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INCIDENCE OF AWARENESS DURING GENERAL ANAESTHESIA FOR CAESAREAN DELIVERY: A COMPARISON OF THREE DIFFERENT INDUCTION AGENTS USING THE ISOLATED FOREARM TECHNIQAUE

A dissertation submitted as partial fulfillment for the Degree of Masters of Medicine (Anaesthetics)

At the University of
Zimbabwe 1993

Submitted by
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HARARE, ZIMBABWE
JUNE 1993

ACKNOWLEDGEMENTS

DR. N.J. CLARK - For his choice, supervision, guidance and materials provided and expert help in preparation and analysis of the data.

PROF. H.M. CHINYANGA - For his training support and contribution to up-to-date knowledge on the subject.

SR. TARUVINGA - Her cooperation help in preparation of the Patients.

MISS S. CHIDARIKIRE - For typing and preparation of the text.

ABSTRACT:

The study was undertaken to determine the incidence of awareness and recall in term gravid women during general anaesthesia for elective Caesarian delivery. This was done using observation for signs of "light" anaesthesia and the response to a standardised, pre-recorded verbal command using the isolated forearm technique. These observations were correlated with patient responses to a standardised series of enquires regarding awareness presented during a postoperative interview.

Three groups of patients were studied, with each group being anaesthetised with a different induction agent. The relative incidence of positive finding was determined by comparing results obtained from these three groups.

It was found that clinical signs of light anaesthesia and awareness were very common during the fifteen minutes following anaesthetic induction. However, actual recall of intraoperative events did not occur. Hence, the results comfirm previous reports of a high degree of discordance between sign of light anaesthesia and actual awareness.

The implication of this finding is that clinical signs of light anaesthesia during Caesarean delivery are non-specific and have very low predictive value for the actual risk of awareness leading to recall.

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SUMMARY & DEFINITION OF TERMS USED

Awareness: This is the ability to recall with or without prompting any events from the period during which the patient is thought to be fully unconscious (it does not include a patient who responded during surgery, but was unable to recall the fact afterwards. (Turnstal 1977)[1,2,3]

Wakefulness: The ability of a patient to respond to a command during anaesthesia without recollection of this fact post operatively.

Dreams: May include any experience (excluding awareness) which a patient is able to recall, and thoughts occurring between induction of anaesthesia and first moment of consciousness after anaesthesia.

INTRODUCTION

Labour has always been painful experience for many women. Pain relief long before the 18th century was provided by traditional birth attendants because doctors rarely practiced midwifery.4

The first anaesthetic was allegedly given billions of years ago-by God for a thoracotomy on Adam for the creation of EVE "And the Lord God caused a deep sleep to a fall upon Adam, and he slept". (Genesis 11:21, Sir James Simpson)[5,6]. The use of herbs with opiate characteristics and alcohol were frequently taken by women in labour. Ancient Chinese literature also

reports the use of a acupunture for the relief of labour pain and inhalation of fumes from hemp to facilitate surgery.[3]

In the Americas, the use of powdered virgins hair and dried ants eggs mixed in the milk of a red cow to expedite labour was a well known regime for Zerughabel Endocott a Physician from Salem Massachusets in the 17th century.[4, 7]

In less advanced communities, pain of labour was associated with evil spirits. And at times brutal trauma was inflicted by jumping upon mothers' abdomens to enhance delivery. Others, used heavy men who grasped the women above the uterine fundus and swung against it after suspending the pregnant mother from trees by ropes under their armpits.

Religion on the other hand, especially Christianity in the past regarded pain as a 'divine punishment through which grace would be achieved'. Anaesthesia was not accepted in obstetrics, although few objected to its use for other purposes. Pain was recognized to be a useful guide to the progress of labour and a promoter of healing.

> Scottish Calvinist Clergy and prominent members of the medical proffesion like C.D. Meigs of U.S.A., F.H. Raimsbothan of British Isles, and F.W. Scanzoni of Germany vigorously opposed Sir James Young Simpson and they often quoted the Bible to advance their arguements. Genesis 3:16 "A woman when in travail hath pain, because her hour is come, but as soon as she is delivered of child she remembered no more the anguish for joy that man is born into the world".[6]

In 1591, Euphame MacColzean was burned on the Stake in Edinburgh because she sought the aid of a witch to ease her labour pains (Donald. D. Moir). Obstetric anaesthesia and analgesia began to develop significantly in the middle of the 19th century. In the early 1940's, various anaesthetic agents were discovered notably ether, nitrous oxide and chloroform. And the first obstetric anaesthesia was described around 1884.[8]

However, the first documented obstetric anaethesia was conducted by Dr. James Young Simpson of Edinburgh on 19th January1847 who administered ether for the delivery of a dead fetus following failure of internal podalic version in a female with a severely contracted pelvis.

LITERATURE REVIEW

Obstetric anaesthesia gained respectability further when Dr. John Snow in 1853 gave Queen Victoria chloroform analgesia for the delivery of Prince Leopold.

The first use of N_2O and oxygen was by Klikovitch in 1880 at St. Petersburg who later demonstrated that it did not interfere with uterine action. However, none demostrated or reported the presence of pain/awareness intraoperatively. Later years saw the increase in active management of patient in labour as a means of improving fetal well being, reducing morbidity and motality of the mother and fetus. However, the developments were met with a number of problems which the anaesthetist encountered, necessitating evaluation and modifying anaesthetic management to provide adequate hypnosis, analgesia, muscle

relaxation and ablation of reflex activity in the mother without undue fetal distress.

