Difficult Airway

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Review

The Difficult Airway

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ABSTRACT

Objective: The difficult airway has gained increasing interest due to a relatively high number of adverse effects following unsuccessful intubation.

Data Collection: Several methods besides conventional endotracheal intubation are described. Special emphasis is put on the "cannot intubate – can ventilate" and the "cannot intubate – cannot ventilate " situation.

Conclusion: Besides traditional techniques, several alternate methods are available today. It is crucial for an anesthesiologist to train at least two alternate methods for the management of the difficult airway.

Key Words: Difficult airway, Combitube, laryngeal mask, transtracheal jet ventilation, surgical airway, training, endotracheal intubation, laryngoscopy, McCoy laryngoscope

INTRODUCTION

The primary task of anesthesiologists and intensive care physicians is the maintenance of sufficient oxygenation and ventilation. Hypoxia is one of the most frequent causes of death or causes of severe neurological defects in anesthesia. An American analysis of more than 3000 secluded malpracticecases between 1975 and 1994 showed that the main reason for more than 1000 deaths was the failed maintenance of oxygenation or ventilation (1). Therefore, the working group "difficult airway" of the American Society of Anesthesiologists (ASA) was founded with the purpose to reduce the incidence of airway-associated emergencies (2). The following summary is based on these guidelines, including the recommendations of the European Resuscitation Council.

THE NECESSITY OF ALTERNATIVE METHODS TO SECURE THE AIRWAYS

Performance of endotracheal intubation needs an experienced physician, specific equipment and adequate access to for the patient's head. Due to different reasons, endotracheal intubation may be impossible also for the experi-

enced anesthesiologist (3). Therefore, it is necessary to have an easy alternative to secure the airways in the critical situation.

THE DIFFICULT AIRWAY

Definition and incidence of the difficult airway

According to ASA definition, a difficult airway is defined when the correct placement of an endotracheal tube (ETT) needs more than 3 trials, or when conventional laryngoscopic intubation takes more than 10 minutes. Difficult airways can be divided according to 1) difficult ventilation, 2) difficult laryngoscopy, and 3) difficult intubation:

1) Difficult ventilation is defined, if no sufficient ventilation can be achieved in the anesthetized patient despite optimal positioning of the patient, optimal dimension of the face mask, and use of oro- and nasopharyngeal tubes. In many cases, a sufficient mask ventilation can be achieved by shifting the patient's head (pillow under the head, shoulders etc.), by optimizing the Esmarch-grip or by holding the mask with two hands and ventilating with a second person. In case that sufficient ventilation / oxygenation is not possible, adequate emergency steps must be taken into account (see "ASA algorithms").

2) Difficult laryngoscopy is defined, if despite optimal conditions only the apex of the epiglottis or only the tongue can be seen. According to Cormack and Lehane (3), difficult laryngoscopy can be divided into 4 grades (Table 1)

Table 1. Classification of the difficult grades of the intubation

grade I	glottis mostly visible
grade II	only posterior commissura visible
grade III	only epiglottis visible
grade IV	epiglottis not visible

In some cases it is possible to optimize visualization of the glottis by external pressure (e.g. BURP: backward-upward-right pressure).

3) Difficult intubation encloses difficulties as well as the failure of the laryngoscopy for correct tracheal placement of the ETT. The incidence of failed intubations is 0.05-0.35%. The critical situation "can't intubate, can't ventilate", which can cause severe neurological defects or the death of the patient, happens in 0.01-2 cases per 10.000 intubations. The most important aim of the management of patients with difficult airways is the support or restoration of adequate oxygenation, while tracheal intubation is secondary.

The reasons for the difficult airway are multiple and can be divided into congenital (supralaryngeal or sublaryngeal) and acquired pathologies. The most frequent reasons of difficult intubation in critically ill patients are local (traumatic intubation) or generalized diseases (SIRS, ARDS) or edemas. Aggravating are other aspects such as suboptimal positioning of the patients, bleedings, and of course limited respiratory reserves of these patients. Cat-

astrophic situations are only avoidable with adequate education and special preparation for the difficult airway. The following measures should be taken into account: elective training of conventional endotracheal intubation as well as different non-invasive and invasive alternate procedures to secure the airways, by participating in workshops, by collecting practical experience with non-invasive devices; also preparing an emergency-bag or an emergency-cart close to the patient.

