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ORIGINAL ARTICLES

ANAESTHESTIC MANAGEMENT IN DISASTERS AN ANAESTHETIST'S EXPERIENCE IN "LAMNO" BANDA ACHE, INDONESIA

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ABSTRACT

Objective: The purpose of this study is to highlight the problems faced by the anaesthesiologist in the field and to mention some of the anaesthetic techniques which have proved useful in such adverse circumstances.

Introduction: Responding to the call for help to the victims of Tsunami on December 26 2004, the Pakistan Field hospital (Level II) arrived in Sumatra (Indonesia) and was deployed in a remote island, Lamno, Banda Ache. A total of 11,299 patients were treated including 1164 surgeries, from 12th January 2005 to 26th February 2005. The main problems were non availability of pressurized oxygen source, hostile and adverse circumstances, language barrier and massive number of tsunami victims requiring immediate medical attention. The Boyle's apparatus could not be used as it requires high pressure gases at 40 to 50 psi. The Oxygen concentrator was the only source of Oxygen.

Type of Study: Descriptive

Material and Methods: The surgical patients mostly had wounds of extremities which were infected. Majority of the surgical procedures included debridements of the wounds, skin grafting and amputation of the extremities. Most of the surgeries were performed under local and regional anaesthetic techniques. A modified general anaesthetic technique using an oxygen concentrator was devised for those few patients where regional anaesthetics alone were inappropriate.

Results: Local anaesthesia was administered to 1055 (90.64%) patients with minor injuries; peripheral regional blocks were administered to 35 (3.0%) patients, spinal anaesthesia to 31 (2.66%) patients and extradural anaesthesia to 17 (1.46%) patients. Eighteen (1.546%) patients were operated under dissociative anaesthesia with Ketamine and 08 (0.687%) patients were administered total intravenous anaesthesia, muscle relaxants, endotracheal intubation, bag valve mask (Ambu's) ventilation, oxygen supplementation from the oxygen concentrator and local anaesthetic infilteration. The incidence of complications was very low and none of the surgical patients had anaesthesia related morbidity or mortality.

Conclusion: Most of the Tsunami affected patients could be managed safely under local anaesthesia, regional blocks or dissociative anaesthesia with Ketamine. The oxygen concentrator proved to be highly useful source of oxygen for a modified general anaesthetic technique without using a proper anaesthesia machine.

Keywords: Anaesthetic management, field, disasters, tsumani, regional anaesthesia, general anaesthesia

INTRODUCTION

The history of anaesthetic management of mass casualties in disasters dates back to the history of anaesthesia itself, when Morton used Ether in 1846 during the American Civil War [1]. The readiness of a military anaesthesiologist for battle conditions must

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go beyond wearing a uniform or being physically fit. True medical readiness implies that the anaesthesiologist possesses the skills and knowledge to perform anaesthesia for any mission, any time, any where [2]. To achieve this goal the anaesthesiologist should be well conversant with the techniques that are "field friendly", requiring minimal logistical support while maintaining safety and providing quality anaesthesia and analgesia.

Although the nature and magnitude of injuries in disasters may differ from the war casualties, the main problems and the basic principles of management are usually similar in both types of circumstances [3]. Generally, the wounds of the head or thorax tend to be lethal where as superficial wounds and the wounds of the extremities tend to be survivable [4]. This finding is supported by the U.S. experience in Vietnam where two thirds of the fatally wounded soldiers had head and chest injuries while three fourths of the survivors had soft tissue or extremity wounds. Anecdotal reports from the recent conflicts in Afghanistan and lraq continue to support these observations [5].

The main problems which hinder the provision of quality care to mass casualties in an austere environment are inadequate equipment, deficient or unavailability of pre filled pressurized Oxygen cylinders which are usually not transported by the air services, lack of facilities for equipment repair and hostile and adverse climatic conditions, inadequate or inappropriate accommodation, deficiency of blood and its products and transfusion facilities, inadequate monitoring equipment, delay in receiving the casualties due to inadequate or inappropriate evacuation facilities in unexpected or difficult terrain and loss of the golden hours, massive number of casualties exceeding the capabilities of medical resources, language barrier and full stomach patients.

