

Survey of compartment syndrome of the lower extremity after gynecological operations

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Abstract

Purpose This study was aimed to investigate incidence, circumstances and consequences of acute compartment syndrome (CS) of the lower extremity after gynecological operations in lithotomy position by collecting data from departments of Obstetrics and Gynecology in Germany.

Design Retrospective observational study.

Setting Departments of Obstetrics and Gynecology in the area of North Rhine (Germany)

Methods A 24-item questionnaire was sent to 168 gynecological departments. In addition, cases anonymously reported to the Expert Committee for Medical Malpractice Claims of the Medical Association of North Rhine between 2002 and 2012 were analyzed.

Main outcome measure Incidence of acute CS after gynecological operations.

Results A total of 59 questionnaires (35 %) were returned for analysis, reporting 21 cases of CS. Based on the collected data, we calculated an incidence of postoperative CS ranging

between 0.067 % and 0.28 %. All reported cases of postoperative CS occurred after surgeries in lithotomy position, 57.1 % of cases occurred after laparoscopic procedures and 76.2 % after procedures longer than 4 h. Overall, 61.0 % of departments do not routinely inform about the risk of this complication when they get patients' informed consent. Reported prevention strategies were inconsistent and ranged from none to multiple measures.

Conclusion CS is a complication clearly associated with long lasting gynecological operations in Lithotomy position. Despite a relatively high incidence, so far no guidelines on perioperative management and medicolegal aspects exist and preventive measures are heterogeneous among institutions. The need for guidelines and recommendations by an expert committee has been identified.

Keywords Compartment syndrome · Gynecological surgery · Incidence · Prevention · Lithotomy position

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Abbreviations

AEKNO	Medical Association of North Rhine
BMI	Body mass index
CS	Compartment syndrome
ICP	Intra-compartmental pressure
LAP	Laparotomy
LSC	Laparoscopy
LT	Lithotomy
Ob&Gyn	Obstetrics and Gynecology
WLCS	Well leg compartment syndrome

Introduction

The term “compartment syndrome” (CS) describes the resulting injury due to a compression of nerves, blood vessels

and muscle tissue inside a confined inelastic space [1, 2]. An increase in intra-compartmental pressure (ICP) leads to impaired perfusion and subsequently to necrosis of tissue and structures within a compartment due to a lack of oxygen. CS is most commonly found in the lower leg after trauma; however, numerous reports are published on CS in an otherwise healthy leg after long-lasting urological, orthopedical, general surgical and gynecological operations [3, 4].

Based on the empirical data gained from individual cases, etiology is commonly considered to be multifactorial comprising intrinsic (e.g., high body mass index [BMI], vascular co-morbidities) and extrinsic factors such as intraoperative positioning of the patient, hypotension and hypovolemia, duration of the procedure and type of leg holder. To our knowledge, there are no standardized and evidence-based recommendations regarding prevention in gynecological departments in Germany. However, several departments have developed and propagated their own prevention plan including intermittent re-positioning of legs, intraoperative leg massage and/or scheduled checks during longer procedures [5, 6]. In general, treatment of CS is mostly surgical in form of fasciotomy. Even though it is a very invasive procedure associated with complications such as wound infection, neurologic deficits and scarring, it remains the only definite treatment option for established CS [1, 7]. A delay in diagnosis and initiation of treatment will also most often lead to functional impediment, which in turn may result in law suits.

After communicating with the expert committee for Medical Malpractice Claims of the Medical Association of North Rhine (AEKNO) we hypothesized that the incidence of this complication after gynecological procedures might be underestimated. On the basis of this assumption this study was initiated to collect data from both the arbitration board of the AEKNO and from a survey distributed to 168 departments of obstetrics and gynecology in the area of North Rhine in order to provide an estimate on the incidence of CS and to give an overview about current clinical management in prevention and diagnosis.