From the foregoing treatese, we can observe that before the discovery of neuromuscular blocking drugs, the administrations of safe dosages of anaesthesia were mainly done by monitoring the stages of anaesthesia first defined by John Snow, but later classified by Guedel (Gareth Jones). With the introduction of neuromuscular blocking agents, it became rather difficult to estimate the level of anaesthesia, because most of the signs for assessing the degree of depth of anaesthesia became modified or totally abolished. Therefore the problem of light anaesthesia emerged, as exemplified by the number of reports in the medical literature dealing with varying degrees of awareness in anaesthetised patients.[9]

It should be stressed that much of the earlier trials of these drugs especially in the late 19th century and early 20th century were mainly public shows with no reserch protocols or experimental design.

Now, a number of techniques have been devised to test for wakefulness. Light general anaesthesia has been assessed by observing signs secondary to sympathetic activity. However, most of these are modified by muscle relaxants, opiods, cholinergic treatment, vasodilators, b-adrenergic antagonists and antihypertensives, therefore become unreliable.

The electro-encephalogram as a monitor of depth of anaesthesia has been used, but there is variability of electro-encephalographic traces with different anaesthetic agents at

equipotent concentrations. (McDowell DG:, DW. Thomas and W.B. Runciman), Temperature, $PaCO_2$ and efferent central nervous input make interpretation difficult, but however, it is useful in studying changes in a given patient.

The sensory evoked responses have been investigated. The auditory evoked potentials tend to correlate with the depth of anaesthesia. However, visual evoked potentials are thought to show large interpatient variation although are helpful in observing changes in a given patient (J.W. Evans).

The surface electromyogram especially of the frontalis muscle activity during general anaesthesia tends to correlate with the depth of anaesthesia because it is innervated by visceral effered fibres of the facial nerve and is resistant to muscle relaxants. The lower oesophageal contractility as a measure of death of anaesthesia has been investigated (J.M. Evans) The lower 1/3 oesophagus is made up of smooth muscles, therefore is not affected by muscle relaxants. The rate of amplitude of contraction of the lower oesophageal sphincter decreases progressively with increasing depth of anaesthesia. However, there is patient variability and premedicants especially anticholinergic and smooth muscle relaxants interfere with this response. The measurement of skin conductance of the skin to estimate the depth f anaesthesia has been done. Sweating is controlled by the autonomic nervous system, and anaesthetics depress the activity of the sudomotor tone therefore the skin conductance decreases corresponding to the depth of anaesthesia.

Studies indicate that 10 percent of general surgical patients experience some degree of awareness of pain intraoperatively, dreams and nightmares, and/or recall of conversations which take place in theatre.[8]

Sensory perception has mainly been used because it is reported to be the last perception to be lost in any state of unconsciousness and the first to return.

The incidence of awareness with thiopentone , nitrous oxide and oxygen is said to lie between 8-42 percent. Addition of halothane is reported to reduce it to about 0-0.5 percent.[8,10]

The isolated forearm technic (IFT) was first described by Turnstal in 1977,[2,11] and later modified by Russel in 1979.[12] Turnstall studied 2 groups of patients, in one group he used thiopentone 3.75 mg/kg followed by 100mg suxamethonium. He maintained his anaesthesia with 0.4% halothane, 33% nitrous oxide and 67% oxygen. He demonstrated wakefulness in 69 percent of patients using the IFT. In his second group, he adjusted the maintenance agents to 66% nitrous oxide and 37% oxygen and 0.4% Halothane. He noted that wakefulness was reduced to almost zero.

However, in both groups of patients, the degree of awareness or dreams was zero. In his study, he suggested that 3.75 mg/kg of thiopentone would not guarantee unconsciousness, but by increasing the nitrous oxide to 66% in the first 3 minutes following induction, he reduced the degree of wakefulness in unpremedicated patients.

Brice, Hetherington, and Utting, conducted a study of awareness and dreaming using light general anaesthesia with nitrous oxide, muscle relaxant, and oxygen without opioid premedication or added opioid analgesia.[9] They also found no evidence of awareness; however dreams occured in 44 percent of their patients. Also, patients who showed marked intraoperative movements were more liable to dream.

They found no correlation between answers obtained from patients immediately post operatively and those got subsequently in the wards. This was because some patients interviewed immediately post-operatively claimed detailed dreaming but some of these same patients subsequently denied all knowledge of such dreams on the wards, whereas those who denied any dreams immediately after waking up were able to remember detailed dreams if interviewed from the wards. Then there were those who gave consistent accounts both immediately post-operatively and on the ward. Their conclusion was that only those dreams retained and remembered were more significant which supports the fact that most dreams that occur in normal sleep are usually forgotten when one wakes up.