Although there is a difference of opinion on the suitability and choice of anaesthetic techniques for the management of mass casualties in disasters, regional anaesthesia (RA) may be more "field friendly" than general anaesthesia [6]. So military anesthesiologists should be well conversant with modern regional anaesthesia techniques and should be able to administer general anaesthesia in remote situations with minimum equipment.

On the morning of 26th December 2004 a massive Tsunami due to an earthquake measuring 9.0 on Rector Scale struck the west coast of North Sumatra (Indonesia), coastal areas of Sri Lanka, India, Maldives and Thailand. Responding to the call for help, the Pakistan Field hospital (Level II) arrived in Sumatra and was deployed in Lamno, Banda Ache, a remote Island where we treated 11,299 patients and performed 1164 surgeries from 12th January 2005 to 26th February 2005.

The purpose of this study is to highlight the problems faced by anaesthesiologist in the field or disasters and to mention some of the techniques and approaches that have proved successful during our experience in Tsunami relief operation in Indonesia (2004 – 2005).

MATERIAL AND METHODS

Patients of all the age groups and of both sexes reporting to Pak Field Hospital in Lamno, Banda Ache requiring surgical interventions and were belonging to low and middle social class.

From 12th Jan 2005 to 26th Feb 2006 we performed surgical procedures on 1164 patients out of 11,299 Tsunami victims reporting to our hospital.

Most of the surgical patients had superficial wounds which were mostly infected due to delay in proper treatment. Patients in Group I (n=1055) who required debridements, superficial suturing or amputation of fingers and toes were managed under local anaesthetic infiltration with 1% Xylocaine with adrenaline 1: 400,000 (<5mg / Kg) or Bupivacaine 0.25 to 0.5% (< 2 mg / Kg) body weight (Bwt).

Intravenous line was maintained and crystalloids were infused accordingly except

in those patients who were stable and required very little amount of local anaesthetic infiltration. Oxygen was supplemented from oxygen concentrator and monitoring was started.

Regional anaesthesia was administered to 83 patients Group II spinal anaesthesia (n = 31) with 0.75% hyperbaric bupivacaine, Group III patients received epidural anaesthesia (n =17) with 0.5% isobaric bupivacaine and Group IV patients peripheral nerve blocks (n =35) with xylocaine 1.0% with adrenaline 1; 400,000.

In Group V, dissociative anaesthesia with ketamine 1.5mg /kg body weight was given to patients (n=18) after administering midazolam (0.05 mg /kg body weight) to reduce the untoward effects of ketamine like vivid dreams, hallucinations and emergence delirium. Five of the patients receiving ketamine and midazolam in whom the surgical procedure was expected to be more painful, were also administered morphine 0.075 mg/kg as a single I.V bolus which transiently caused bradypnoea / apnoea. Two of these patients had drop in SpO2 85 – 86 %, which improved within one to two minutes on oxygen supplementation by a face mask and lifting the jaw, without IPPV. Atropine Sulpate 0.3 - 1.0 mg was administered to treat Bradycardia and glycopyrolate (0.2 mg) to reduce the excessive Oropharyngeal secretions on as required basis.

Group VI, patients (n=8) had to be administered general anaesthesia .Inj Metaclopramide 15 µg/kg body weight (bwt) was given as a prophylactic measure to prevent nausea and vomiting. Morphine 0.15 mg / kg was administered IV and anaesthesia was induced with intravenous anaesthetics (Thiopentone Sodium 4-7 mg/kg or Propofol 1.5 to 2mg/kg bwt (table-1). Muscle relaxation was achieved with Atracurium Besylate 0.7 mg /kg Bwt. Endotracheal intubation was performed and ventilation was controlled by Ambus' bag with Oxygen supplementation from the Oxygen concentrator through the inlet to the Ambu's bag. Bupivacaine 0.25% (< 3 mg / Kg) was infiltrated locally before the start of the surgical procedure.

