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Prevention of venous thromboembolic complications with and without intermittent pneumatic compression in neurosurgical cranial procedures using intraoperative magnetic resonance imaging. A retrospective analysis

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ABSTRACT

Object: To evaluate the introduction of intraoperative and postoperative pneumatic compression additionally to the use of compression stockings, low molecular weight heparin-LMWH and early mobilization, a retrospective study in cranial neurosurgery using intraoperative MRI was performed.
Methods: A retrospective analysis of 207 neurosurgical patients using intraoperative MRI was performed. A group of 86 patients was treated with the additional use of intraoperative and postoperative pneumatic compression until mobilization out of bed. One hundred twenty-one patients were treated without the use of additional pneumatic compression. Postoperatively the patients were screened for deep venous thrombosis by ultrasound and pulmonary embolism by CT-scan if suspicious. Statistical analysis was performed.
Results: The development of deep venous thrombosis was reduced from 9.9% to 3.5% in our patients with the additional use of intraoperative and postoperative pneumatic compression. That is a 64.6% relative risk reduction to develop deep venous thrombosis with the use of intraoperative and postoperative pneumatic compression.

An additional 52% relative risk reduction was found for the chance of developing pulmonary embolism.

In the 15 patients with detected deep venous thrombosis, the OR-time was more than 100 min longer than in the 192 patients without detected deep venous thrombosis. The difference between both groups was significant.
Conclusion: This study demonstrates the benefit of pneumatic compression with a risk reduction for the development of thromboembolic complications. OR-time is another risk factor that attributes to a significant risk for the development of thromboembolic complications.

1. Introduction

Deep venous thromboembolism is reported to be the most common adverse event after intracranial neoplasm surgery ranging from 3% to 26% [1]. In adults with malignant gliomas the reported incidence of venous thromboembolism was as high as 72% and generally accepted as 20–30% [2]. Risk factors in malignant gliomas were reported to be age greater than 75, Glioblastoma tumor subtype, subtotal resection compared to total resection, glioma size greater than 5 cm, intraluminal thrombosis in the tumor pathological specimen, A and AB blood type, steroid therapy, chemotherapy, radiation, as well as limb paresis [2]. Other authors found no correlation between tumoral intravascular thrombi in histological specimen and the incidence of deep venous thromboembolism [3]. A reason for the high incidence of deep venous thromboembolism in high-grade glioma might be related to activation of the

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coagulation cascade by a variety of complex interactions, including tumor hypoxia, upregulation of VEGR expression and increases of tissue factors [4]. Concerning the neurosurgical factor, the risk of developing thromboembolism was found to be higher in the first 2 months after surgery [5]. In the first month after surgery only 27% of venous thromboembolic complications are diagnosed [6].

Prophylactic techniques for deep venous thromboembolism had been widely demonstrated and confirmed [7], but adherence remains unstudied [1].

While the use of image guidance, intraoperative functional mapping and real-time intraoperative MRI guidance can allow surgeons to maximize the resection and preserving function, the second most frequent adverse effect with 0–20% [1]. On the other hand these procedures are time consuming and might lead to a higher risk of thromboembolic events.

To evaluate the introduction of intraoperative and postoperative pneumatic compression additionally to the use of compression stockings, low molecular weight heparin-LMWH and early mobilization, a retrospective study in cranial neurosurgery using intraoperative MRI was performed.

2. Materials and methods/case material

A retrospective analysis of 207 neurosurgical patients using intraoperative MRI (Espree, Siemens, Germany) was performed. For the prevention of venous thromboembolism in every patient graduated compression stockings (GCS) prior to surgery and low molecular weight heparin-LMWH 1 or 2 days after surgery, depending on the postoperative CT-scan, was used.

One hundred sixty-eight (81.2%) patients received low molecular weight heparin-LMWH 1 day after surgery, 32 (15.5%) patients received low molecular weight heparin-LMWH 2 days after surgery, while seven (3.4%) children received no low molecular weight heparin-LMWH at all.

A group of 86 patients were treated with the additional use of intraoperative and postoperative pneumatic compression (Kendall SCD^{TM} Sequential Compression System, Covidien, Germany) until mobilization out of bed. One hundred twenty-one patients were treated without the use of additional pneumatic compression. Postoperatively the patients were regularly screened for deep venous thrombosis by ultrasound of the limbs and pulmonary embolism by CT-scan if suspicious. Suspicious means any thrombosis diagnosed with ultrasound or hypoxia or respiratory events or chest pain. Treatment consisted of increased low molecular weight heparin-LMWH and clinical as well as ultrasound control examinations of the limbs. Mean hospital stay was 16.6 ± 0.7 (mean ± SE) days. The differences between the numbers of the groups were for technical reasons.