The comparison of induction agents and degree of awareness was done by Schultetus et all[13] and Russel.[14] Russel compared one group given thiopentone (sleeping dose), suxamethonium 1-1.5mg/kg, and Nitrous Oxide:Oxygen (N_2O:O_2) in a 2:1 ratio with a second group given total intravenous anaesthesia using etomidate 100/mg/kg/minute for 10 minutes ,followed by 10/mg/kg/minute for the remainder of the operation, combined with suxamethonium, nitrous oxide: oxygen in 1:1 ratio. Both

groups received vecuronium and fentanyl. Of his 54 patients, 31 showed purposeful movement of the isolated arm, but only 11 showed signs of light anaesthesia, that is sweating etc. Forty four percent in the $N_2O:O_2$ / fentanyl group showed wakefulness, and 7% in etomidate infusion group showed wakefulness. There was one case of awareness in $N_2O:O_2$ group.

The study reported by Schultetus et al included 3 groups:

i) Ketamine 0.5mg/kg + Thiopentone 2 mg/kg

ii) Ketamine 1 mg/kg

iii) Thiopentone 4 mg/kg

All groups had background $N_2O:O_2$ in ratio of 70:30. The results of this study were as follows:

- Only one patient receiving Ketamine responded to command
- 46% of those on the combination or thiopentone alone responded to command
- 8% showed post operative recall (3 patients) one had got thiopentone and 2 the combination
- The incidence of dreams was 11% but there were no hallucinations
- They noted a high proportion of patients who responded to command with rare post-operative recall and purposeful arm movement in response to surgical stimuli.

What was very striking about the studies of Russel and Schultetus was the presence of signs of light general anaesthesia (lacrimation, and increases in blood pressure and heart rate) despite the fact that in Schultetus' study , one group showed almost no hand/arm movement response to the IFT. This probably indicated a poor relationship between the visual signs of light anaesthesia and awareness in patients exhibiting responses to surgery or verbal command. Therefore, there is a wide variance between anaesthetics and the unrehability of accepted signs of awareness associated with rarity of post operative recall (Gareth Jones)[1].

MATERIALS AND METHODS

The study of the degree of awareness in term gravida coming for elective caesarian section under general anaesthesia was undertaken using the isolated forearm technique with a sphygmomanometer inflated to 250 mmHg to exclude forearm from suxamethonium. Details of the study protocol are as follows:

PATIENT SELECTION & PREPARATION

Thirty gravid term women of ASA I and II were studied after informed consent for operation and anaesthesia.

All patients were fasted overnight. Excluded from the study were those who had a history of hypertension, diabetes mellitus, morbid obesity or foetal compromise.

All patients were informed preoperatively they would be interviewed postoperatively about their intraoperative experiences if any, but were not told

what type of message would be delivered to them through the earphone.

The patients were randomly allocated to any of the 3 groups.

- Thiopentone 5 mg/kg
- Etomidate 0.3 mg/kg
- Ketamine 1.5 mg/kg

All patients were not premedicated except those who received magnesium tricillicate on the morning of the operation.

INTRAOPERATIVE MANAGEMENT

All patients received suxamethonium, alcuronium, halothane 0.5% and Nitrous Oxide: Oxygen 50:50 and were ventilated with the same Manley Pulmovent at tidal volume of 7-10mg/kg.

Supplementary Narcotic analgesia was given only after release of the tourniquet and a delivery of the baby.

The cuff was inflated after giving the induction agent, but before the administration of suxamethonium and was kept inflated for only 15 minutes. The isolating cuff was put on either of the arms where there was no intravenous line.

Blood pressure monitoring was by an automated auscillometric method. The cuff was put on either of the 2 legs in order not to interfere with drug/fluid administration in the free arm. Measurements of systolic blood pressure, diastolic blood pressure, mean artrial pressure and Heart rate were displayed.

Positioning of the patients was supine with a left uterine displacement.

Other routine monitors used included a precordial stethoscope and, electrocardiogram, and sphygmomanometer. For study purposes 3 determinations of arterial blood pressure and heart rate were recorded and averaged to obtain baseline values of Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Heart Rate (HR).

The patients were pre-oxgenated with 100% oxygen for 3-5 minutes followed by the designated induction agent, inflation of isolating cuff then administration of suxamethonium. Cricoid Pressure was applied on all patients before giving of induction agent.

On intubation of the trachea and proper positioning of the endotracheal tube, Halothane and nitrous oxide were turn on and the patients ventilated.

Alcuronium was given after there was clinical evidence of recovery from the suxamethonium-induced neuromuscular blockade.

Surgery commenced when the level of anaesthesia was thought to be adequate.

A standardised tape-recorded message instructing the Patient to move the fingers, hand, or arm on the side of the isolated arm was delivered to the patient through carefully fitted earphones, and repeated over for a period of one and a half minutes (after adjusting the reception to an acceptable volume of noise to the anaesthetist). This message was subsiquently delivered at intervals 1, 5, 10 and 15 minutes after the administration of suxamethonium. Any movement of patients arm/fingers of the isolated arm which were purposeful during this period was considered a positive response and was taken as evidence of intra-operative awareness.

Other observations taken at these times intervals included:

- Systolic and diastolic blood pressure
- Heart rate
- Sweating
- Lacrimation
- Eyelid movement

Additional study variables recordeded were :-

- The induction-to-delivery time
- Uterotomy-to-delivery time
- Apgar score of the newborn babies
- Total surgical time
- Total anaesthetic time
- Estimated blood loss.

All data points were recorded on a standardised data collection form, a copy of which is presented in Appendix I.

After 15 minutes following the administration of suxamethonium, the cuff was released and anaesthetic management continued in the usual standard way.