Heart rate, SpO2 and NIBP were monitored by criticare monitor model (506) and three lead ECG was monitored by the defibrillator. Depth of anaesthesia and level of muscle relaxation were judged clinically. Intermittent boluses of intravenous anaesthetics, thiopentone sodium 1 mg /kg bwt or propofol 0.5 mg /kg were given every 5- 10 minutes (table-1) as indicated by the increase in heart rate more than 10 per minute and muscle relaxant was administered on as required basis. At the end of the surgical procedure, the muscle relaxation was antagonized with Neostigmine (prostigmine) 40 µg/kg + Atropine 15.0 µg/kg. However in one patient who undervent laparotomy for blunt abdominal trauma and had ruptured spleen, anaesthesia was supplemented with ketamine 2 mg/kg followed by 0.5mg/kg every 10 to 15 minutes, total of 310 mg in 4 hours surgery. Postoperative analgesia was provided with administration of injection Diclofenac sodium 75mg I.M and morphine .075 mg /kg or meperidine 0.5 mg /kg on as required basis.

RESULTS

We administered anaesthesia to 1164 patients of both sexes and all age groups ranging from 11 days to 97 years and most of these were young adults (fig. 1).We used local anaesthesia in 1055 (90.64%) patients (Group – I) out of 1164 patients and had local anaesthetic toxicity (table-2) in only two (0.19%) patients who had brief episodes of circumpolar numbness, agitation and seizures which were managed successfully by Inj Thiopentone sodium 1 mg /Kg and Oxygen inhalation without endotracheal intubation.

In group–II and III significant hypotension i.e. decrease in mean arterial pressure (MAP) of more than 20% occurred in 9 (29%) patients out of 31 group-II and 4 (23.5%) patients out of 17 of group-II.

Peripheral Regional blocks were administered to 35 (3.0 %) patients (Group – IV). Out of these 35 patients, 11 (31.4%) patients received Brachial plexus block, one (9.1%) patient receiving brachial block through interscalene approach developed ipsilateral Horner's syndrome which recovered spontaneously after 06 hours. Four patients (11.4%) out of total 35, received ankle block while 2 (50%) patients had inadequate regional blockade which were supplemented with Inj Midazolam and Ketamine (table-2).

Only 18 (1.55%) patients were administered dissociative anaesthesia with Ketamine and Midazolam (Group – IV), out of which five patients were also administered inj Morphine 0.075 mg/kg. Two patients out of these five had transient hypoxemia indicated by SpO2 below 90%. In this group seven patients had hypertensive response who had increase in MAP more than 20% and one (5.56%) patient had emergence delirium.

All the patients receiving total intravenous anaesthesia (Group-V) had adequate analgesia and anaesthesia and smooth recovery except in one patient who had delayed recovery and received Ketamine supplementation instead of Thiopentone top ups.