Material and methods

Based on a previously published survey, we created a 24-item questionnaire which was distributed to all 168 departments of Obstetrics and Gynecology in the area of the Medical Association of North Rhine [8]. Questionnaires were returned anonymously by fax or email. We offered a €50 reward to any institution returning a questionnaire. Questions included type of department, number of cases of CS per year, general number and duration of procedures, occurrence of CS in the reported period of time, type of procedure after which CS occurred, intraoperative positioning, risk factors, management and outcome of these cases as well as pertinent law suites.

Information was entered into an Excel database for descriptive analysis. The overall incidence of CS was estimated based on the reported total number of gynecological procedures per individual hospital and the period of time, which was observed by the staff member who answered the questionnaire.

The data regarding both number of gynecological procedures per year and number of years reported were provided using categories rather than exact numbers (categories <25, 25–50, 51–75, 76–100, and more than 100 for the number of gynecological procedures per year; categories <1, 1–5, 6–10, and more than 10 years for the period of time reported). Thus, we could not provide a precise estimate of CS incidence. However, based on the categorical data, we calculated the minimal and the maximal possible total number of gynecological procedures using the minimum and maximum number for each category, respectively (assuming a maximum of 150 gynecological procedures per year and a maximum period of time of 20 years). We then obtained the lower limit of CS incidence by dividing the number of reported CS cases by the maximal possible total number of gynecological procedures, and the upper limit of CS incidence by dividing the number of reported CS cases by the minimal possible total number of gynecological procedures.

An inquiry was sent to the expert committee for Medical Malpractice Claims of AEKNO requesting anonymous disclosure of reported cases of CS after surgical (gynecological, general, urological, etc.) procedures within the last 10 years (between 2002 and January 2012). The AEKNO is the representative chamber of 53.000 medical professionals for an area comprising 9.6 million inhabitants. Under the umbrella of AEKNO, the expert committee for Medical Malpractice Claims, which consists of independent doctors and jurists, gives out free-of-charge expert opinions in the case of accusations of negligent medical treatment. The participation in the investigation procedure is voluntary. The statements of the commission are not legally binding for the partners. However, they are very often the basis for an extrajudicial execution of doctor's liability disputes. Furthermore, the departmental section for the regulation of fees settles any possible dispute that may arise between patients and doctors. Available documents from cases occurring after gynecological procedures were anonymously reviewed with respect to type and duration of procedure, intra- and postoperative management, individual risk factors and outcome.

The study was approved by all responsible ethical boards and conducted in accordance with the Declaration of Helsinki.

Results

In response to the survey, 59 departments (35 %) returned questionnaires for blinded analysis (for department characteristics, see Table 1). Overall, 22 (37.3 %) of the institutions

Table 1 Characteristics of departments which returned questionnaires

Characteristics	<i>N</i>	%
Institution		
Ambulatory	1	1.7
Community hospital	22	37.3
Teaching hospital	31	52.5
University hospital	5	8.5
Observed time period		
<1 year	3	5.1
1–5 years	18	30.5
5–10 years	19	32.2
>10 years	16	27.1
No answer	3	5.1
No. of procedures in LT position lasting longer than 3 h per year		
25	13	22.0
25–50	19	32.2
51–75	9	15.3
76–100	6	10.2
>100	4	6.8
No answer	8	13.6
Preoperative patient information about CS		
Yes	15	25.4
No	36	61.0
No answer	8	13.6
Preventive measures		
Yes	22	37.3
No	9	15.3
No answer	28	47.5

n=59; *N* number, *LT* lithotomy, *CS* compartment syndrome

reported to have established preventive measures in their routine. Whereas 73.4 % of departments having experienced a case of postoperative CS reported preventive measures, only 25 % without CS case did. Preventive measures reported included various positioning devices, regular position check-ups, intermittent leg massage and re-positioning. Patients were routinely informed about the risk of CS for procedures >3 h in 25 % of the institutions and departments with cases of postoperative CS were more likely to do so (53.3 %) than departments without cases of CS (15.9 %).