A uterotonic was given routinely after delivery of the baby and consisted of either Ergometrine or Oxytoxin. A narcotic was only given after delivery of the baby and following the release of the tourniquet on the isolated forearm.

POSTOPERATIVE INTERVIEW

All patients were interviewed 24 hours post operatively. They were asked to identify:-

- The last preoperative memory
- The first post operative memory
- Any intra operative dreams
- Their worse peri-operative experience.

Responses to the above enquiries containing any possible reference to intraoperative events were recorded as positive for both *awareness* and *recall*.

Two patients whose anaesthetic mangement deviated from the study protocol because of difficulty with endotracheal intubation in one case, and apparatus malfunction requiring changing of vaporiser in the second case were eliminated from the study.

RESULTS

Patient Characteristics: Some patient characteristics are summarised in Table 1. As can be seen from the Table, the three study groups did not differ with respect to Patient Age, Weight, ASA Class distribution, and baseline values of HR, SBP, and DBP.

Table 1.

		THIOPENTONE (n = 11)	KETAMINE (n = 10)	ETOMIDATE (n = 9)	
AGE (yr)	mean	28	27	28	NS; ANOVA
	SD	5	3	6	F=0.094; P=0.910
WEIGHT (kg)	mean	77	74	72	NS; ANOVA
	SD	18	11	9	F=0.357; P=0.703
ASA CLASS	I	9	10	6	NS; X^2 = 3.818
	II	2	0	3	P=0.148
Baseline:					
HR (bpm)	mean	91	88	80	NS; ANOVA
	SD	22	17	15	F=0.964; P=0.394
SBP (mmHg)	mean	144	146	154	NS; ANOVA
	SD	15	22	27	F=0.514; P=0.604
DBP (mmHg)	mean	77	78	80	NS; ANOVA
	SD	8	10	10	F=0.329; P=0.723

HR = Heart Rate; SBP and DBP = Systolic and Diastolic Blood Pressure respectively; Group means for AGE, WEIGHT, HR, SBP, and DBP were compared using 1-way Analysis of Variance (ANOVA); Group ASA CLASS composition was analysed by cross tabulation and Chi-square testing; For all comparisons, $P < 0.05$ was considered significant.

Clinical Signs of Light Anaesthesia: The clinical signs of light anaesthesia recorded for study purposes were observations for Sweating, Lacrimation, Eyelid Response, and post-induction changes in Heart Rate and Blood Pressure.

Observations of Sweating, Lacrimation, and Eyelid Response were recorded as discrete responses on an all-or-none basis. The results were analysed for inter-group difference by cross-tabulation and Chi-square testing of observed frequencies. Results of this analysis are summarised in Tables 2 - 4. In these Tables, the row headings identify the different treatment groups as THIO (thiopentone), KET (ketamine), and ETOM (etomidate), and the column headings give the number of post-induction time intervals (the 1, 5, 10, and 15 minute intervals) at which positive responses were recorded. The left uppermost cell in each Table provides the key for interpreting the contents of the cells within the Table.

Haemodynamic signs of light anaesthesia were taken as the post-induction changes in Heart Rate, Systolic and Diastolic Blood Pressure (HR, SBP, and DBP respectively). These haemodynamic variables were measured by an automated oscillotonometric method (Critikon Dinamap). Group means and standard deviations of these variables were computed. Post-induction values of HR, SBP, and DBP were compared to the baseline, pre-induction values given in Table 1. For purposes of this study, a post-induction increase in either HR, SBP, or DBP of 20% of more was taken as clinical evidence of light anaesthesia.

As can be seen from Tables 2-4 which follow, there were no significant inter-group differences in the visually observed clinical signs of light anaesthesia, except for the distribution of post-induction observations intervals at which lacrimation was observed (see below).

Sweating: No significant inter-group differences in the incidence of post-induction sweating were observed. (see Table 2.)

Table 2. SIGNS OF LIGHT ANAESTHESIA - SWEATING

Chi-Square: 9.452 Phi: 0.561 Contingency
Significance: 0.150 Cramer's V: 0.397 Coefficient: 0.489

Cell Count Row % Column % Total %	Data File: Awareness Study/Clin Signs				
	0	1	3	2	AGENT Totals
KET	10 100.00 47.62 33.33	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	10 33.33
THIO	7 63.64 33.33 23.33	3 27.27 60.00 10.00	1 9.09 33.33 3.33	0 0.00 0.00 0.00	11 36.67
ETOM	4 44.44 19.05 13.33	2 22.22 40.00 6.67	2 22.22 66.67 6.67	1 11.11 100.00 3.33	9 30.00
SWEATING Totals	21 70.00	5 16.67	3 10.00	1 3.33	30 100.00

Lacrimation: A significant inter-group difference in the distribution of positive lacrimation responses was observed. Positive responses were more common in the KETAMINE group at observation intervals 2 and 3 (5 and 10 minutes post-induction respectively) and in the THIOPENTONE group at interval 4 (15 minutes post-induction ($\chi^2 = 16.32$; $P = 0.012$). (see Table 3.)