DISCUSSION

In cases of severe trauma, resuscitative measures i.e., immediate maintenance of airways, breathing and surgical control of bleeding is required to save the life [7]. Major surgical interventions like thoracotomy or laparotomy may have to be performed on inadequately resuscitated and full stomach patients. Rapid sequence induction and intubation is the preferred technique for managing airways, breathing and oxygenation however some patients may require awake intubation with appropriate topical anaesthesia. Crystalloids or colloids [8] are infused through wide bore peripheral I.V cannulae (14-16 G), central venous cannulation or venous cut down till the availability of cross matched and compatible blood or its products. Pulse oximetry, non invasive blood pressure monitoring and ECG are considered as basic monitoring requirements [9]. New models of defibrillators like Welch Allyn PIC 40 incorporate monitoring of ECG, NIBP, and SPO2 in addition to the defibrillation modes. Portable ventilators like "Com PAC" or Porta PAC [10] should be available with a back up D.C battery system and all the serious patients must be monitored continually with an automatic monitor, during the transport and evacucation as well. Once the airways have been secured and intra venous fluids have been started, amnestic drugs like midazolam or diazepam may be administered. Dissociative analgesia / anaesthesia with ketamine (I.V or I.M) has been widely used in emergency situations [11, 12]. Judicious doses of opioids like morphine, meperidine, fentanyl, sufentanyl or remifentanyl may be used either alone or in combination with other anaesthestics (balanced anaesthesia). Muscle relaxants may have to be used very carefully and neuromuscular paralysis preferably should be monitored with a nerve stimulator. Anaesthesia may be maintained with either continuous infusion or intermittent doses of ultrashort acting I.V anaesthetics like propofol, thiopentone, etomidate, or midazolam and Ketamine [13]. Unlike I/V anaesthetics, inhalational anaesthetics like halothane, isoflurane, enflurane, sevoflurane and desflurane require a vaporizer. Compact Boyle's apparatus with a ventilator is ideal but in the war like situations or disastrous circumstances the prefilled pressurized cylinders of medical gases may not be available. The traditional equipments like Oxford Miniature vaporizer (OMV) [14] or Tri-service anaesthetic apparatus [15] may be used. These apparatuses have drawover vaporizers [16] and use the atmospheric air as the carrier gas which can be enriched with oxygen at low pressure from the Oxygen concentrator or Oxygen cylinders. These apparatuses may be used either for spontaneous breathing [17] or controlled

breathing through self inflating bellows [18]. One of the anaesthesia machines, the "Oxivent [19]" has been specially designed for use at remote locations. Some new anaesthesia machines have been developed for use in the fields which are compact, robust, and portable and can be dropped through parachutes.

The main advantage of intravenous anaesthetics in the field is that these do not require special anaesthesia equipment and the ventilation can be controlled through endotracheal tube and a bag mask valve device such as ambu's resuscitating bag with Oxygen supplementation even in the absence of an anaesthesia machine. One of the major problems in the disastrous situations is the unavailability of prefilled pressurized oxygen cylinders. Oxygen concentrators which use the principle of molecular sieve provide 90 – 99% oxygen by separating the atmospheric air containing 21 % Oxygen and 79% nitrogen. Nitrogen is adsorbed on aluminium silicate containing filters (Zeolite) through pressure swing adsorption (PSA) and almost pure oxygen is delivered either at low or high flow and pressure for medical use. There are numerous regional anaesthetic techniques [20] which can be used in the field or field like circumstances as in disasters. These vary from topical applications or simple infiltration of local anaesthetics to major nerve conduction blocks or neuro-axial blocks with differential nerve blockade at different levels. The use of a nerve locator (nerve stimulator) highly augments the success rate and reduces the rate of complications. Continuous regional blocks by placing a catheter are very useful to provide analgesia for prolonged surgeries and postoperative pain [20].

Most of the tsunami affected surviving patients were young adults (fig. 1) of both sexes and commonly had respiratory tract infections, gastroenteritis, multiple infected wounds and musculoskeletal injuries. There were some non disaster related surgical emergencies as well.

We have managed more than 90% of cases under local anaesthesia (group – I) who mainly required debridment of the wounds and later on skin grafting in some of the cases. All the patients in this group had satisfactory analgesia and anaesthesia. The only complication was local anaesthetic toxicity in two of the patients (0.19%) which was managed successfully without any long term sequele. The severity and rate of complications in our patients was much lower as compared to the study of Paix Br. and colleagues [21] who used Ketamine as the technique of choice and the study of Charuluxananan and colleagues [22] who used general endotracheal anaesthesia in 69.2% of cases.

