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The present study is an attempt to compare the relative efficacy of alkalinization and/or hyaluronidase with 2% lignocaine hydrochloride plus adrenaline, in peribulbar block for routine cataract surgery.

Modification of local anaesthetic by the addition of agents such as hyaluronidase and sodium bicarbonate has been practiced for some time now. Fernando and Jones (1991) studied the comparison between the effect of plain and alkalinized mixtures of lignocaine and bupivacaine for elective extradural caesarean section. Modification of a local anaesthetic is usually carried out, either, to speed the onset of block i.e. by adding sodium bicarbonate or hyaluronidase or, for prolonging the duration of block i.e. by adding adrenaline. As yet there is no local anaesthetic available that combines reliable quick onset with prolonged action.

The present study was carried out on 210 healthy patients, between 40-82 years age scheduled for senile cataract surgery. These patients were randomly allocated into three groups of seventy each. pH of the groups was constituted by adding the required amount of 7.5% sodium bicarbonate solution. pH of Group-1 was kept at 3.45, Group-2 and Group-3 at 6.5 each.
The parameters recorded in each group are as follows:

- Time to onset of akinesia
- Residual movements
- Supplementary anaesthesia required
- Duration of akinesia and anaesthesia
- Post – Injection Thrust
- Conunctinal chemosis
- Lid edema
- Pulse, BP
- Post-operative subjective onset of pain

The demographic and operative data in all the groups was comparable. Most of the patients in each group were between the age of 45 to 75 years. All had acquired senile cataract. Male/Female ratio was 1.1 in Group-1 and 3, 1.3 in Group 2. All the patients underwent an identical procedure for routine cataract surgery i.e. ECCE with PC IOL implantation, all performed by one surgeon. The mean duration of surgery for each case was comparable in all the three groups; 18.47 ± 2.32 minutes for Group-1, 18.55 ± 2.57 minutes for Group-2 and 18.00 ± 2.25 minutes for Group-3 patients.

**Time to onset of akinesia**

It is the time taken from the time of giving the injection to the time of appreciable restriction of movements of the globe and loss of lid movements. Following the peribulbar injection this was checked
for every 2 minutes for 15 minutes. The patients was asked to move the eyeball in various directions and to squeeze the lids.

In this study, as seen in the frequency distribution curve on page 45, 65 out of 70 patients in Group 3 had a time to onset of akinesia within 8 minutes. This is in contrast to 42 patients in Group 1 and 43 in Group 2 who had a time to onset of akinesia by 15 minutes.

These results co-relate well with the findings of earlier studies which are as follows:

Zahl et al (1991) showed that pH adjusted lignocaine + bupivacaine had a faster onset of complete akinesia (7.0 ± 2 minutes) when compared with the other groups.

Roberts et al (1993) in their study on peribulbar anaesthesia with alkalinization and hyaluronidase demonstrated that the solution containing hyaluronidase and pH adjusted to 6.7 was the most effective.

Lewis et al (1992) while studying plain versus pH – adjusted bupivacaine for eye block noted a shortened onset time of peribulbar block but this was associated with excessive orbicularis muscle activity and thus a requirement for increased supplementation compared with plain solution.

Srinivasan et al (2000) in their study on sodium bicarbonate an alternative to hyaluronidase in ocular anaesthesia for cataract surgery concluded that 51.5% eyes achieved complete akinesia within 5
minutes in the bicarbonate group in comparison to 21.6% eyes attaining complete akinesia within 5 minutes in the hyaluronidase group. The mean time to onset of akinesia was $7.51 \pm 5.89$ minutes in the pH – adjusted group whereas it was $8.86 \pm 3.82$ minutes in the hyaluronidase group.

In the present work Group 1 patients who received an acidic injectate ($\text{pH} = 3.45$) of an 8ml solution of 2% lignocaine with adrenaline 1:200,000 + 50 IU/ml hyaluronidase had a higher onset time (47 out of 70 by 15 minutes) as compared to group 3 patients (65 out of 70 within 8 minutes). This may be because the volume of injectate being less than the volume of the periocular space, initially compartmentalizes where the endogenous buffering systems slowly neutralize this acidic solution. Also hyaluronidase is inactive at this pH; thus explaining for the prolonged onset time.