Table 3. SIGNS OF LIGHT ANAESTHESIA - LACRIMATION

Chi-Square: 16.323 Phi: 0.738 Contingency
Significance: 0.012 Cramer's V: 0.522 Coefficient: 0.594

Cell Count Row % Column % Total %	Data File: Awareness Study/Clin Signs				
	3	4	1	2	AGENT Totals
KET	5 50.00 83.33 16.67	0 0.00 0.00 0.00	1 10.00 16.67 3.33	4 40.00 50.00 13.33	10 33.33
THIO	0 0.00 0.00 0.00	7 63.64 70.00 23.33	3 27.27 50.00 10.00	1 9.09 12.50 3.33	11 36.67
ETOM	1 11.11 16.67 3.33	3 33.33 30.00 10.00	2 22.22 33.33 6.67	3 33.33 37.50 10.00	9 30.00
LACRIMATION Totals	6 20.00	10 33.33	6 20.00	8 26.67	30 100.00

Eyelid Reflex: No significant inter-group differences were observed in frequency of positive Eyelid Responses following induction of anaesthesia. (see Table 4. next page)

Table 4. EYELASH RESPONSE

Chi-Square: 1.942 Phi: 0.254
Significance: 0.379 Cramer's V: 0.254

Cell Count Row % Column % Total %	Data File: Awareness Study/Clin Signs		
	0	1	AGENT Totals
KET	10 100.00 37.04 33.33	0 0.00 0.00 0.00	10 33.33
THIO	9 81.82 33.33 30.00	2 18.18 66.67 6.67	11 36.67
ETOM	8 88.89 29.63 26.67	1 11.11 33.33 3.33	9 30.00
EYE LID RES Totals	27 90.00	3 10.00	30 100.00

Haemodynamic Signs of Light Anaesthesia: For purposes of this study, the post-induction changes in HR, SBP, and DBP were expressed in two different ways, those being the maximum change from baseline recorded for each haemodynamic variable at *any one* of the post-induction observation periods, and as the average of *all four* post-induction recordings for each haemodynamic variable.

For each of these expressions, group means and standard deviations were calculated. The "within-group" changes relative to baseline values for that group were analysed using paired t-tests with Bonferroni correction. Inter-group comparisons were made using one-way ANOVA. In all cases, a P value less than 0.05 was considered significant.

Results of the analysis of maximum haemodynamic changes are summarised in Table 5 and illustrated in Figure 1.

Figure 1.

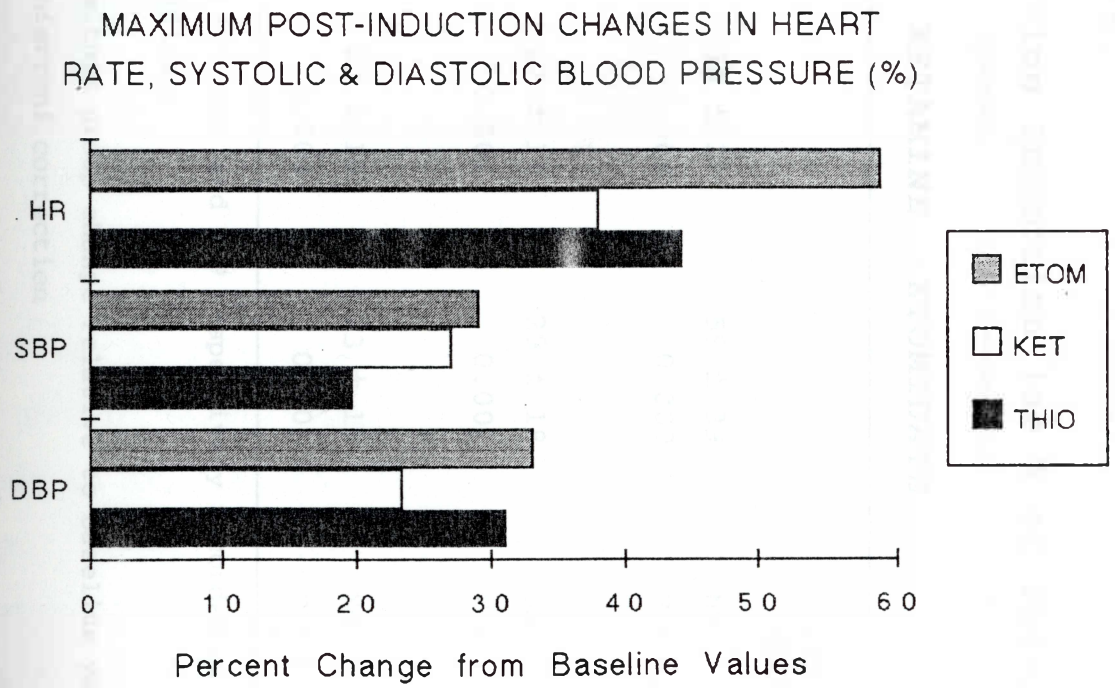


Table 5.

