, details*[7]
Adriani 1986		L?	?		+	+	-	Femoro-popliteal bypass, *iv* heparin 1h postop.
Darnat 1986	f75	L?	C	?	+	+	--8h	2*5000 IU heparin perioperativly, history of pelvic radiotherapy, vertebral arthrosis
Sollmann 1987	f75	$L_{2/3}$	C	?	+	+	-12h?	PVD, sympatholysis, *iv* heparin as a bolus plus continuously, paresis following removal of EDC (recovery within 6 weeks)
Gustafsson 1988	m46	$T_{11/12}$	C	+	?	+	-29h	Pancreatitis, ankylosing spondylitis, alcoholism, thrombocytopenia
Wulf 1988	m21	$T_{9/10}$	C	+	-	-	**n.s.	Thrombocytopenia, epidural haematoma as an incidental finding at autopsy, originating from removal of EDC (?)
Reith 1989(*)	f55	$T_{10/11}$	C	-	?	-	-4d	Cholecystectomy, cholestasis
Dickmann 1990	m67	L?	C	urokinase	?	-	++acute	PVD, Embolism, fibrinolysis with urokinase (recovery within 3 days)
Dickmann 1990	m74	L?	C	?	+	?	++acute	PVD, Embolectomy, Heparin *iv* intra- and postoperatively (recovery within 24 h))
Scott 1990	f ?	L?	?	?	?	?	+	Obstetrics
Williams 1990	m63	C_7/T_1	S	steroid NSAID	-	-	++acute	Spondylosis, chronic pain management
Bills 1991	f81	$L_{2/3}, L_{3/4}$	A		+	+	--24h	Attempted EDC for hip replacement, *iv* heparin on 2nd postop. day (thrombosis), subarachnoidal + subdural haematoma cervicocaudal
Eastwood 1991	m71	C?	C	(ASA)	+	?	++2h	Carotid artery bypass, 5000 IU heparin at surgery, Intraop. removal of EDC, spinal and cutaneous haemangioma (immediate recovery)
Klement 1991	m56	$L_{3/4}$	C	-	+	-	++4h	Postop. 10000 IU heparin, coagulopathy, thrombocytopenia, paraplegia following removal of EDC (recovery within a few days)
Metzger 1991(*)	f54	$T_{10/11}$	C	+	+	-	-60h	Cholecystectomy, preop. coagulopathy (heparin and cholestasis)
Tekkok 1991	m42	$L_{2/3}$	C	?	+	-	--14d	Femoral bypass surgery, *iv* heparin intra- and postoperatively, dextran, paraplegia following removal of EDC
Wille-J. 1991	m68	$L_{3/4}$	C	+	?	+	--	External fixature (fracture of tibia), preoperative anticoagulation (warfarin)
GHAT1992 (Tryba 1990)	m45	L?	C	? (postop+)	LMWH	+	--48h	Hip surgery, ankylosing spondylitis, high dose LMWH periop (clinical trial), postop. coagulopathy, Cell-saver, HES
Onishchuk 1992	m69	$L_{3/4}$	C	-	+	+	--48hr?	Femoro-popliteal bypass surgery, intra- and postoperativ *iv* heparin plus fibrinolysis (urokinase)
Brockmeier 1993	?	$T_{6/7}$	C	-	?	+	--60h	Thoracotomy, paraplegia following removal of EDC