Group 2 patients who received on alkalinized injection ($\text{pH} = 6.5$) of 2% lignocaine with adrenaline 1:200000 also showed a higher onset time (43 out of 70 by 15 minutes). This result is against the pharmacokinetic theories of local anaesthetic solutions but can be explained according to the thermodynamic principles for weak bases i.e. an increase in temperature and pH (Kamaya et al) results in more of the less soluble neutral species. After the peribulbar injection the solution initially compartmentalizes and heating by the surrounding tissues results in more of the neutral species and precipitation. Consequently there is poor absorption, reduced efficacy, lid edema, chemosis and tightening of palpebral aperture.
Group 3 patients who received an alkanized lignocaine hyaluronidase injectate had the shortest onset time (65 out of 70 within 8 minutes). This can be attributed, firstly to, hyaluronidase being an enzyme (protein) decreases the rate of crystal formation and subsequent precipitation. Also a combination of increased hyaluronidase activity and anaesthetic lipophilicity results in decreased compartmentalization and precipitation.

**Supplementary Anaesthesia required**

If there was movement ( > 1 mm in any direction) of the eyeball at the end of 15 minutes, the peribulbar block was supplemented with a retro-bulbar injection with the same mixture.

In the present study only 5 out of 70 patients (0.71%) in Group 3 i.e. in the pH adjusted lignocaine hyaluronidase group required reblock in sharp contrast to 24 out of 70 (34.2%) in Group 1 and 25 out of 70 (35.7%) in Group 2 requiring the retrobulbar block.

These results co-relate well with –

Zahl et al (1991), who showed that 2 out of 20 patients in the pH adjusted group required supplemental injection against 4 out of 20 in the plain group at the end of 30 minutes. He found these results not to be significant by Fisher’s exact analysis.

Roberts et al (1993) while comparing the effect of pH and the addition of hyaluronidase to a mixture of lidocaine and bupivacaine on the efficacy of peribulbar block found only 2 out of 20 patients
requiring reblock in the pH adjusted lidocaine bupivacaine hyaluronidase group (pH = 6.7) against 11 out of 20 requiring reblock in the plain lignocaine bupivacaine hyaluronidase group (pH = 5.0).

Srinivasan et al (2000) in their study found reblock rate to be 21.66% in the pH – adjusted group while it was 18.33% in the hyaluronidase group.

The results of this study do not co-relate with the findings of Lewis et al (1992) according to whom the requirement for anaesthetic supplement at 20 minutes was 9 out of 26 in the plain group and 13 out of 24 in the pH adjusted group. According to him pH – adjusted bupivacaine shortened the onset time of peribulbar block but was associated with excessive orbicularis muscle activity and a requirement for increased supplementation compared with the plain solution.

Supplement injections add to the risk of complications with each prick and so defeat the very purpose of the peribulbar block. This can be avoided to the maximum with group 3 solution, whereas, the supplement injection rate increased in group 1 and group 2 thereby increasing the probability of complications.

**Residual Movements**

At the end of 15 minutes each patient was asked to move the eyeball in all directions and the remaining movement, if present was
noted. Total akinesia or movement of less than 1 mm in any direction is taken as adequate for safe surgery to proceed.

In our study success was 92.8% in group 3 patients (65 out of 70) who received an 8 ml injectate of an alkalinized solution of 2% lignocaine with adrenaline and 50 IU/ml hyaluronidase (pH = 6.5). This is in contrast to 60% patients in Group 1 (42 out of 70) and 57.1% in Group 2 (40 out of 70) who achieved total akinesia at the end of 15 minutes. In our study success was 92.8% in Group 3 patients (65 out of 70) who received an 8 ml injectate of an alkalinized solution of 2% lignocaine with adrenaline and 50 IU/ml hyaluronidase (pH =6.5). This is in contrast to 60% patients in Group 1 (42 out of 70) and 57.1% in group 2 (40 out of 70) who achieved total akinesia at the end of 15 minutes.

Most surgeons are content with small amounts of residual movements but complete akinesia is the ultimate requirement for safe and successful surgery.

In our study we observed that the last muscle to attain akinesia was the medial rectus, while the vertical movements were lost the earliest.