Maximum Haemodynamic Changes Following Induction (as % of Baseline)

		THIOPENTONE	KETAMINE	ETOMIDATE	Inter-group Comparisons
ΔHR_max (%)	(mean ± SD)	44 ± 40	38 ± 19	59 ± 39	NS
	*(P value)	0.004	0.000	0.002	F = 0.933; P = 0.406
ΔSBP_max (%)	(mean ± SD)	20 ± 8	27 ± 16	29 ± 18	NS
	*(P value)	0.000	0.001	0.001	F = 1.116; P = 0.342
ΔDBP_max (%)	(mean ± SD)	31 ± 24	23 ± 18	33 ± 19	NS
	*(P value)	0.002	0.003	0.001	F = 0.609; P = 0.551

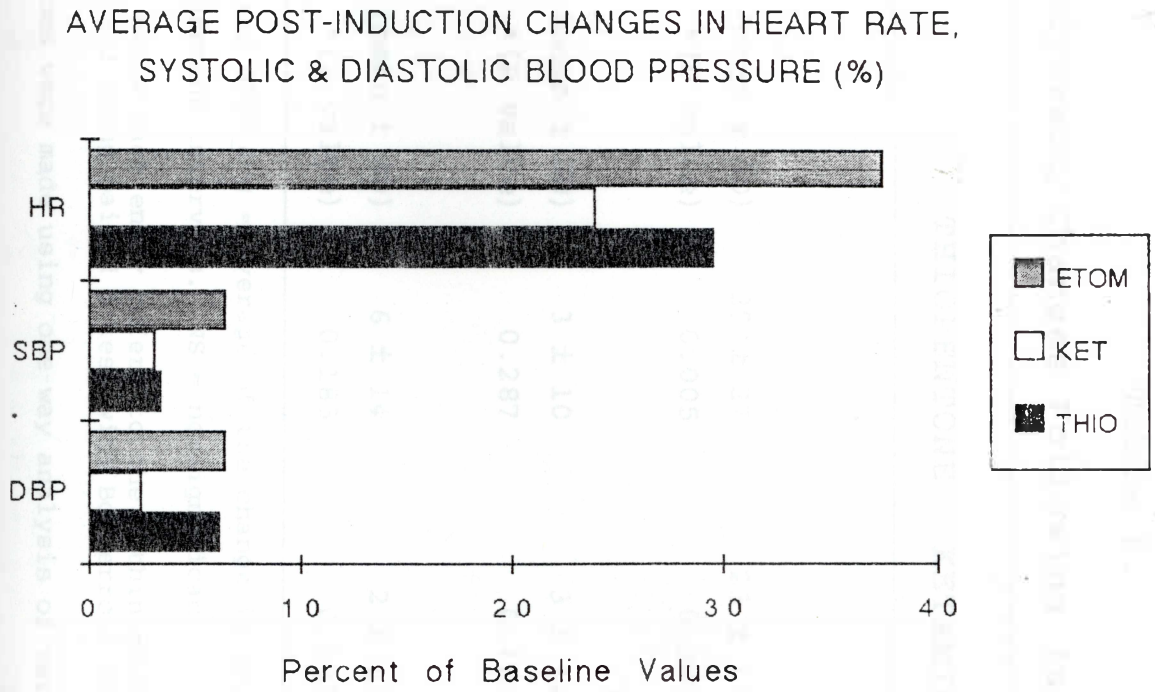
ΔHR_max, ΔSBP_max, and ΔDBP_max = maximum change in HR, SBP, and DBP respectively recorded at any one of the post-induction measurement intervals. NS = nonsignificant

* The P-value given below each entry refers to the within group change relative to baseline values for that group, and was obtained using paired t-test with Bonferroni correction

Intergroup comparisons were made using one-way analysis of variance (ANOVA)

Results of the analysis of average haemodynamic changes are summarised in Table 6 and illustrated in Figure 2.

Figure 2.



As can be seen from Figures 1 and 2, and Tables 5 and 6 the each group experienced significant maximum post-induction changes in HR, SBP, and DBP relative to baseline values for that group. However, there were no significant inter-group differences in the magnitude of these post-induction changes. The average of the post-induction recordings was significantly different from the group baseline values only for HR. Again, there were no significant inter-group differences in the averaged post-induction values for HR, SBP, and DBP.

Table 6.

Average Haemodynamic Changes Following Induction (as % of Baseline)

		THIOPENTONE	KETAMINE	ETOMIDATE	Inter-group Comparisons
ΔHR_avg (%)	(mean ± SD)	29 ± 27	23 ± 17	37 ± 30	NS
	*(P value)	0.005	0.002	0.005	F = 0.730; P = 0.491
ΔSBP_avg (%)	(mean ± SD)	3 ± 10	3 ± 14	7 ± 11	NS
	*(P value)	0.287	0.461	0.119	F = 0.232; P = 0.795
ΔDBP_avg (%)	(mean ± SD)	6 ± 14	2 ± 13	7 ± 11	NS
	*(P value)	0.183	0.585	0.114	F = 0.306; P = 0.739

ΔHR_avg, ΔSBP_avg, and ΔDBP_avg = average of the change in HR, SBP, and DBP respectively recorded at the four post-induction measurement intervals. NS = nonsignificant

* The P-value given below each entry refers to the within group change relative to baseline values for that group, and was obtained using paired t-test with Bonferroni correction

Intergroup comparisons were made using one-way analysis of variance (ANOVA)

Intraoperatove Awareness: The Hand/Arm Movement Responses: Twenty to 30 percent of the subjects in each treatment group exhibited signs of intraoperative awareness by giving a positive Hane/Arm Movement respones at one or more of the post-induction observation intervals. However, there were no significant inter-group differences in the frequency of positive responses. (see Table 7.)