In total 21 cases of CS were reported from 15 institutions (see Table 2), which is equivalent to an incidence between 0.067 % and 0.28 %. Four departments reporting two (2×) and three cases (2×), respectively, had patients with postoperative CS on more than one occasion. CS after laparoscopic procedures occurred in 12 cases (57.1 %) and nine cases (42.9 %) were reported after open procedures. In all reported cases procedures were carried out in lithotomy (*LT*) position and in 11 cases patients spend some time in Trendelenburg position. Surgery duration was longer than 2 h in all cases and longer than 4 h in 16 cases (76.2 %). Five cases of CS occurred after laparoscopic surgery with a duration of 2–4 h, while no case had been reported after a laparotomy lasting less than 4 h (Fig. 1). Risk factors, including diabetes, peripheral

Table 2 Characteristics of patients and procedures for reported CS cases

		#	%
Operative procedure after which CS occurred	LSC	12	57.1
	LAP	9	42.9
Anamnestic risk factors	Y	9	42.9
	N	9	42.9
	No answer	3	14.3
Fasciotomy performed	Y	16	76.2
	N	2	9.5
	No answer	3	14.3
Permanent neurological deficits	Y	5	23.8
	N	12	57.1
	No answer	4	19.0
Intraoperative positioning	LT	10	48
	LT and Trendelenburg	11	52

n=21; *n* number, *Y* yes, *N* no, *LT* lithotomy position, *CS* compartment syndrome, *LSC* laparoscopy, *LPT* laparotomy

arterial disease, a smoking habit or a BMI >25 kg/m² was reported for nine (43 %) cases. Surgeons felt that diagnosis was delayed in four (19 %) cases due to misinterpretation of early symptoms. Fasciotomy was conducted in 16 cases (76.2 %). Four cases (19 %) resulted in a lawsuit. Six patients (28.6 %) now suffer from permanent disability.

Between 2002 and 2012, 47 cases of CS were reported to the expert committee and assessed with respect to malpractice. Nine cases occurred after gynecological procedures (Table 3). These procedures were all carried out with patient in *LT* position. Mean duration of operation was 6 h. Pain was the first symptom in six (66.7 %) cases while paraesthesia and numbness appeared as first symptoms in three cases (33 %). Fasciotomy was conducted in 77.8 % of cases. The council concluded that five out of nine cases (55.6 %) represented malpractice, either because diagnosis or onset of treatment was delayed (60 %) or because of a failure to take preventive measures such as changing the patient's position when the time of operation exceeded 3 h. Interestingly, in one case the

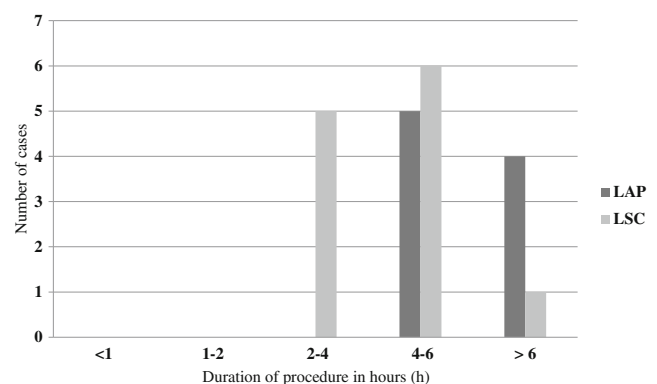
**Fig. 1** Occurrence of CS in relation to duration and type of procedure