Statistical analysis was performed regarding age, gender, the time interval regarding the initiation of low molecular weight heparin-LMWH in days after surgery, Body Mass Index (BMI), smoking habits, preoperative palsy graded from 0 to 5, intraoperative and postoperative pneumatic compression, occurrence of venous thrombosis and pulmonary embolism, occurrence of thrombotic vessels in histopathology, position of the patient (only prone or supine possible with the used intraoperative MRI), diagnosis, time in OR (from in to out) and mean hospital stay. No patient was excluded from the study. Ethic approval was obtained by the local ethic committee (Medical School Hannover)

Statistical analysis was performed using StatView 5.0.1 SAS, Cary, NC, USA. The level of significance was set at 5%.

3. Results

3.1. Comparison between the patients regarding the occurrence of pulmonary embolism and deep venous thrombosis

3.1.1. Age

The mean age of the 15 patients with thrombotic events was 44.3 ± 3.8 with a range of 17–67 years. The mean age of the 192 patients without thrombotic events was 42.5 ± 1.2 with a range of 2–76 years

The mean age of all treated patients was 42.6 ± 1.1 (mean ± SE) with a range of 2–76 years. The mean age of the four patients with pulmonary embolism was 55.5 ± 3.9 with a range of 50–67 years. The mean age of the 203 patients without pulmonary embolism was 42.4 ± 1.2 with a range of 2–76 years.

The differences did not reach statistical significance.

3.1.2. Gender (Fig. 1)

Of the 82 female patients 7 (8.5%) female patients had detected deep venous thrombosis, while no female patient had detected pulmonary embolism.

Of the 125 male patients 8 (6.4%) male patients had detected deep venous thrombosis, while 4 (3.2%) male patients had detected pulmonary embolism.

In the 82 female patients the mean OR-time (from in to out), was 389.7 ± 13.7 min (mean ± SE) ranging from 105 to 700 min. In the seven female patients with detected deep venous thrombosis the OR-time was 489.2 ± 53.9 min (mean ± SE) min. No pulmonary embolism was detected in the female group. The time differences of the groups reached statistical significance (p = 0.0146).

The mean age of the 82 female patients was 39.8 ± 1.9 years ranging from 2 to 76 years. Twenty (24.4%) out of 82 female patients had a high grade glioma as histological result, while 34 (27.2%) out of 125 male patients had a high grade glioma as histological result.

In the 125 male patients the mean OR-time (from in to out), was 407.6 ± 11.9 min (mean ± SE) ranging from 115 to 870 min. In the eight male patients with detected deep venous thrombosis the OR-time was 508.3 ± 62.8 min (mean ± SE) min. In the 117 male patients without detected deep venous thrombosis the OR-time was 400.7 ± 11.8 min (mean ± SE) min ranging from 115 to 820 min. In the four male patients with detected pulmonary embolism the mean OR-time (from in to out), was 483.75 ± 67.03 min (mean ± SE) ranging from 365 to 655 min. In the 121 male patients without detected pulmonary embolism the mean OR-time (from in to out), was 405.1 ± 12.0 min (mean ± SE) ranging from 115 to 870 min. The time differences of the groups with and without deep venous thrombosis reached statistical significance (p = 0.026) (Fig. 1).

The time differences of the groups with and without pulmonary embolism did not reach statistical significance (p = 0.24).

3.1.3. BMI (Fig. 2)

The 15 patients with detected deep venous thrombosis had a BMI of 30.3 ± 2.1 kg m^{-2} (mean ± SE) ranging from 18.4 to 52.9 kg m^{-2}.192 patients without detected deep venous thrombosis had a BMI of 26.3 ± 0.5 (mean ± SE) ranging from 14.7 to 66.8 kg m^{-2}. The BMI differences of the groups with and without deep venous thrombosis reached statistical significance (p = 0.024) (Fig. 2).

The four patients with detected pulmonary embolism had a BMI of 31.1 ± 2.6 kg m^{-2} (mean ± SE) ranging from 26.5 to 35.9 kg m^{-2}. Two hundred three patients without detected pulmonary embolism had a BMI of 26.5 ± 0.5 kg m^{-2} (mean ± SE) ranging from 14.7 to 66.8 kg m^{-2}. The BMI differences of the groups with and without pulmonary embolism did not reach statistical significance (p = 0.18).