The algorithm „difficult airway" of the American Society of Anesthesiologists („ASA Difficult Airway Algorithm")

To reduce the incidence of airway-associated emergency situations, the working group of the management of the difficult airway developed guidelines for the management of the difficult airway published in 1993 (2).

The question whether spontaneous breathing during management of the difficult airway should be maintained or whether the patient should be ventilated fully anesthetized is important. The primary use of the flexible fiberoptic bronchoscope should be kept in mind. Administration of muscle relaxants should be avoided since minimal respiratory excursions in emergency situations can preserve a minimum of oxygenation and the survival of the patient.

A very problematic situation in the critically ill patient is the so-called „cannot intubate, can ventilate" and the „cannot intubate, cannot ventilate" situation. Both emergency situations are of outmost importance necessitating a quick and systematic procedure:

In the „cannot intubate, can ventilate" situation, proper alternative should be considered. As alternate techniques, the use of different laryngoscopes (e.g. McCoy®), tracheal tube exchangers, the Combitube® (4), the Intubating laryngeal mask (Fastrach®) (5), "lightwands" (e.g. Trachlight®) (6), the retrograde intubation method, as well as the use of flexible or rigid fiberoptics (e.g. flexible bronchoscope or Bullard® laryngoscope) (7,8) is recommended. If intubation is not successful with these techniques, it is recommended to perform a surgical airway access.

The management of the „cannot intubate, cannot ventilate" situation should be made non-traumatic to minimize the development of edemas, bleedings or secretions. The risk of a „cannot intubate, cannot ventilate" situation is increasing with the number of unsuccessful intubation attempts. The incidence of this dangerous situation is counted in literature with 0.01 to 2.0 per 10,000 cases of general anesthesia (9). The recommendation of the „ASA Algorithm" (similar the European Resuscitation Council, fig.1 (10)) for the obligate call for help is one of the following procedures: a) esophageal-tracheal Combitube, b) laryngeal mask, c) transtracheal jet ventilation, or d) emergency coniotomy.

Ad a) The Combitube® (Tyco-Kendall, Mansfield, MA) is a double lumen tube, which can be inserted into

the trachea or the esophagus (4). The so-called "pharygeal" lumen is marked through a blocked distal end with perforations at the pharyngeal level, while the so-called "tracheoesophageal" lumen has a distally open end. At the upper end the Combitube provides an oropharyngeal balloon to seal the cavum oris et nasi and secures the Combitube against accidental extubation. At the bottom end, a conventional cuff closes the esophagus or trachea.

The Combitube (37 F SA: for patients from 120 to 180 cm; 41 F: for patients >180 cm) is inserted into the patient until the ringmarks lie between teeth, and then the balloon and the cuff are blown up. Test ventilation starts at the longer blue connector. Ventilation can be continued, if auscultation over the lungs is positive and over the epigastrium negative. The air flows over the pharyngeal perforations into the hypopharynx and from there into the trachea. Via the unused "tracheoesophageal" part, the stomach is decompressed and with the help of the bypacked catheter, gastric fluids can suctioned. If auscultation over the lungs is negative, ventilation is changed to the shorter connector without changing the position of the Combitube. If auscultation over the lungs is positive, the placement of the Combitube has happened in the trachea. In rare cases, the Combitube is placed too deeply: then the Combitube must be pulled back about 2-3 cm, fixed in this position and than the patient is ventilated via the longer connector. Intubation gets easier if you fold the Combitube between balloon and cuff about 90° and leave it in this position for some seconds. The use of a laryngoscope helps safe placement of the Combitube.

The Combitube can be used in acute situations such as failed intubation because of severe oropharyngeal bleedings, vomiting, bleeding, locked temporo-mandibular joint, bullneck, fractures and luxations of the cerebral vertebras or patients with cardiac arrest. The Combitube has been accepted as a recommended alternate airway also in the guidelines of the „American Heart Association" (11) and the „European Resuscitation Council" (10). The advantages of the Combitube are simple handling, safety against aspiration and the possibility to use higher ventilation pressures when compared to the laryngeal mask. For changing the intubation to a conventional endotracheal tube the patient is stabilized with a laryngoscope or by fiberoptics (12). Its efficacy and safety has been shown in several studies (13-15).

Ad b) The laryngeal mask gains more and more acceptance for the management of the difficult airway. The LMA is used at the difficult airway at following cases: LMA as a guide for fiberoptic intubation in the awake patient or for fiberoptic intubation in the „cannot intubate, can ventilate" situation, also as an emergency airway in the „cannot intubate, cannot ventilate" situation. A recent further development to the laryngeal mask is the so-

called LMA-Fastrach®. The LMA Fastrach has a stiff metal shaft with grip, which optimizes tube orientation and is able to take up ETT's up to 8.5 mm inner diameter.

