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Thieme

Training microneurosurgery – four years experiences with an in-vivo model

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Abstract:

Objective: Enquiries among surgical trainees revealed an increasing discontent regarding their quality of training. Forty per cent of young surgical trainees judge their training as inadequate and 70% are offered no structured training programme. Working time restrictions and economic pressure may be strong factors hindering residents from becoming skillful sugeons. Therefore additional training forms seem to be requested.
Method: An in-vivo swine model was evaluated for its practical use in training neurosurgical residents. Surgical procedures included craniotomy, dural opening, brain surgery and excision of an artificial tumor created by injection of colored fibrin glue. Microscopy and bleeding management with bipolar cautery and haemostyptics were an integrated part of training. Supervision was warranted by experienced neurosurgeons with a relation of up to three trainees by one senior surgeon in a two-day course. Standardized questionnairies before and after training were used to assess quality and utility of the programme.
Results: Twenty-four residents participated in the course so far (1st to 5th year of training). Minor experience with less than 100 surgeries was seen in 59% of trainees and another 59% had done more than 100 assistances. Spinal surgery was the common experience predominantly. All participants judged their surgical training as insufficient. 77% had no microsurgical lab at their clinics. Expectations of the course were met for all trainees and the tutorials judged as excellent (65%) or good (35%). The in-vivo model (97%), a realistic laboratory set-up (94%), the working environment (94%) and close supervision (94%) were the most favorable aspects of the course.
Conclusion: Educational training in surgical specialities is becoming a major problem in our daily practice and requires additional training facilities. In this context in vivo models are an ideal opportunity for young neurosurgeons training bleeding

management and surgical complications in particular. This educational form is thought to be a unique training model which is now added by spinal and neurovascular courses.

Hintergrund: In den letzten Jahren haben zahlreiche Umfragen unter den Assistenten eine wachsende Unzufriedenheit mit der Ausbildungssituation ergeben. 40% der jungen Chirurgen bewerten ihre Ausbildung als unzureichend und 70% wird kein strukturiertes Programm angeboten. Arbeitszeitgesetz und Kostendruck haben eine maßgebliche Verbesserung in den letzten Jahren unmöglich gemacht, weswegen andere Formen der Ausbildung gefragt sind.
Methode: Ein in-vivo Schweinemodell wurde hinsichtlich seines praktischen Nutzens für die neurochirurgische Ausbildung evaluiert. Kraniotomie, Duraeröffnung, Hirnpräparation mit Entfernung eines artifiziellen Hirntumors (farbmarkierter Fibrinkleber) waren Bestandteil eines 2-Tages Kursus. Besonderes Augenmerk galt der Mikrochirurgie und Blutungsmanagement unter Verwendung der bipolaren Koagulation und Hämostyptika. Die Supervision wurde durch erfahrene Neurochirurgen mit einem Verhältnis von 2-3 Assistenten auf einen Anleiter sichergestellt. Die Evaluation erfolgte mit Hilfe eines standardisierten Fragebogens vor und nach dem Kursus.
Ergebnisse: 24 Assistenten im ersten bis fünften Ausbildungsjahr nahmen an dem Kursus teil. Eine geringe Erfahrung (59% mit weniger als 100 Eingriffen und 59% mit mehr als 100 Assistenzen), überwiegend in der spinalen Neurochirurgie, war allen Teilnehmern gemeinsam. Alle Assistenten beurteilten ihre Ausbildung als insuffizient und 77% gaben an, kein mikrochirurgisches Labor zur Verfügung zu haben. Die Erwartungen an den Kursus wurden aus Sicht der Teilnehmer voll erfüllt. Die praktischen Übungen wurden als sehr gut (65%) und gut (35%) bewertet und mit dem praxisnahen in-vivo Modell (97%), einer sehr realen Arbeitssituation (94%) und einer intensiven Betreuung (94%) begründet. 95% sahen den Kursus als empfehlenswert an und 87% wünschten ein weitergehendes Kursprogramm.
Zusammenfassung: Es scheint außer Zweifel, dass ergänzende Ausbildungskurse erforderlich und gefragt sind. Unserer Meinung nach stellt der in-vivo Kursus eine einmalige Möglichkeit dar, Blutungsmanagement und chirurgische Komplikationen zu trainieren. Auf der Grundlage unserer ersten Erfahrungen werden neurovaskuläre und spinale Kurse eingerichtet, die eine sehr sinnvolle Ergänzung der neurochirurgischen Ausbildung darstellen sollen.