Table 7. SIGNS OF AWARENESS - HAND/ARM MOVEMENT

Chi-Square: 5.174 Phi: 0.415 Contingency
Significance: 0.739 Cramer's V: 0.294 Coefficient: 0.384

Cell Count Row % Column % Total %	Data File: Awareness Study/Clin Signs					
	0	4	1	2	3	AGENT Totals
KET	4 40.00 40.00 13.33	0 0.00 0.00 0.00	2 20.00 33.33 6.67	2 20.00 28.57 6.67	2 20.00 40.00 6.67	10 33.33
THIO	5 45.45 50.00 16.67	1 9.09 50.00 3.33	1 9.09 16.67 3.33	3 27.27 42.86 10.00	1 9.09 20.00 3.33	11 36.67
ETOM	1 11.11 10.00 3.33	1 11.11 50.00 3.33	3 33.33 50.00 10.00	2 22.22 28.57 6.67	2 22.22 40.00 6.67	9 30.00
HAND/ARM RES Totals	10 33.33	2 6.67	6 20.00	7 23.33	5 16.67	30 100.00

Post-Operative Reports of Awareness and Recall: None of the study subjects in any of the treatment groups (THIO, KET, and ETOM) reported any experiences of awareness and/or recall during the post-operative interview.

DISCUSSION

There is a dose-related change in the central nervous system response to the administration of general anaesthetic agent. The electroencephalogram demonstrates graded changes in brain function which increasing concentration of anaesthetic agents. However, there are drug and individual differences in the susceptibility to the effect of anaesthetic agents.

It is known that there are factors which affect the pharmacokinetic and pharmacodynamic action of specific agents. However, the signs of depth of anaesthesia have frequently been related to the concentrations of particular anaesthetic agents. This is true because the response to surgical stimuli is related to the depth of anaesthesia.

General anaesthetic agents produce hypnosis attenuation of stress response to stimuli, and may produce muscle relaxation and analgesia. The concept of minimum alveolar concentration (MAC) has therefore been used as a standard for comparing different volatile anaesthetic agents. The minimum alveolar concentration is that which is required to prevent movement in 50% of patient when a standard stimulus (incision) is applied.

The MAC required to prevent movement in response to endotracheal intubation is about 1.3 times that required for a standard incision. whereas that needed to obtund autonomic reflexes (pupils, heart rate, BP etc.) is 1.5 times MAC. (Grantham and Hermeroff, 1985) Therefore, it is in light of this, that one may probably expect a rather significant number

of obstetric patients to exhibit a high degree of light anaesthesia in the first fifteen minutes following induction of anaesthesia.

The clinical signs of anaesthesia and wakefulness were observed in the 30 patients who received either of the three agents, thiopentone, ketamine and etomidate.

SWEATING:

Severty percent (21) of the patients in all the 3 groups showed no sweating. However, there was no sweating at all in the ketamine group. On analysis, there was no statistical significancy between the 3 groups. (P = 0.150)

The sweat glands are controlled by the sympathetic system, although the post ganglionic fibres are cholinergic. A stimulus applied during light general anaesthesia may therefore induce sweating. Narcotic are also thought to augment this effect, however all patients received a narcotic after delivery of the baby and release of the tourniquet, therefore outside the study period.

Ambient temperature and humidity may affect the amount of sweating observed especially in the upper part of the body. Probably determining the skin conductance would be more acurate as general anaesthesia depress the sudomotor responses and changes in skin impendence may occur before obvious sweating occurs. It has been suggested that sweating can also be estimated by an evaporimeter. From this, probably one may conclude that sweating is not frequently seen during the use of

these induction agents plus Halothane 0.5%, Nitrous: Oxygen 50:50, but when it occurs, is a good sign of light general anaesthesia.

LACRIMATION:

This sign was observed in all patients in all the three groups. Tearing was more common in KETAMINE group at 5 and 10 minutes post-induction and was more common in the THIOPENTONE group at 15 minutes post-induction ($P = 0.012$). Lacrimation was seen in all patients after intubation probably because most of these patients endotracheal intubation was done under light genral anaesthesia before the introduction of volatile agent. Yet endotracheal intubation needs about 1.3 times the MAC required for a standard incision. However, lacrimation observed after intubation and introduction of volatile anaestheic agent and muscle relaxants may have been due to a stress response to pain, discomfort or just increased sympathetic outflow in a light stage of general anaesthesia. Airway irritation either due to suction or the presence of an endotracheal tube may cause lacrimation. Volatile anaesthetic agents are also known to irritate the airway and cause lacrimation, however halothane which we used does not probably irritate the airway. Lacrimation was more pronounced in the KETAMINE group earlier in the post-induction period. This may well be due to its effects on the autonomic nervous system and its cocaine-like effect combined probably with other factors of light general anaesthesia.

EYELID RESPONSE:

Ninty percent (27) of all the patients in the 3 groups showed no eyelid response. There was a total of 3 (10%) patients who showed a response at one interval. Two were from the THIOPENTONE group and one from the ETOMIDATE group.

The eyelid (upper) has got the levator-palpebrae muscle which is innervated by both somatic and visceral nerves because it has skeletal and smooth muscle components. The application of muscle relaxants will abolish action of the voluntary action of the eyelid. And adequate depth of anaesthesia would depress, the sympathetic supply to the muscle. However, eyelid movement can occur secondary to excessive sympathetic stimulation. In all the 3 groups there was no significancy in the eyelid response to light general anaesthesia ($P = 0.379$)

HAND / ARM MOVEMENT:

Muscle relaxation occurs as the depth of anaesthesia increases. And the response which occurs to surgical stimulus is used in the measurement of the minimum alveolar concentration (MAC) for different volatile anaesthetic agents.