Table 3 Summary of cases reported to the Medical Association North Rhine

Year	Age (years)	Operation	Duration (h)	Side	Access	Fasciotomy	Malpractice	Statement of the AEKNO committee in cases of malpractice
2003	43	Hysterectomy for uterine fibroids	3	Right	LSC	Y	Y	No preventive measures taken (change of position after 3–4 h)
2006	46	Ovarian cancer debulking	10	Bilat	LSC LAP	Y	Y	No preventive measures taken (change of position after 3–4 h), Delayed diagnosis
2008	28	Myomectomy	6	Bilat	LSC	Y	Y	Delayed diagnosis
2009	20	Pelvine Lymphonodectomie (vulvar cancer)	4,5	Right	LSC	Y	N	–
2009	47	Ovarian cancer debulking	7	Bilat	LAP	N	Y	Delayed diagnosis
2009	57	Radical Hysterectomy for (endometrial cancer)	6,5	Bilat	LAP	N	N	–
2009	68	Total hysterectomy, BSO (endometrial cancer)	6	Bilat	LAP	Y	N	–
2010	63	Hysterectomy for (endometrial cancer)	4,2	Left	LAP	Y	Y	Delayed diagnosis
2010	44	Laparoscopically assisted vaginal Hysterectomy for uterine fibroids	–	Bilat	LSC	Y	N	–

AEKNO Medical Association of North Rhine, LSC laparoscopy, LAP laparotomy, Y yes, N no, BSO bilateral salpingoophorectomy, Bilat bilateral

expert committee concluded that it is the duty of the treating physician to take preventive measures (40 %) when operating time exceeds 3 h, even if it was unexpected.

Discussion

Incidence

The estimated incidence between 0.067 % and 0.28 % for developing a CS after operations exceeding 3 h is based on a survey with a 35 % response rate distributed to 160 departments of obstetrics and gynecology (Ob&Gyn). This response rate is comparable to those from other questionnaire studies. However, by giving a €50 incentive, we tried to motivate all departments, not only those affected by a CS, to return their questionnaire. We still cannot exclude that our results are biased by a selective response.

Only very few other estimates can be found in the literature. Halliwill et al. [9] estimated an incidence of one case of CS after 3,500 gynecological operations (0.028 %) including all gynecological operations in LT position at their institution regardless of duration. We would expect our estimate to be higher, since it reflects the incidence of CS after operations longer than 3 h. In addition, our estimate might be biased towards high incidences by the fact that institutions, which had witnessed a CS, might be more prone to respond to the questionnaire. Tomassetti et al. [10] published an incidence of 0.8 % by looking at data from their institution. The true incidence remains speculative and is probably underestimated [11].

Intraoperative positioning and CS

The time spent in LT position is considered to be a key factor for the development of CS. It has been shown by invasive pressure measurements that lower extremity compartment pressure constantly increases over time in LT-positioned patients [12]. A rise above the suggested critical threshold of 30 mmHg ICP was reached on average after 5 h. According to the returned questionnaire of our survey, no CS was reported after operations shorter than 2 h. Interestingly, all reported CS cases after operations lasting 2–4 h ($n=5$) were done by laparoscopic route. It is conceivable that application of a pneumoperitoneum might be risk increasing by elevating intra-abdominal pressure. This assumption is subject of an ongoing study in our department.

All reported cases were observed after operations in LT position. Even though no specific descriptions were given, it can be assumed that most operations were carried out in low or standard LT position, typical for gynecological procedures. Nevertheless it should be noted that there are different modifications of this position which vary in the extent of leg elevation and flexion of the hip joint, termed low, standard, high and exaggerated LT position. An experimental study showed a decrease of local arteriolar pressure in the lower leg by 0.8 mmHg for every centimeter of leg elevation [13]. In high and exaggerated LT position, lower extremity systolic pressure was reduced to levels commonly associated with CS (52–71 mmHg) [14]. The addition of head down tilt (Trendelenburg) may further increase the risk due to an additional pronounced decrease in perfusion pressure. If head down tilt or LT position are reversed perfusion pressure seems

to normalize immediately [15]. These results show that alone by elevation of a patient's extremity, its tolerance for increased tissue pressure is lowered. The levels of perfusion pressure decrease in such a way, that even a moderate rise in ICP can lead to a differential pressure (mean arterial pressure minus ICP) less than 30 mmHg at which adequate blood flow to the limb can no longer be maintained and ischemia develops [16]. Since LT position is still commonly used for most gynecological operations, we propose that low LT position should be used whenever possible instead of high or exaggerated.