Author/Year	*sex/age*[1]	*Segm./Tech.*[2]		*Coag. Status*[3]	*Heparin*[4]	*Puncture*[5]	*outc*[6]	*Indication, risk factors, details*[7]
Lao 1993	f36	$L_{2/3}$	C	+	-	+	+14h	Preeclampsia, Caesarean section, praeop. coagulopathy, vaginal haemorrhage, radiating pain; seizure following injection via EDC (*iv*?)
Bent 1994	f30	$L_{3/4}$	S	-(post-op+)	LMWH	+	++n.s.	Fibular ligament rupture, postoperative LMWH, symptoms 5 days following single shot epidural, MRI finding, spontaneous restitution
Ganjoo 1994	m72	$L_{3/4}$	C	-	?	-	--20h	TUR of prostate, 12h postop EDC removed, 3 days later paraplegia
Nicholson 1994	f83	$L_{2/3}$	C	+(warfarin)	+	+	-36h	femoral bypass, ASA class 4, PVD, diabetes mell., preoperative warfarin for thrombosis, myocardial infarction and atrial fibrillation.
Weis 1994	?	$T_{10/11}$	C	+	?	Perf	--	Colonic surgery, EDC insertion in general anaesthesia, von Willebrand's disease, spinal subdural haematoma following EDC removal
Weis 1994	?	$T_{5/6}$	C	?	?	?	--7h	Cholecystectomy, EDC insertion in general anaesthesia
Dahlgren 1995	f92	$L_{3/4}$	C	+	+	-	-48h	Embolectomy. Patient on dicumarol. Heparin given intra- and postoperatively (20.000 U per day)
Dahlgren 1995	m56	$L_{3/4}$	C	?	+	?	-n.s.	Vascular graft, juvenile diabetes, angiopathy, re-operation after 3 days, fully heparinized + salicylates, symptoms after EDC removal
Hartigan 1995	f86	β	C	?	?	?	-?	Resection of colon carcinoma, weakness developed on 3rd postoperative day
Morisaki 1995	f69	$T_{7/8}$	C	+	?	+	+n.s.	Thoracotomy, hepatic cirrhosis, bloody tap, Thrombocytopenia conservative treatment since neurologic findings had stabilized
Scott 1995	f82	?	C	?	?	?	--n.s.	Abdominal surgery, severe haemorrhage, MRI-finding
Wulf 1995	m54	$L_{2/3}$	C	-	+	+	22h--	Orthopaedic surgery, ankylosing spondylitis, combined spinal-epidural anaesthesia (CSE), haemodilution (Hydroxyethylstarch)
Wyderka 1995	f28	$L_{3/4}$	C	?	?	Perf?	++70d	Obstetrics, cranial subdural haematoma
Badenhorst 1996	f ?	L ?	C	+(warfarin)	-	-	+24h	Knee arthroplasty, symptoms after removal of catheter at prolonged prothrombin time

Part B: Case reports with uncertain aetiology (in which epidural haematoma is discussed as one of the possible causes of paraplegia) (References Part B: [49, 53-62])

Author/Year	*sex/age*[1]	*Segm./Tech.*[2]		*Coag. Status*[3]	*Heparin*[4]	*Puncture*[5]	*outc*[6]	*Indication, risk factors, details*[7]
Ruppert 1957	f47	L?	?	?	?	?	?	Hysterectomy, Paraplegia within 24hr
Eisen 1960							++	"bizarre" (Paresis without sensoric deficit)

Author/Year	*sex/age*[1]	*Segm./Tech.*[2]		*Coag. Status*[3]	*Heparin*[4]	*Puncture*[5]	*outc*[6]	*Indication, risk factors, details*[7]
Mayer 1963	m72	?	?	?	+	?	--	2hr postop. *iv* heparin, no surgical therapy due to poor patient condition
Honkomp 1966	f28	$T_{11/12}$	A	?	?	+	-	Nephropexia, motor and sensory deficit left leg on the 11th(!) day following surgery
Zuev 1980	m41	$L_{2/3}$	S	?	?	?	++n.s.	Vascular surgery, postop. haemorrhage, 3 days later paresis with fever, leucocytosis, pathologic ESR; spontaneous recovery
Ballin 1981	f22	$L_{3/4}$	?	?	?	+	++	Obstetrics, spinal stenosis, spontaneous recovery
Skouen 1985	m66	$L_{3/4}$	C	+	?	-	-n.s.	Radical cystectomy, intraoperative hypotension, motor deficit without sensory deficit, CT-scan and myelogram without pathology
Jöhr 1988	m71	$T_{5/6}$	C	?	?	-		Thoracotomy. Paraplegia first postoperative day. No cord compression in CT-scan. Compromised arterial cord supply due to surgery
Puke 1988	?	?	?	?	?	?	?	?
Puke 1988	?	?	?	?	?	?	?	?
Yoshida 1989	f76	$T_{8/9}$	C	?	?	?	++n.s.	Gastrectomy, paraplegia and sensory loss after removal of EDC, MRI-finding, spontaneous recovery within three hours
Scott 1995	?	?	C	?	?	?	++n.s.	?, pain and leg weakness after removal of EDC, CT-finding, indomethacin therapy, recovery during conservative management
Sternlo 1995	f66	$L_{2/3}, L_{3/4}$	A	?	LMWH	+	+30h	Knee arthroplasty, spinal stenosis. Epidural abandoned, spinal anaesthesia. Subdural haematoma (complication of spinal anaesthesia, since no dura perforation was mentioned with the Tuohy needle).
Dahlgren 1995	f70	$L_{2/3}, L_{3/4}$	C	?	LMWH	?	--24h	Laparotomy (disseminated carcinoma), reoperation (peritonitis). Rheumatoid arthritis, steroids. Subdural haematoma (TH_{11}-L_1) 2 days after removal of EDC