The above results are in accordance with : Roberts et al (1993) who demonstrated a 10% failure rate in the lidocaine bupivacaine hyaluronidase adjusted to pH 6.7 group in comparison to a 55% failure rate in the bupivacaine hyaluronidase group where pH was 5.0.
Srinivasan et al (2000) while comparing pH – adjustment with hyaluronidase concluded a success rate of 78.3% in the pH-adjusted group against 81.6% in the hyaluronidase group.

Duration of akinesia and anaesthesia

In the present study duration of akinesia and anaesthesia is taken from the time of achievement of akinesia till the completion of surgery or wearing-off of anaesthesia or akinesia, whichever is earlier of the two.

Mean duration of surgery for each case in Group-1 was 18.47 ± 2.32 minutes, Group-2 18.55 ± 2.57 minutes, Group-3 18.00 ± 2.25 minutes. None of the patients in any group complained of pain or discomfort during the whole surgical procedure and neither was any movement of the eyeball or the twitching of lids seen during this time.

Therefore we can conclude that alkanization of lignocaine hydrochloride solution is as efficacious as the non-alkalinized solution concerning the quality of block.

Results of the present study are comparable with those of Zahl et al (1991), Lewis et al (1992) and Srinivasan et al (2000); all of whom have reported that there was no supplementary injections required once surgery had commenced and that all patients were comfortable during the procedure.

Post Injection Thrust (Subjective to the surgeon)
Thrust is the pressure applied by the vitreous as well as retro-orbital tissues on the anterior chamber of the eye when the eye has been opened for surgery. This is not synonymous with intraocular pressure since it has been seen that even though intraocular pressure may be low pre-operatively, on opening of the anterior chamber there is thrust of the vitreous. This is seen when too much of the anaesthetic solution has been deposited in the periorbital space or there is retrobulbar haemorrhage.

In our observation the post-injection thrust as experienced by the surgeon was minimal in 3 cases each in Group 1 and 2 out of the total 70 i.e. 4.2% while none of the cases in Group 3 had any thrust. The difference between the three groups is not significant.

None of the previous studies have reported any case of post-injection thrust with alkalinization.

**Conjunctival Chemosis**

Post-injection conjunctival chemosis occurs more commonly with peribulbar anaesthesia due to diffusion of anaesthetic solution into the subconjunctival space. This also indicates the success of the block and is a necessary evil for proper anaesthesia. However, it has been observed by us as well as by other authors that moderate amount of chemosis does not hamper surgery in any way.

In our results 4 patients out of the 70 in Group 2 had chemosis; 3 had mild chemosis i.e. in one quadrant only while 1 had moderate chemosis i.e. in 2 quadrants. This chemosis did not interfere in the
surgical procedure in any of the 4 cases and the results of surgery were good in all these 4 cases. None of the cases in Group 1 and 3 had any conjunctival chemosis. These results are significant at 5% level of confidence.

Thus we can conclude that alkalinization alone may lead to significant chemosis when compared with plain lignocaine hydrochloride or with hyaluronidase along with alkalinization.

**Lid Edema**

Edema of the lids following the peribulbar injection was taken note of as this may result in difficulty in opening of the palpebral aperture and consequently a pressure on the eyeball.

In the present study 4 patients in group 2 developed lid edema. One of these patients was postponed due to a tight palpebral aperture. In the other 3 patients surgery proceeded successfully expect that the surgeon faced minimal vitreous thrust. None of the cases in group 1 and 3 had any lid edema.

None of the previous studies have mentioned any lid edema in any of the cases. Srinivasan et al (2000) have reported no anaesthetic adverse effects such as lid edema, chemosis and congestion while comparing the efficacy of sodium bicarbonate with hyaluronidase.

**Post-operative subjective onset of pain**
This a subjective feeling and is assessed by asking the patient at 30 minute intervals for the initial 2 hours following surgery whether he feels pain or not.

None of the patients in any group felt pain so severe as to require supplement analgesia post-operatively which is a routine practice at our institution.

**Systemic Safety Variables**

There was no significant differences in the pulse rate, systolic and diastolic B.P. pre-block and 10 minutes post-block in any of the cases in any group. There was no untoward event during the surgery or post-operative period.