Ad c) Transtracheal jetventilation (TTJV) is a wide spread procedure in the USA. After puncture of the cricothyreoidal membrane oxygen is pushed with relatively high pressure (1.5 to 2.5 bar) into the trachea (16). For a TTJV, the cricothyreoidal membrane is punctured with a suitable cannula in a caudal direction of about 30° (free air aspiration!) with use of the Seldinger technique or directly with a 16 or 14 G catheter. With a Luer-Lock the jet catheter is connected with the jet ventilation system (source of oxygen with free selectable gas pressure). Now manual strokes of gas are released which last about 0.5-0.75 sec with a frequency of about 8-10/minute at the inspiration. Expiration happens exclusively passively, so that an adequate flow of gas is guaranteed. The most frequent complications of this procedure are: dislocation of the catheter with consecutive emphysema of the skin, the mediastinum, pneumothorax, as well as hematoma, puncture of the esophagus etc.. The TTJV is a procedure for experienced doctors only and should be trained under elective conditions.

Ad d) Surgical airway: If intubation as well as supraglottic alternate airways fail, emergency coniotomy has to be performed. The cricothyroideal membrane is felt between the thyroideal cartilage and the cricoideal cartilage (the vertical length of the cricothyreoidal membrane in the adult is about 0.7-1.0 cm). Then a vertical incision is made, the cutis, subcutis and muscularis are held open. Then, the membrane is widely cut horizontally and the tube (5-5.5 mm I.D.) is inserted into the trachea, a tracheal dilatator or a speculum can be helpful. An experienced surgeon can go ahead with a regular tracheotomy at emergency situations. For emergency coniotomy there are several percutaneous sets available based on the Seldinger technique (e.g. Arndt Emergency Cricothyrotomy Set, Cook).

The flexible bronchoscope (7) should not be missed as a help for the intubation at the intensive care unit, for access the orotracheal or the nasotracheal route can be taken. It is recommended to use a spiral tube to make insertion easier through the vocal cords.

The tube exchanger may also helpful for changing of tubes: via the positioned tracheal tube the tube exchanger is inserted, the tube is removed without removing the tube exchanger and the new tube can be inserted under laryngoscopic visualization over the tube exchangers as a leading wire.

CONCLUSION

Besides traditional techniques, several alternate methods are available today. It is crucial for an anesthesiologist to train at least two alternate methods for the management of the difficult airway.

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Laryngeal Ventilation in Limb Girdle Muscular Dystrophy: Case Report

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ABSTRACT

Objective: Patients with Muscular Dystrophy may present special challenges to the anesthetist: increased incidence of malignant hyperthermia (MI); cardiovascular and respiratory disease. The following case report identifies some of the concerns such patients offer and shows how laryngeal ventilation is used. In this case we used the Laryngeal Mask Airway (LMA). Laryngeal ventilation may sometimes be used to meet these challenges.

Case report: We describe an adult woman with Limb Girdle Muscular Dystrophy who was scheduled for hemorrhoidectomy surgery with Parcks technique. The patient refused regional anesthesia. She had global muscular weakness that prevented her deambulation, but she had no significant respiratory or cardiac component to her disease. Anesthetic management included general anesthesia using propofol (bolus and infusion), fentanyl, nitrous oxide and positive pressure laryngeal ventilation by laryngeal mask airway (LMA). Muscle relaxants and volatile inhalation agents were not administered. Throughout the course of the case cardio-respiratory stability was well-maintained, and emergence was uneventful.

Conclusion: In patients with Muscular Dystrophy to subject to proctosurgery, the main advantages of laryngeal ventilation over tracheal with tube is the avoidance of muscle relaxants, involved in the increased incidence of MI, the minimal effects on cardiovascular response at insertion and removal procedures and the potential advantages in terms of respiratory function and work. The advantage of the laryngeal ventilation by LMA over the uses of a facemask is that ventilatory support is easier. We emphasize moreover that:

1) Similar result is possible by using others devices for laryngeal ventilation such as Comitube and more recent Laryngeal Tube (LT) or Airway Management Device (AMD)

2) The respiratorial autonomy, in the immediate postoperative, can meaningfully reduce the resource to the intensive care unit, amplifying therefore the quality of the clinical performance and with certain economic implications.