[1]Sex: m(ale)/f(emale); years of age.

[2]Segm(ent for puncture); Tech(nique): C(ontinuous), S(ingle shot), A(ttempted) epidural anaesthesia.

[3]Preexisting coagulopathy or anticoagulant therapy: (+ = yes, - = no, ? = no information); ASA:Acetylsalicylic acid, NSAID: non steroidal anti-inflammatory drug.

[4]Perioperative heparin (+ = yes, - = no, ? = no information); LMWH: low molecular weight heparin.

[5]Difficult puncture, bloody tap etc. (=+), Perf. = perforation of the dura.

[6]Neurological outcome: -- permanent severe deficits, -: significant residual deficit; +: good recovery; ++: complete restitution (time scale: interval between symptoms and surgical evacuation of haematoma, h = hours, d = days, n.s.: no surgery performed).

[7]EDC: epidural catheter, GA: general anaesthesia; PVD: peripheral vascular disease; HES: Hydroxyethylstarch; ESR: Erythrocyte sedimentation rate; MRI: Magnetic resonance imaging.

(*)The case reports by Reith (1989) and Metzger and Singbartl (1991) probably refer to the same patient.

gathered over 45 yr (Table I) with 50% of the complications published during the last 10 yr. This could be due to higher incidence of the complication, increased use of epidural anaesthesia or thromboprophylaxis and anticoagulation or both or, more likely, to better reporting and focus of interest by anaesthetists.

ANKYLOSING SPONDYLITIS

An increased risk of spinal haematoma causing cord compression following epidural anaesthesia in patients with ankylosing spondylitis has not been described previously. Taking into account the incidence of this pathology in the entire population, the incidence of case reports of spinal haematoma in this population is high. Nevertheless, an exact analysis of the specific risk is not possible, since the frequency of epidural anaesthesia in these patients is not known. Patients suffering from ankylosing spondylitis may be prone to this complication because of one or more of the following risk factors:

- The higher incidence of difficult, traumatic attempts to identify the epidural space due to anatomical abnormalities,
- Pretreatment with analgesics such as NSAIDs,
- A higher incidence of epidural haematomas resulting in cord compression and neurological symptoms due to a narrow epidural space with smaller foramina.

Incidence of spinal haematomas calculated from the literature

The incidence of haematomas was calculated from the aggregate experience reported in reviews in the literature. In some papers, a complication of epidural anaesthesia was the impetus to publish a case report in combination with a review of the author's own experience e.g.[10,65] Therefore, the derivation of an incidence based on these reports would induce bias and a falsely high calculation of risk. On the other hand, many cases are unreported. With these limitations, a summary of reports regarding the experience with epidural anaesthesia is given in Table II.[32,49,52,55,60,64,66–88,102,103] Seven spinal epidural haematomas occured in more than 1,300,000 cases, suggesting an incidence of approximately 1 in 190,000 epidurals (95% confidence interval: lower limit: 1 in 406,242; upper limit: 1 in 96,949).