Introduction

Ten years ago, enquiries among EANS-trainees (European Association of Neurosurgery) were emphasizing the insufficient training programme at their clinics and the low surgical experience level reached within their training period [3]. Quality concepts were introduced, morbidity and mortality conferences were initiated, and hospitals were assessed for their good clinical practice and education programmes [4, 15, 20, 22, 24]. Although attention was paid to improving education programmes in surgical specialities, changes have not been revolutionary in the last decade.

The European Working Time Directive (EWTD) may be one of the main reasons for insufficient training where shifting and alternating duties are in contrast with predictable schedules in the operating rooms. A high level of medical routine, pressure of time, and costs may be further strong factors hindering residents from becoming skillful surgeons. Therefore additional methods of surgical education seem to be necessary. While hands-on cadaver courses have spread across countries, we started with an in vivo model in cranial neurosurgery four years ago.

Training model

A swine model (weight: approximately 40 kg; age: 3–4 months) was chosen as an in vivo training object since the cranial vault and brain anatomy are similar to those of humans, allowing young neurosurgeons to focus quickly on improving their neurosurgical skills. Ideal conditions were found at the European Surgical Institute of Johnson & Johnson in Norderstedt, Germany. The facility offered full veterinary and anaesthetic support for practical training purposes in the laboratory. Analgesia and sedation were achieved by intramuscular administration of metamizole and a combination of xylazine and ketamine, following the guidelines of the Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC). Operating microscopes (Möller-Wedel, Wedel, Germany), bipolar coagulation, suction, and microsurgical instruments (Codman, Johnson & Johnson) provided an almost realistic copy of the daily situation in the operating room (OR).

Practical tasks included craniotomy, dural opening, and brain surgery with dissection of sulci and gyri. Excision of an artificial tumour was one goal of surgery by inserting a transcortical injection of coloured fibrin glue. Handling of the microscope and bleeding management with accurate suction, aimed bipolar coagulation, and pointed application of haemostyptics were further topics of training. Each resident was invited to

operate on one cerebral hemisphere while the other resident assisted him or her in handling the instruments and accompanying the surgical steps through the assistant tube of the microscope. Two to three residents were supervised by one senior neurosurgeon to guarantee optimal and proper handling of the animals during surgical dissection.

Standardized questionnaires regarding their practical skills, year of residency, training programme in their home hospitals, experiences in microsurgical laboratories, and expectations on the course before starting the tutorials were analysed. Evaluation was completed by a second enquiry asking about the contents and practical use of the programme and the limitations and improvements which should be made in the future. Rating scales (1–10; qualitative scale of excellent, good, satisfactory, or inadequate) or free text was used for assessment.

Results

Twenty-four residents participated in the course so far (1st to 5th year of training). Minor experience with less than 100 surgeries was seen in 59% of participants. Fourteen residents (59%) had performed more than 100 surgical assistances, while ten trainees had done more than 200 assistances. Spinal surgery was the common experience predominantly. All residents judged their training as insufficient, in particular due to the lack of a structured education programme. Pressure of time, economic costs, competition among residents, low case loads, and high expectations by the patients were found to be the most important reasons for inadequate training. Seventy-seven per cent had no microsurgical lab at their clinics and only two participants were offered microsurgical practice related to research activity. Nineteen (77%) had attended other workshops, predominantly spinal courses (Figure 1). Expectations of the course were: learning basic techniques in patient positioning, cranial approaches and bleeding management, training in microsurgical techniques, and acquisition of tips and tricks for daily surgical practice. On finishing the course, practical and theoretic tutorials were judged as excellent (65%) or good (35%) due to the in vivo model (97%), the working environment (94%), a realistic laboratory set-up (94%), complication management (85%), and close supervision (94%) (Figures 2 and 3). Eight residents (35%) would have appreciated more time on practical tutorials and more microsurgical instruments. Finally, the course met the expectations of all participants. Ninety-five per cent would recommend this course and 87% asked for further in vivo workshops (Figure 2).