Key Words: Anesthesia; Laryngeal Mask Airway; Combitube; Laryngeal Tube; Airway Management Device; muscular disorders, limb-girdle muscular dystrophy.

INTRODUCTION

Patients with Muscular Dystrophy may present special challenges to the anesthetist increased incidence of malignant hyperthermia (MI); cardiovascular and respiratory disease (1). There are no previous reports of general anesthesia in patients with Limb-Girdle Muscular Dystrophy (2-4). The following case report identifies some of the concerns such patients offer and shows how the laryngeal mask airway (LMA) may sometimes be used to meet these challenges.

CASE REPORT

The patient was a 46-year-old woman, height 159 cm, weight 50 kg, who had Limb-Girdle Muscular Dystrophy for 27 years, and scheduled for elective hemorrhoidectomy with Packs technique. The diagnosis was made at a specialty clinic for neuromuscular disorders based on her clinical presentation, muscle biopsy characteristics, electromyographic studies, and biochemical investigations. She had global muscular weakness that severely limited her activities of daily life, but she had no significant respiratory or cardiac component to her disease, despite smoking 20 to 30 cigarettes daily for many years. Previous anesthetics for an appendectomy, at age 26, and an abortion, at age 28, were uneventful. Pulmonary function testing was normal. There appeared to be no impairment of bulbar muscles or any other clinical findings that would raise concerns about aspiration. Because of psychological concerns about being awake for the surgery, the patient adamantly refused to have the procedure done under regional anesthesia. An anesthetic machine without vapourizers was used. General anesthesia with noninvasive monitoring was chosen and began with fentanyl 4 mcg kg-1 and propofol 3 mg kg-1 and maintained with propofol 10 mg kg-1 hr-1 and 67% nitrous oxide in oxygen. A size 4 LMA was easily inserted on the first attempt. The patient was placed a slight head-down lithotomy position for the procedure. The patient underwent positive pressure ventilation (tidal volume 500 ml, peak pressure 18 cmH2O, rate 11 min-1) via the LMA throughout the case, which lasted 55 minutes.

There were no desaturation events. Hand temperature ranged between 36.1 and 36.3 for the case. Throughout the course of the case cardio-respiratory stability was well-maintained, and emergence was uneventful, with the LMA being removed upon mouth opening to verbal command. There were no postoperative complications. Postoperative analgesia was maintained with 90 mg of IV ketorolac administered over 24 hours.

DISCUSSION

Limb Girdle Muscular Dystrophy is a form of muscular dystrophy that is actually a set of muscular disorders sharing similar characteristics rather than a single disease of muscle (2-4). Unlike X-linked disorders such as

Duchenne Muscular dystrophy, Limb Girdle Muscular Dystrophy affects both males and females. Pathologically, Limb Girdle Muscular Dystrophy is caused by defects in certain proteins associated with muscle membrane (3). Onset of the dystrophy may begin late in the first decade or may be delayed until the patient enters his or her forties. The dystrophy is progressive, with impairment of the shoulder girdle and pelvic muscles featuring strongly.

Respiratory insufficiency from weakness of the diaphragm is a common finding as the disease increases in severity. Cardiac involvement may lead to cardiomyopathy, congestive heart failure and arrhythmias. Intellectual capacity is unimpaired.

Laboratory features of Limb-Girdle Muscular Dystrophy include elevation of serum CK levels, with abnormal electromyographic studies and abnormal muscle histology. A number of special tests may be required to distinguish Limb-Girdle Muscular Dystrophy from phenotypicaly similar disorders such as Duchenne Muscular Dystrophy or the inflammatory myopathies. Genetic testing my show either autosomal dominant or autosomal recessive inheritance, consistent with the concept that Limb-Girdle Muscular Dystrophy comprises a number of distinct subtypes. There is no specific treatment for Limb-Girdle Dystrophy.

Although muscular dystrophy in its various forms only occasionally presents to the anesthetist, there are a number of important anesthetic implications. First, it should be born in mind that there are a number of forms of muscular dystrophy, with Duchenne Muscular Dystrophy being the best known. While a fair amount of anesthesia literature exists concerning the Duchenne variety of muscular dystrophy (5), the medical literature offers relatively little specific information about anesthetic management for other varieties of muscular dystrophy. A literature search revealed only one report of anesthesia in a patient with Limb Girdle Muscular Dystrophy: a parturient with a difficult airway managed with epidural anesthesia (6). For this reason and since there is a potential commonality of concerns with respect to respiratory management in such cases, our management echoed the anesthetic concerns present in the Duchenne variety.