Some authors report their experience with epidural anaesthesia in the presence of therapeutic anticoagulation without bleeding complications (i.e. in vascular or open heart surgery).[72–74,78,90–94] Usually, patient selection, anticoagulation regimen, and monitoring were very strict (i.e. surgery postponed in the case of bloody tap, time interval between epidural catheter placement and start of anticoagulation, standardized neurological surveillance etc.).[73,75,78]

Severe complications with neurological sequelae are rare events following epidural anaesthesia. Therefore, prospective studies on the incidence are hard to accomplish. Two recent studies attempted a prospective design. Dahlgren *et al.*[49] in a retrospective/prospective study reported two cases of spinal epidural hematomas in fully heparinized patients and a third case with a questionable causal relationship to epidural anaesthesia based on an experience in 9,232 epidurals (Table I Part A and B, Table II). As stated above, one could argue that central neural blockade was inapproproate in these cases of full therapeutic anticoagulation. Scott and Tunstall[89] in a prospective study in an obstetric population (most probably treated with low dose heparin and in some cases with acetysalicylic acid) reported no spinal haematomas in more than 100,000 epidurals (Table II).

Discussion

Retrospective analysis of the reports in the literature indicate an incidence of approximately one clinically important spinal epidural haematoma in approximately 190,000 epidural anaesthetics. The analysis of corresponding case reports delineates two clear-cut risk factors of spinal epidural haematoma formation, in accordance with previous reviews:[3,4] Coagulopathies and anticoagulant therapy. In addition, ankylosing spondylitis (Morbus Bechterew) was identified as a further risk factor in the present analysis. Neither treatment with acetylsalicylic acid or other NSAID,[90,95] nor prophylaxis against venous thrombosis and pulmonary embolism using low dose unfractionated heparin increase this risk.[41,52]

Less information exists relating to the incidence of these complications following treatment with the newer, low molecular weight heparins[41,62,63,88,96] but since the risk of other (surgical) bleeding complications such as wound haematoma is not increased in comparison with the use of unfractionated heparin,[97] it is unlikely that low molecular weight heparins present a special risk. It can be concluded from this analysis of case reports, that the combination of low dose heparin or NSAID with epidural anaesthesia is safe clinical practice.

Therapeutic anticoagulation (e.g., full heparinization for vascular surgery) does carry an increased risk (Table I). Therefore, critical consideration of the risk/benefit ratio and a strict clinical regimen is essential in these situations. Patients who have received epidural anaesthesia or patients receiving postoperative epidural analgesia should be monitored with regard to neurological function (e.g., by visits of an acute pain service). If neurological deficits develop, one should not assume that they are due to prolonged local anaesthetic effect. This was the reason for the poor neurological outcome in some of the case reports.[40,41,48 etc.]

Neurological outcome is related to the time between clinical symptoms and surgical decompression (Figure). Early recognition is needed. The clinical symptoms are back pain (radicular), bladder dysfunction and sensory and, more often, motor deficits. These symptoms should

TABLE II Incidence of persistent neurological deficits and spinal haematoma associated with epidural anaesthesia (References 32, 49, 52, 55, 60, 64, 66–88, 102, 103)