However, in the isolated forearm technique (IFT) the arm was isolated from muscle relaxants and inhalation agents so that both voluntary and involuntary action would be maintained in this arm to enbable patient to respond to command if in light general anaesthesia.

One third (33.33%; 10 patients) of all patients in the 3 groups showed a purposeful hand movement response. When this sign of awareness was compared in the 3 groups, there was no statistically significant difference between them (P = 0.739). However, increased tonus was observed in the isolated forearm of some patients who received Ketamine. A peculiar, transitory flexion rigidity of the fingers and moderate movement/twitching was also seen in patients given etomidate. These particular changes in the patients given Etomidate and Ketamine did not however intefere with the intrepretation of the hand movement in response to command. The effectiveness of the cuff to isolate the forearm from muscle relaxant was compared with a series of ten(10) patients whose isolated forearm was monitored with nerve stimulator and was found to be effective.

There was however one patient in the Thiopentone group whose blood pressure rose so high during intubation, that it probably could have overcome the cuff pressure.

The correlation of clinical signs of light general anaesthesia with awareness and recall was made. It was observed in this study that clinical sign of light general anaesthesia, that is lacrimation, sweating and hand/arm movement were observed in all the 3 groups of patients.

- The frequency of lacrimation however, was found to be more significant in the KETAMINE and THIOPENTONE groups compared to the ETOMIDATE group.
- The incidence of patient awareness, as indicated by ability to follow the command for hand/arm movement

during periods of apparent unconsciousness was examined, was found to be 20-30 percent in all the patients. However, there was no significant difference between the 3 groups. This was similar to what Turnstall demonstrated in his study.

- With respect to postoperative recall, there was no incidence reported in all the groups.
- When the haemodynamic responses to intubation and surgery were compared the effects of the three induction techniques were comparable. There was no significant difference between them. However there was a significant change from baseline of maximum and average changes in each of the individual groups, which is similar to what has been reported in other studies.
- The incidence of emergence phenomonea such as dysphoric dreams, and hallucinations were not different in all the three groups. Only one patient in the KETAMINE group reported dreaming 24 hours post-operatively
- The low incidence of dreams and halucination is particularly noteworthy for the KETAMINE group, and was probably due to fact the combination with other drugs like nitrous oxide, Narcotic and Halothane greatly reduces this side-effect of Ketamine.
- In respect to the newborn, the apgar scores, neurobehavioral tests, were not different between the groups.

CONCLUSION

From this study, it is clear, that there is a great discrepance between the signs of light general anaesthesia and awareness and recall postoperatively as has been shown in the literature (Turnastall Russel, Schultetus, Gareth Jones, Evans.

The ability to detect conciousness during genral anaesthesia using signs of light genral anaesthesia appear to be difficult and inconclusive though are a good guide to the depth of anaesthesia.

However, the use of a single physiological variable in a single patient may have limitation therefore a number of signs are more useful as a means of information processing, that is signal summation and signal evaluation (J.M. EVAN).

Therefore it is reasonable to assume that the concentration of anaesthetic agents used were reasonable to ensure consciousness with little risk of awareness and recall.

APPENDIX I.

DATA COLLECTION FORM

for the study by

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of

INCIDENCE OF AWARENESS DURING GENERAL ANAESTHESIA FOR CAESAREAN DELIVERY: A COMPARISON OF THREE DIFFERENT INDUCTION AGENTS USING THE ISOLATED FOREARM TECHNIQAUE

AWARENESS DURING CAESAREAN SECTION STUDY

U.Z. Department of Anaesthetics

Methods: Study of the degree of awareness in term gravidas during elective Caesarean Section under general anaesthesia using the isolated forearm technique (sphygmomanometer inflated to 200-300 mmHg) to exclude forearm from suxamethonium.

Assessment: Response to standardised pre-recorded command to move fingers/hand delivered through earphone headset during the immediate post-induction phase of general anaesthesia.

Name: _____

Age (yrs): _____ Weight (kg) _____

Case No. _____ Diagnosis _____

ASA Class _____

Premedication (antacid only) Y/N

Induction Agents:

Thiopentone (5 mg/kg) _____

Etomidate (0.3 mg/kg) _____

Ketamine (1.5 mg/kg) _____

Times (hh:mm):

Induction agent _____ Halothane/N_2O _____

Cuff inflated _____ Alcuronium _____

Suxamethonium _____ Delivery time _____

Uterotonic:

Ergometrine _____

Pitocin _____

Apgar Score: _____

Patient Responses:

	--- Time Intervals: (min.)* ---				
	BL	1	5	10	15
Pulse (bpm)					
BP (mmHg)					
Sweating					
Lacrimation					
Eyelid response					
Hand/are movement					

(* Time Interval = time from suxamethonium administration)

Intraoperative Summary:

Induction-to-Delivery Time _____

Uterotomy-to-Delivery Time _____

Total Anaesthetic Time _____

Total Surgical Time _____

Estimated Blood Loss _____

Postoperative Observations:

Last Preoperative Memory _____

_____

First Postoperative Memory _____

_____

Intraoperative Dream(s) _____

_____

Worst Perioperative Experience _____

_____

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