Discussion

The present tasks in a medical career are characterized by a high level of medical care, economic pressure, increase in administrative work, and ongoing technological innovations driving the surgical procedures to greater complexity [7, 9, 12, 13, 25].

Working hour restrictions may have a further strong impact on education and training programmes at present. Upon review of the literature, residents in North America (working hours restricted to 80 hours) perceived an improvement in their work–life balance. But it appears that patient safety and quality of training worsened while attendances at the clinic decreased [5–7, 9, 12, 26]. A rise in errors in patient care may be explained by cross coverage and its communication problems [6, 7, 26]. But the most worrisome trend is the decrease in assistant and teaching cases, which is expected to worsen the level of surgical experience reached during training and to lengthen the duration of residency for another two years [19].

In Germany EWTD was rolled out in 2009 and restricted working time to a 48-hour week. Considerable satisfaction in medical professions should have been expected, but at present, 20–30% loss of income, compromised continuity of patient care, and worsening of education seem to be of major concern, comparable to the experiences in the United States [7, 25]. Several enquiries among trainees in surgical specialities during the last years confirmed an increasing discontent with the quality of training in particular. Forty per cent of young surgical trainees judge their training as inadequate and 70% are offered no structured training programme.

Evaluating the enquiries of our small group of neurosurgical trainees, economic pressure seems to be one decisive reason for inadequate training. Reduction of the number of hospital days, reduction of operating time, and reduction of complications at the same time dictate the daily routine. Surgery is sped up by senior surgeons who take over to reduce operating time and costs. Therefore teaching time is restricted and thus patience and continuity of education are lost. Today, competition among trainees is noticed far more than in the past; further, their experiences are becoming fewer and their learning curve is decelerating.

Besides better and structured education programmes, other training opportunities seem to be required. Especially practical experiences are of special interest for residents. While Internet resources [16, 27] and computer based learning systems have

been established [2, 11, 14, 21], tactile simulators [29] as well as robotic systems have been developed [21]. In addition, a number of hands-on courses are offered to satisfy the enquiries. As cadaver courses are well known in their contents, in vivo dissection is limited to the microsurgical labs or may be performed sporadically in relation to research activity. Vessel anastomosis or peripheral nerve surgery may be the predominant techniques in these models [1, 10, 17, 18]. Our experience with an in vivo swine model is a new and unique educational form, mimicking the daily micro-neurosurgical practice ideally (Table 1).

Microscopic dissection and bleeding management of a pulsating brain using an OR-equipment is a particular challenge which can be learnt with calmness and patience in this set-up. Bipolar cautery and appropriate suction without damaging the brain are major contents of neurosurgery in which it is possible to train without risks for the patient. Suctioning while bleeding, handling the microscope, changing the instruments, and decision making are as complex in the in vivo model as in a real operating room. Individual stress factors may aggravate the difficulty significantly and are noticed in the lab as well. Surgical failure ends up in an unclear, blood-filled cavity or damaged brain and learning is mediated by the successful or disappointing in vivo dissection. However, upon completion of this course participants should be able to control bleedings, handle their instruments with care, and manage complications during microsurgery.

A team approach has been implemented by the realistic set-up in which the second surgeon has to take over the nursing job, has to anticipate the next surgical step, and is asked to exchange his experiences with the performing surgeon to achieve an optimal blood dry and clear resection cavity. From our point of view, the in vivo model presents an ideal opportunity for microsurgical training including social skills, which are also required in the competitive medical career today.