Author	*Incidence*	*Patients (source)*
Blumensaat 1951	0: 2,000	Thoracic and lumar epidural anaesthesia, various patients (personal experience)
Bonica 1957	0: 3,637	Various patients (personal experience)
Eisen 1960	0: 9,532	No permanent neurologic deficits, epidurals for obstetrics (personal experience)
" "	1: 5,091	1 Paraplegia (most probably not a haematoma) (personal experience)
Lund 1962	0: 10,000	Without neurological deficits, lumbar and thoracic epidurals (personal experience)
Hellmann 1965	0: 26,127	Obstetric epidurals
Holdcroft 1976	0: 1,000	Obstetric epidurals
Moore 1978	0: 6,779	Various patients (personal experience)
Cunningham 1980	0: 100	No complications with EDC during vascular surgery, *iv* heparin (personal experience)
Rao 1981	0: 3,164	No complications with EDC during vascular surgery, *iv* heparin (personal experience)
Allemann 1983	0: 200	No complications with EDC, periop. *iv* heparin and/or dextran (personal experience)
Odoom 1983	0: 1,000	No complications with EDC, periop. *iv* heparin (personal experience)
Crawford 1985	0: 26,490	No haematoma with epidural anaesthesia for obstetrics (personal experience)
Stenseth 1985	0: 1,085	No pathology with thoracic or lumbar epidural catheters (personal experience)
Baron 1987	0: 912	No complications with EDC during vascular surgery, *iv* heparin (personal experience)
Lowson 1988	0: 99	No complications with EDC in combination with low dose heparin (personal experience)
Puke 1988	1: 100,000	Spinal haematoma associated with epidural anaesthesia (Swedish patients insurance)
Vaes 1988	0: 19,047	Original source not available
Waldman 1989	0: 790	Cervical epidural steroids for chronic pain management (personal experience)
Scott 1990	1: 506,000	Epidurals for obstetrics (British survey)
Mätzsch 1992	0: 54,678	Epidurals with low dose prophylaxis of thromboembolism (Swedish survey)
Maier 1994	0: 1,736	No neurological deficits in postoperative epidural analgesia (personal experience)
Lubenow 1994	0: 1,324	Continuous epidural analgesia in postthoracotomy patients (personal experience)
Leon-Casasola 1994	0: 4,227	Surgical cancer patients (47% thoracic catheters) (personal experience)
Horlocker 1995	0: 592	Orthopaedic procedures, 39% on antiplatelet drugs (personal experience)
Palot 1994	1: 288,351	One subdural haematoma in obstetric epidurals (French survey)
Steude 1995	0: 2,003	Postoperative pain management, Thoracic and lumbar catheteres (personal experience)
Strafford 1995	0: 1,620	Thoracic, lumbar and caudal catheters in children (personal experience)
Scherer 1995	0: 4,185	No haematoma with thoracic EDC (personal experience)
Wulf 1995	1: 133,744	One epidural haematoma, thoracic EDC, ankylosing spondylitis (German survey)
Dahlgren 1995	2: 9,232	Two epidural haematoma (full heparinization) (personal experience)
Scott & Tunstall 1995	0: 108,133	No haematoma in obstetric epidurals (prospective study in UK 1990-1991)
Scott 1995	1: 1,014	One epidural haematoma (personal experience)
Broekema 1996	0: 614	No haematoma in postsurgery patients, 68% thoracic catheters (personal experience)
Total	**6: 1,334,506**	**Risk of spinal haematoma associated with epidural analgesia (95% confidence interval: lower: 1 in 406,242, upper: 1 in 96,946)**

TABLE III Findings associated with spinal haematoma following epidural anaesthesia

Fibrinolytic therapy (urokinase)	($n = 2$)
Previously unknown spinal haemangioma or ependymoma	($n = 2$)
Low molecular weight heparin	($n = 2$)
Aspirin or other NSAID	($n = 3$)
Insertion of epidural catheter during general anaesthesia	($n = 3$)
Thrombocytopenia or impaired platelet function	($n = 5$)
Ankylosing spondylitis (Morbus Bechterew)	($n = 5$)
Coagulopathy before application of epidural technique	($n = 14$)
"High-dose" intravenous heparin therapy (vascular surgery)	($n = 18$)

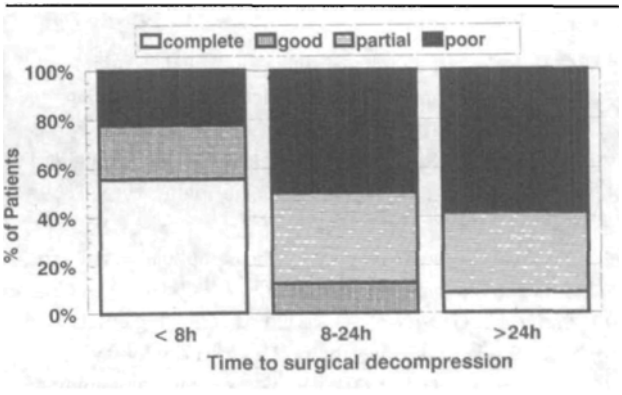

FIGURE Neurological recovery after spinal epidural haematoma depends on the time intervall between symptomes of cord compression and time of surgical decompression.

initiate immediate further diagnostic efforts. Magnetic resonance imaging is the most appropriate tool. If transport of the patient to a hospital with MRI would prolong

the start of surgical therapy considerably, other diagnostic means such as myelography or computed tomography should be considered.

Immediate surgical decompression in the case of epidural haematoma is the best way to achieve neurological restitution. Most of the patients with good recovery had less than eight hours delay from the onset of symptoms to surgery.

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