Central neuro axial blockade (Group – II & III) spinal and epidural anaesthesia was administered to 2.66% and 1.46% of the patients respectively. The major side effect was hypotension and its incidence was not significantly different in both of these techniques. Our results in this group are similar to the study of Charuluxananan and colleagues [22], who used spinal anaesthesia in 3.7% of the cases and had only intraoperative hypotension as the major side effect. Hypotension in underestimated hypovolemic patients can be prevented and managed by adequate preload with crystalloids or colloids and use of vasopressors like ephedrine or norepinephrine [23].

Peripheral nerve blocks were used in 35 patients (Group – IV) and had inadequate blocks in three patients (8.57%) which were effectively managed with IV midazolam and Ketamine, as recommended by Lenz G, and Stehle R [24]. The most likely reason for higher incidence of inadequate blocks in our cases may be the less precise technique, unavailability of the nerve locator and lower concenteretation of local anaesthetics i.e is 1.0% lignocaine or 0.25% of Bupivacaine. Only one patient developed self limiting Horner's syndrome which indicates the spread of local anaesthetic to the Stellate

ganglion. The significant advantages of regional anaesthesia are that the patients are awake and protecting their airways, better pain control, early mobility, cost effectiveness, simple and safe techniques, which can be applied by the surgeons and even by the paramedics under supervision. The main disadvantages include concerns about hygiene, nerve injuries, intra - vascular injections, toxicity of drugs and chances of failed blocks. Combinations of regional anaesthetic techniques supplemented with ketamine or other anaesthetic agents can be very useful and raise the threshhold for the toxicity of local anaesthetics as well [25].

Dissociative anaesthesia was given to 18 patients (Group – V) out of which five patients who had to undergo relatively more painful procedures or had tachypnoea during surgery were supplemented with morphine. Within one minute of the administeration of morphine they had bradypnoea with increased tidal volume. Two patients (11.11%) developed transient hypoxemia indicated by SpO2 less than 90%, which is quite high as compared to the previous reports of Pederson L. Benumof J[26], who have reported incidence of desaturation as 95.22 per 10,000 cases. Magnitude of painful stimulus, speed of injection, physical status of the patients and

Table-1: Duration of surgery and total dose of IV anaesthetic agents for general endrotracheal anaesthesia

Sex	Age Years	Body Weight kg	Type of Surgery	Duration of Surgery minutes	Induction dose of Thiopentone sodium	Total Dose of Thiopentone sodium Top ups mg	Induction dose of Propofol Bolus / mg	Propofol Top ups mg	Ketamine mg
Male	43	65 kg	Laparotomy	275 minutes	250	-	-	-	310 mg
Female	36	61 kg	Laparotomy	90	-	-	100	110	-
Female	05	15 kg	Bil inguinal hernia (PPV)	60	-	-	30	40	-
Male	63	83 kg	Growth Scalp and Neck	120	400	500 mg	-	-	-
Male	52	69 Kg	Disarticulation of left shoulder joint	150	375	625	-	-	-
Male	71	56 Kg	Penetrating chest injury	55	300	125	-	-	-
Female	58	47 Kg	Head Injury for burholes (BIL)	80	250	300	-	-	-
Male	07	19 Kg	Trauma Face and Chest	50	-	-	40	50	-

Table-2: Types of anaesthesia & complications

Type of Anaesthesia	No. of Patients	Complications	Incidence of complications
Local Anaesthesia (Group – I)	1055 (90.63%)	Local Anaesthetic toxicity	02 (0.19%)
Spinal Anaesthesia (Group – II)	31 (2.67%)	Hypotension	09 (29%)
Epidural Anaesthesia (Group-III)	17 (1.46%)	Hypotension	04 (23.5%)
Peripheral Blocks (Group - IV)	35 (3.0%)	Inadequate blocks	03 (8.57%)
➢ Brachial plexus blocks	11(31.4%)	Inadequate block Horner's syndrome	01 (9.1%) 01(9.1%)
➢ Sciatic /Femoral blocks	07 (20%)		00
➢ Ankle block	04 (11.4%)	Inadequate block	02 (50.0%)
➢ Bier's block	12 (34.2%)		00
➢ Intercostal nerve block	01 (2.8%)		00
Dissociative Anaesthesia (Group – V)	18 (1.55%)	Transient hypoxemia Hypertension Emergence delirium	02 (11.11%) 07 (38.88%) 01 (5.56%)
Total Intravenous Anaesthesia (Group – VI)	08 (0.69%)	Delayed recovery	01 (12.5%)