CONCLUSION

Our management was thus based on the following principles. First, the possible but admittedly contentious link between Malignant Hyperthermia (MH) and Limb-Girdle Muscular Dystrophy dictated that MH triggers such as succinylcholine and the potent inhalation agents such as isoflurane or halothane be avoided (1). While clear and convincing evidence of a link between Malignant Hyperthermia (MH) and Limb-Girdle Muscular Dystrophy is lacking, we nevertheless thought it wise to take this prudent precaution. The potential for cardiomyopathy additionally raises concerns about myocardial depression

from anesthetic drugs and dictates vigilance with respect to cardiac monitoring (4). Also, the potential for respiratory insufficiency in these patients dictated that positive pressure ventilation is employed to ensure adequate oxygenation and ventilation. We also sought to avoid all forms of muscle relaxants both because of uncertainty about what an appropriate relaxant dose might be, as well as because of concerns about a potential prolongation of effect or difficulty with reversal. We avoided succinylcholine especially, since it is not only an MH trigger, but may also trigger hyperkalemia in myopathic patients (7). Since muscle relaxation is generally used for endotracheal intubation, we sought to avoid intubation by using the LMA (8) instead. Still, we acknowledge that it is possible to intubate without muscle relaxants [9]. In this situation the main advantages of the LMA over an endotracheal tube is the avoidance of muscle relaxants, the minimal effects on cardiovascular response at insertion and removal (10) and the potential advantages in terms of respiratory function and work (11). The advantage of the LMA over the uses of a facemask is that ventilatory support is easier.

Our experience in airway management suggest that a similar result is possible using other device for laryngeal ventilation such as Combitube (12). We emphasize moreover the use of the Laryngeal Tube (LT) (13) and the Airway Management Device (AMD) (14).

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Case report

Securing the airway with the help of the Combitube in a patient trapped in a car.

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ABSTRACT

Objective: Description of a case of difficult intubation in a patient experiencing a car accident.

Case: After a car accident, a 24 year old patient was trapped in his jeep. During rescue, immediate intubation became mandatory. Since access to the patient's head was limited, a Combitube was inserted standing in front of the patient, ventilation worked well. The patient was admitted to the hospital and could be weaned from the respirator three days later. After 4 weeks, he could be discharged from the hospital without neurological sequelae.

Conclusion: The Combitube is a valid alternative to endotracheal intubation in cases of difficult access to the patient's head.

Key Words: Airway, Combitube, trapped, emergency intubation

INTRODUCTION

The Combitube (Tyco-Kendall, Mansfield, MA, USA) has been shown to be adequate for lung oxygenation and ventilation during cardiopulmonary resuscitation (CPR) (1), elective surgery (2), mechanical ventilation during tracheotomy (3), and mechanical ventilation in the intensive care unit (4). In the following we describe the use of the Combitube in a case of difficult access to a patient trapped in his car after an accident.

CASE REPORT

On July 27, 2000, a 24 year old soldier experienced an accident with his jeep in a countryside area of San Diego. The car threw over several times, the patient was then trapped in his jeep. Eight hours later, he was found by a patrol who was dispatching the Fire-Department and the emergency medical system. At the arrival of the rescue team, it was recognized that the patient was jammed and had to be saved from the car. After rescue, the patient's situ-

ation worsened dramatically. Therefore, it was decided to intubate and to ventilate him while still sitting in the car. Since adequate access to the patient's head was limited, a Combitube was inserted standing in front of the patient. The Combitube happened to be inserted into the esophagus, oxygenation and ventilation worked well. Furthermore, the patient received a venous access for fluid resuscitation. Via pathless area, the patient was brought to the helicopter and transported from there to the hospital, where he was admitted to the trauma ward. Laboratory tests revealed plasma potassium levels of 7.85 mmol/L, ph was 7.01, lactate levels were elevated. X-rays revealed a fracture of the right thigh. The patient's hemodynamic situation deteriorated and a central venous catheter was performed. The patient was administered several red cell packs as well as fluid which led to reversal of shock. Ultrasound examination did not provide further information on a bleeding site. Finally, the patient regained normal blood pressure. He could be weaned from the respirator three days later. After four weeks, he could be discharged from the hospital without neurological sequelae.