The benefits of different type of leg holders have also been subject to debate. There are three types of leg holders commonly used: (a) a calf support with a boot-like device (Allen Stirr-up), (b) a Bierhoff leg holder (supports the distal part of the thigh, knee and upper calf) and (c) a cloth sling around the ankle. Experimental studies showed that ICP increased immediately after placing a leg in any type of calf supporting leg holder (Allen Stirr-up or Bierhoff), while a decrease in ICP was noticed when resting the legs in a cloth sling [14, 17].

Patient-dependent risk factors

In nine (43 %) CS cases from our survey, additional risk factors were reported. It is difficult to define the significance of individual risk factors as conclusions in the available literature are mostly drawn on the basis of case studies rather than from controlled trials and therefore results are often contradictory (e.g., obesity) [16, 18, 19].

Primary and secondary prevention

So far, no evidence-based guidelines for prevention of CS exist in the standard literature, but after all 22 (37.3 %) of the institutions in our survey reported that they have introduced preventive measures for patients at risk. All emphasized to take extra precautions during preoperative positioning. Other factors were the use of extra padding (30 %), of boot-like devices and intermittent calf massage (13 %) or general avoidance of LT. One institution stated that they reposition the legs every 2 h.

Most often, these measures had been established after a case of CS had occurred. Tomassetti et al. [10] reported from their institution that CS incidence decreased from 0.8 % to 0 % after establishing a combination preventive measures including minimal use of classic LT position, use of a modified supine position whenever there is no need for vaginal and perineal access, mobilization of the legs during the operation, application of intermittent compressive stockings and use of forced-air warming devices and a moldable bean bag [10]. It remains elusive if indeed the combination of these measures is required or if a single factor is sufficient for the reported decrease.

Moreover, the preventive role of intermittent calf compressing stockings which were used by two institutions of

our survey is controversially discussed. Although a study conducted on healthy volunteers showed a decrease of ICP in each position (supine and LT) when intermittent calf compression was applied [14], some authors think that it is not effective in decreasing CS risk but instead might increase the risk for other complications such as deep venous thrombosis [20, 21].

Prompt diagnosis of CS is crucial in order to prevent permanent functional deficits. Of the 21 cases reported in the postal survey, four surgeons felt that there was a delay in diagnosis. In one case, this was attributed to a masking of symptoms because of the use of epidural anesthesia in another due to simple misinterpretation of symptoms. This was also true for three cases (33 %) of malpractice reported to AEKNO. In all of these cases pain was the first symptom. The role of (especially epidural) analgesia in masking first symptoms of a developing CS and thereby delaying diagnosis has been controversially discussed [22–25].

Medicolegal aspects

In addition to the severe consequences for the patients, malpractice claims are an important issue in this context. Of the nine cases presented to the expert committee of AEKNO 55 % were considered as malpractice. This number matches exactly the result of a Canadian survey reporting that 55 % of legally completed cases, between 1998 and 2008, resulted in a settlement or judgment for plaintiff most often due to failure or delay by the medical staff in performing diagnostic tests [26]. Another study concerning the medicolegal aspects found that early diagnosis and fasciotomy performed within 8 h after first presentation of symptoms, were uniformly associated with a successful defense [27].

From the forensic point of view, patients need to be informed about complications which are specific for an individual procedure independent of its actual incidence. Analysis of our data indicates that CS is associated with gynecological procedures in LT position, suggesting that CS has to be considered as a *typical* complication for gynecological operations in LT position scheduled for 3 h or longer.

Conclusions

CS of the lower extremity is a severe complication of gynecological surgery in Lithotomy position. Despite its relatively low incidence the surgical team must be aware of this complication, first symptoms and associated risk factors. Despite a long tradition of performing gynecological surgery in LT position, its use requires a proper indication and should be limited to procedures that cannot be performed in supine position such as procedures requiring vaginal access. We see

a clear need for guidelines and recommendations by an expert committee.

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Conflicts of interest None.

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