opioid administration, all may have contributed to this high incidence of transient hypoxemia. In this group one patient (5.56%) had emergence delirium and 38.88% patients had intraoperative hypertension which correlates with the findings of Olasinde A.A., and Oluwadiya KS. [27] who noticed transient elevation of blood pressure in 43% and emergence delirium and confusion in 15% of the cases. Injection of midazolam 1-2 minutes before the injection of Ketamine might have contributed to this lower incidence of emergence delirium in our patients. Development of intraoperative hypertension indicates unsuitability of Ketamine in known hypertensive patients, ischaemic heart disease patients, thyrotoxic patients and in those patients where even mild to moderate degree of hypertension can be detrimental like neurosurgical cases [28].

We used a modified total intravenous anaesthetic technique in 8 patients (Group – VI) where ventilation was controlled by Ambu's bag with Oxygen supplementation by the Oxygen concentrator and infiltrated the local anaesthetics in the line of incision before the start of surgery (Preemptive analgesia). The patients had adequate analgesia, anaesthesia, and smooth recovery except in one patient who had a delayed recovery (12.5%) and was administered IV ketamine in addition to morphine, thiopentone sodium and atracurium besylate. The delayed recovery was probably due to the long duration of action of the ketamine which was used instead of thiopentone top ups. In contrast to the study of Stehle R. [25] we had no case of laryngospasm in our patients. Timely administration of glycopyrolate and oxygen supplementation from the oxygen concentrator, vigilant monitoring, appropriate depth of anaesthesia, low altitude, genetic and racial differences, all might have contributed to the low incidence and less severity of the complications in our study groups as compared to the other studies [29, 30] .

Clinical implications of different anaesthetic techniques have already been well documented [31, 32] however further planned studies are required to establish the efficacy and safety of the modified general anaesthetic technique used by us.

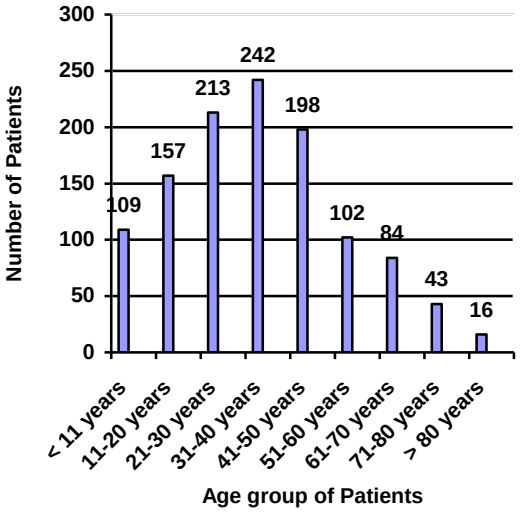

Fig. 1: Age groups of patients

CONCLUSION

Most of the surgical patients in Tsunami disaster could be managed under local anaesthesia and regional blocks while those few patients in whom regional blocks were inadequate were managed under dissociative anaesthesia with Ketamine or a modified total intravenous anaesthetic technique using oxygen concentrator very effectively and safely. The incidences of complications were quite low and were managed without any serious consequences.

We recommend that the practice of regional anaesthetics techniques should be stressed upon during the training of junior anaesthesiologists and the protocols to manage mass casualties should be rehearsed frequently during the peace times.

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