Taking into account the multiplicity of problems in medical education, solutions have to be found. In Europe, training programmes were initiated by the European and national associations of neurosurgeons, reforming our education programmes [8, 23, 28]. But a national structure for all training courses is still missing and it would be helpful to install a thorough education programme resulting in a synthesized form of theoretic and practical courses, thereby diminishing the amount of travel for all—residents and faculty.

Conclusion

The present situation of educational training in surgical specialities is dictated by economic pressure, the high level of medical supply, and the Working Time Directive, which are obstacles to a personalized and time consuming training programme. Our in vivo model has turned out to be a very useful supplement for young neurosurgeons mimicking the daily surgical practice ideally. A structured theoretical and practical educational programme covering spinal and cranial neurosurgery in a synthesized module for all levels is now the consistent next step.

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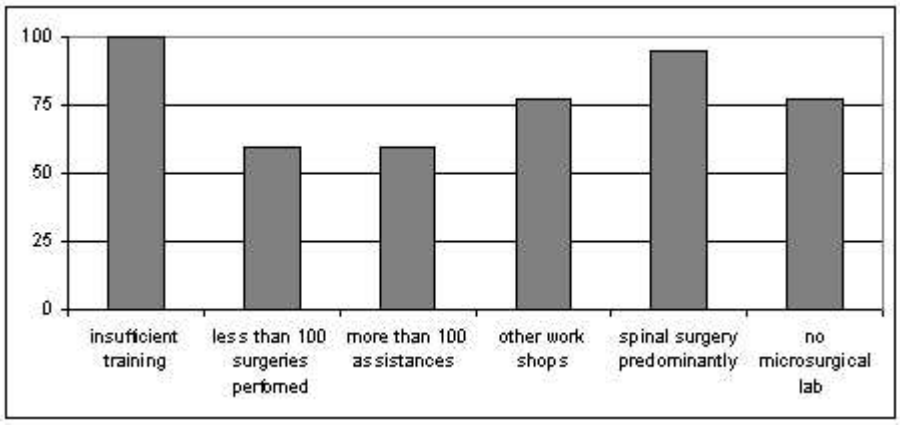
Figure 1
24 residents, from the 1st to 5th year of training, participated on the course. All residents judged their training as insufficient. Less surgical experience was striking and the majority had attended other courses already.

Figure 2a
Intraoperative microscopic view of a human cortex

Figure 2b
Microscopic image of the swine cortex in the laboratory

Figure 3
Expectations on the course were met for all trainees. The benefit of the course was judged as excellent (65%) or good (35%). The in vivo model (97%), working environment (94%), and realistic lab set-up (94%) were appreciated most by the trainees. Tips and pitfalls by the supervisors as well as sufficient timing for dissection were other important factors for the participants.

Table 1
Comparison between in vivo swine model and human cadaver specimen related to the surgical skills which can be obtained (ineligible 0; appropriate +; ideal learning object ++).