DISCUSSION

The Combitube has found increasing acceptance in the prehospital airway management (5-9). In the first study, paramedics successfully inserted the Combitube 71% of the time when it was used as a first-line airway adjunct (5). Later, Atherton and Johnson described a nearly 100 % success rate when the Combitube was trained several times thereby allowing skill retention (5). In another study, flight nurses inserted the Combitube when orotracheal rapid sequence intubation (RSI) failed (6). The patients experienced several injuries: Seven exhibited mandibular fractures, four traumatic brain injury, two facial fractures, and one hemopneumothorax. In a study supported by the inventors of the competitive devices, the Combitube was rated best when the Combitube was compared to the pharyngeal tracheal lumen airway (PTLA), the laryngeal mask airway (LMA), and the oral airway (OA)/mask used in conjunction with a bag-valve device by emergency medical technicians (EMTs) during cardiopulmonary resuscitation. The overal success rate of insertion and ventilation was significantly higher with the Combitube (86% successful insertion rate) despite the fact that some of the EMTs had been previously trained with the LMA in the operating room (7). In the Combitube group, blood gas analyses showed a lower mean PaCO2, a higher PaO2, and a higher mean exhaled volume when compared with the PTLA, LMA, and OA/mask groups. The assessment of the EMTs resulted in a rating of the Combitube as the best device in overall performance and adequacy of airway patency and ventilation in comparison to the other devices (7). In a retrospective study of 12,020 cases of non-traumatic cardiac arrest, Tanigawa and Shigematsu found the Combitube to have a better first at-

tempt insertion rate (82.4%) as compared to esophageal gastric tube airway (EGTA) and LMA (8). A 98% insertion success rate could be observed in a series of 1498 patients by the emergency medical system of Québec, Canada (personal communication, Lefrancois D, Quebec, Canada, 2000). Haynes and coworkers showed that all Combitube placements were located correctly by rural emergency medical technicians with selected advanced skills (9). Overall treatment was judged 94 % appropriate, with improvement in 60 % of patients.

In addition, the Combitube was used successfully for elective airway management and published in several case reports (10-14).

The contraindications of the Combitube include: patients with an intact gag reflex, known esophageal pathology, ingestion of caustic substances, supraglottic stenoses, or tumors. In case of a glottic or subglottic obstruction an airway has to be placed with its opening below the obstruction using either an endotracheal tube (ETT), transtracheal jet ventilation (TTJV), or a surgical airway. As an international recognition, the Combitube has been included as an appropriate alternative for "can't ventilate-can't intubate" (CVCI) situations by the American Society of Anesthesiologists (15), as a class IIa device by the American Heart Association for Advanced Cardiac Life Support (16), and as an alternative to failed endotracheal intubation in the advanced airway management algorithm of the Airway and Ventilation Management Group of the European Resuscitation Council (17), the Difficult Airway Society of Great Britain, and the Italian SIIARTI (18). It is a valuable addition to the difficult airway cart in any facility dealing with emergency intubation situations. It can be easily stored packed in a tray, roll-up kit, or single kit.

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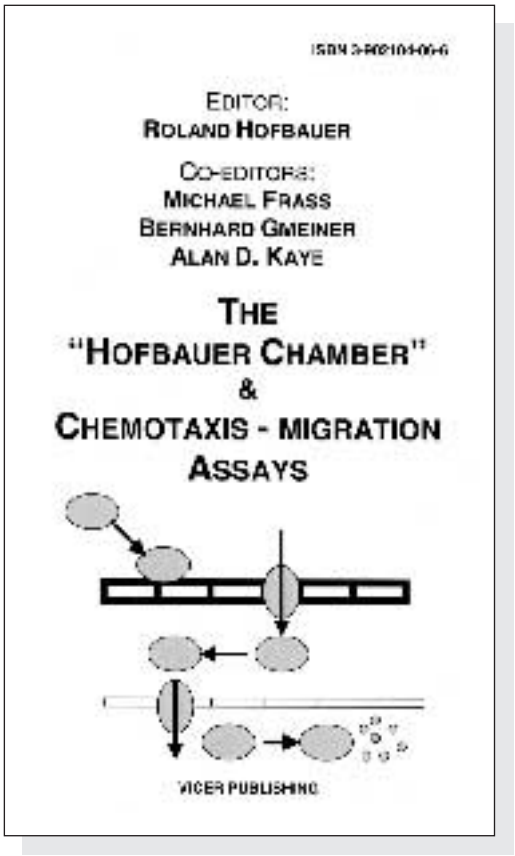

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