24 residents, from the 1st to 5th year of training, participated on the course. All residents judged their training as insufficient. Less surgical experience was striking and the majority had attended other courses already.
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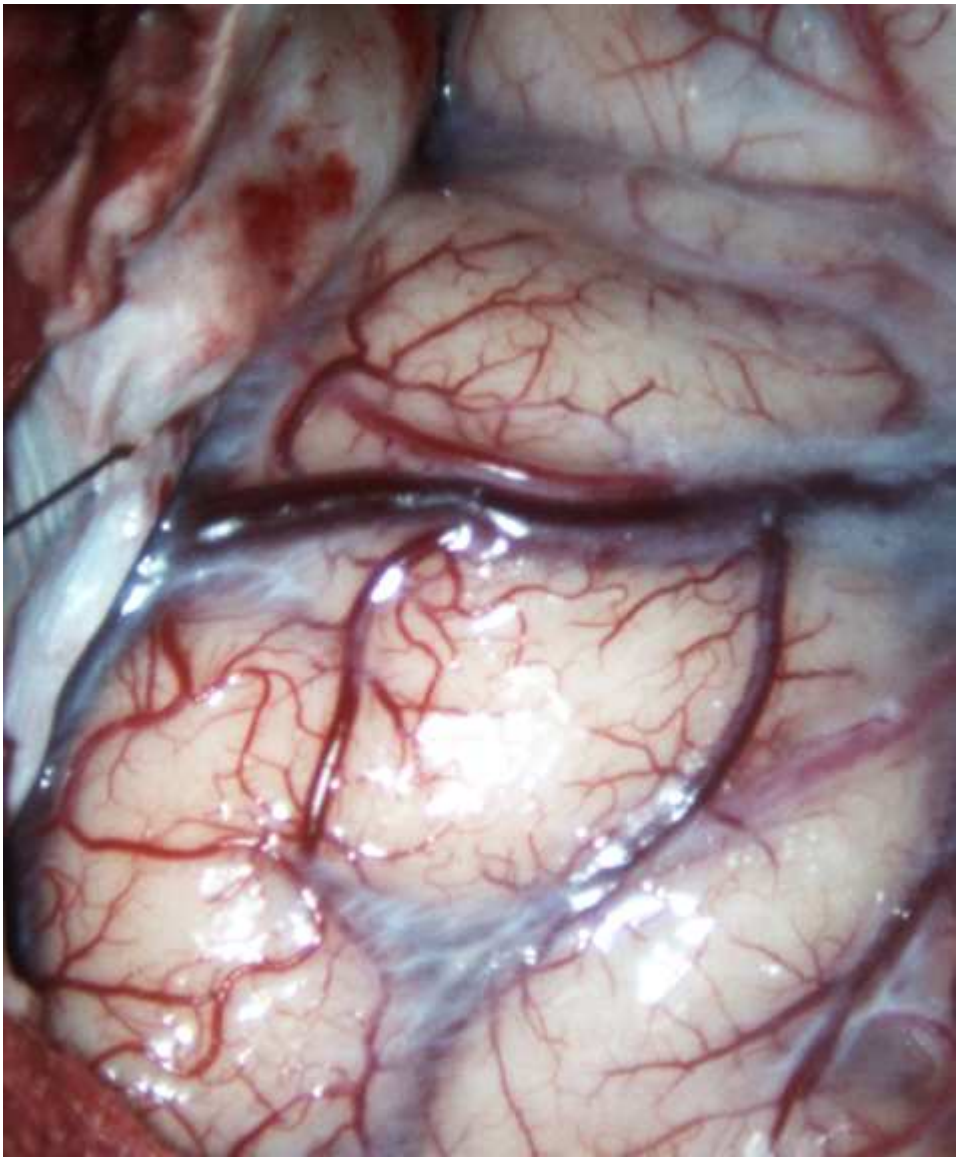
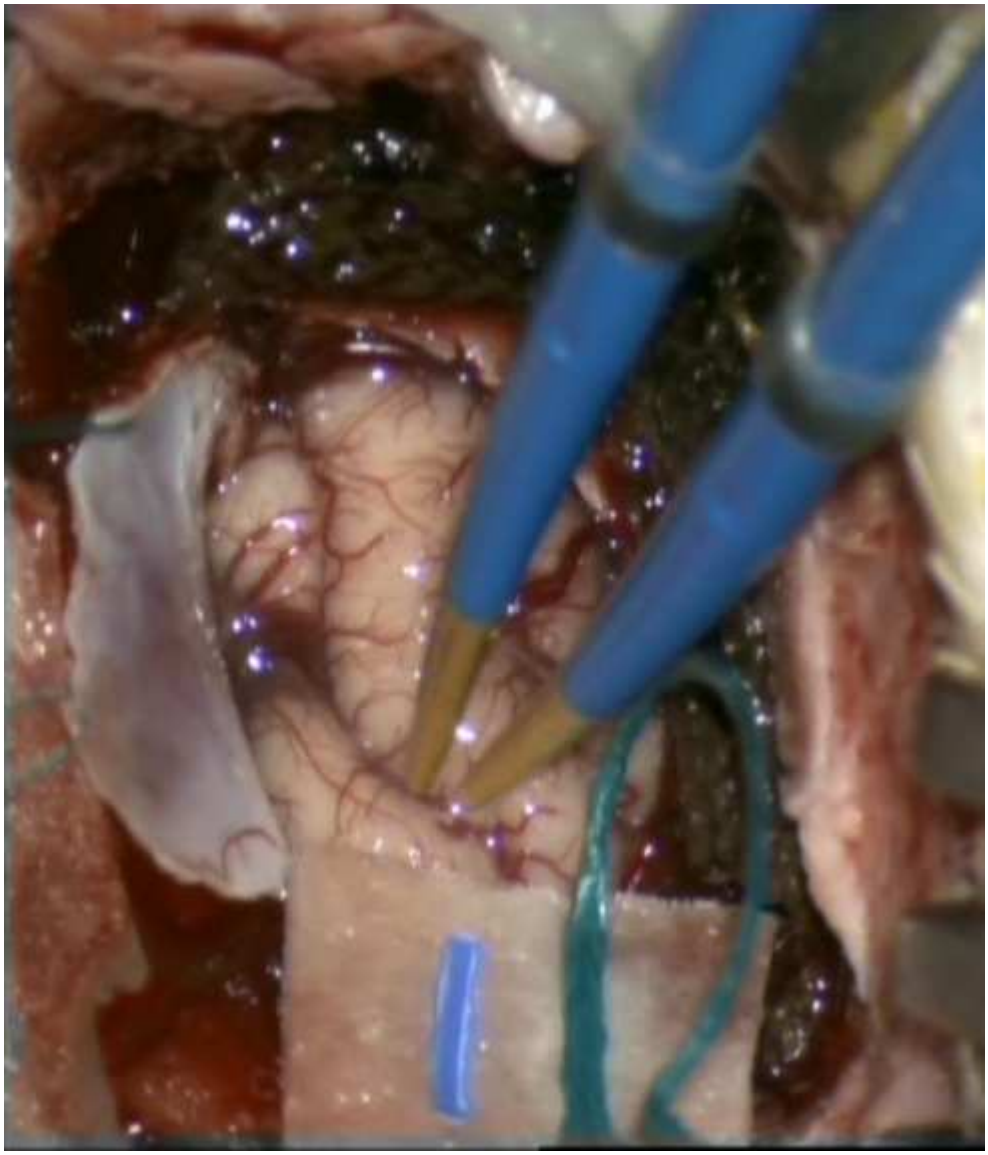
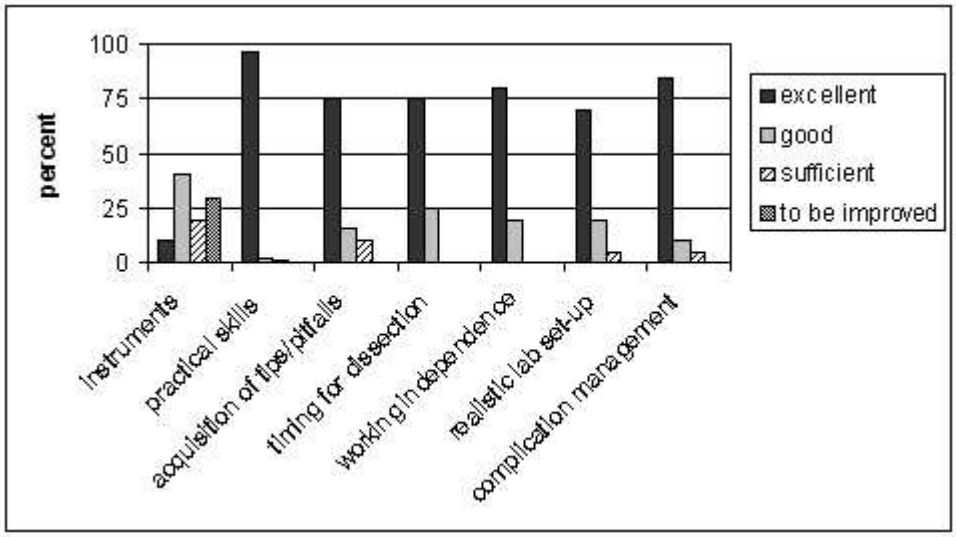


Intraoperative microscopic view of a human cortex
167x203mm (72 x 72 DPI)



Microscopic image of the swine cortex in the laboratory
172x202mm (72 x 72 DPI)



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170x95mm (72 x 72 DPI)

skills	in-vivo model
identification of anatomic landmarks	0
skull base anatomy	0
brain parenchyma anatomy	+
soft tissue preparation	++
set-up compared to real operating room	++
hemostasis and bleeding management	++
bipolar cautery and suction	++
additional techniques (ultrasonic aspirator, intraoperative ultrasound e.g.)	++
craniotomy, bone drilling	++
team approach and social skills	++

human cadaver specimen	
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Introduction

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been established [2, 11, 14, 21], tactile simulators [29] as well as robotic systems have been developed [21]. In addition, a number of hands-on courses are offered to satisfy the enquiries. As cadaver courses are well known in their contents, in vivo dissection is limited to the microsurgical labs or may be performed sporadically in relation to research activity. Vessel anastomosis or peripheral nerve surgery may be the predominant techniques in these models [1, 10, 17, 18]. Our experience with an in vivo swine model is a new and unique educational form, mimicking the daily micro-neurosurgical practice ideally (Table 1).

Microscopic dissection and bleeding management of a pulsating brain using an OR-equipment is a particular challenge which can be learnt with calmness and patience in this set-up. Bipolar cautery and appropriate suction without damaging the brain are major contents of neurosurgery in which it is possible to train without risks for the patient. Suctioning while bleeding, handling the microscope, changing the instruments, and decision making are as complex in the in vivo model as in a real operating room. Individual stress factors may aggravate the difficulty significantly and are noticed in the lab as well. Surgical failure ends up in an unclear, blood-filled cavity or damaged brain and learning is mediated by the successful or disappointing in vivo dissection. However, upon completion of this course participants should be able to control bleedings, handle their instruments with care, and manage complications during microsurgery.

A team approach has been implemented by the realistic set-up in which the second surgeon has to take over the nursing job, has to anticipate the next surgical step, and is asked to exchange his experiences with the performing surgeon to achieve an optimal blood dry and clear resection cavity. From our point of view, the in vivo model presents an ideal opportunity for microsurgical training including social skills, which are also required in the competitive medical career today.

Taking into account the multiplicity of problems in medical education, solutions have to be found. In Europe, training programmes were initiated by the European and national associations of neurosurgeons, reforming our education programmes [8, 23, 28]. But a national structure for all training courses is still missing and it would be helpful to install a thorough education programme resulting in a synthesized form of theoretic and practical courses, thereby diminishing the amount of travel for all residents and faculty.

Conclusion

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The present situation of educational training in surgical specialities is dictated by economic pressure, the high level of medical supply, and the Working Time Directive, which are obstacles to a personalized and time consuming training programme. Our in vivo model has turned out to be a very useful supplement for young neurosurgeons mimicking the daily surgical practice ideally. A structured theoretical and practical educational programme covering spinal and cranial neurosurgery in a synthesized module for all levels is now the consistent next step.

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Figure 1
24 residents, from the 1st to 5th year of training, participated on the course. All residents judged their training as insufficient. Less surgical experience was striking and the majority had attended other courses already.

Figure 2a
Intraoperative microscopic view of a human cortex

Figure 2b
Microscopic image of the swine cortex in the laboratory

Figure 3
Expectations on the course were met for all trainees. The benefit of the course was judged as excellent (65%) or good (35%). The in vivo model (97%), working environment (94%), and realistic lab set-up (94%) were appreciated most by the trainees. Tips and pitfalls by the supervisors as well as sufficient timing for dissection were other important factors for the participants.

Table 1
Comparison between in vivo swine model and human cadaver specimen related to the surgical skills which can be obtained (ineligible 0; appropriate +; ideal learning object ++).

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