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Fentanyl as an adjuvant to the local anesthetic in the peribulbar block for vitrectomy operations

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ABSTRACT

Background: Adding certain drugs to the local anesthetics (LA) in peribulbar block (PBB) increases its intensity and duration of action, so we did this research to assess the impact of fentanyl addition to the LA in PBB for vitrectomy.

Methods: Forty patients were divided into:

Control group: They got 9.5 ml of 0.5% bupivacaine (6 ml), 2% lidocaine (1.5 ml), 45 IU hyaluronidase (in 1.5 ml lidocaine), and 0.5 ml saline.

Fentanyl group: They got the same medications plus 0.5 ml (25 mcg) of fentanyl instead of the saline.

Our primary outcome was the duration of the block, and our secondary outcomes were the start of the motor block, scores for globe and lid akinesia, the quality of the block, scores for patient and surgeon satisfaction, postoperative VAPS, and the first request for analgesia and complications from the drugs used or the technique.

Results: The start of the motor block was significantly rapid in the fentanyl group. Additionally, there were notable variations in the length and intensity of the block between the two groups. The postoperative pain score was lower in the fentanyl group. While it was acceptable in the control group, the block quality was perfect in the fentanyl group. Complete patient satisfaction happens more often in the fentanyl group. There were no complications reported.

Conclusion: Fentanyl, when added to LA mixtures in PBB in vitrectomy, decreased the onset, increased the duration of lid and globe akinesia, and improved the quality of analgesia without causing any complications.

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1. Introduction

Because of the faster recovery time for the patient and the potential avoidance of side effects associated with general anesthesia, LA has become the alternative of preference for many ophthalmic surgeons (Prineas, 2017) [1].

Retrobulbar block (RBB) is superior to PBB in terms of delivering adequate anesthesia, akinesia, and postoperative analgesia, but it has a greater risk of serious complications, including retrobulbar hemorrhage and globe perforation. PBB has the disadvantage of a slow start of orbital akinesia and the recurring need for block replenishing, but it causes less discomfort, has less toxicity, and lowers the likelihood of optic nerve sheath penetration (Alhassan et al., 2007) [2].

However, posterior segment procedures are time-consuming and may sometimes leave patients in agony. This is most likely due to the traction of the ocular muscles and sclera as a consequence of the gas bubble expansion that caused the increase in intraocular pressure (Fekrat et al., 2001) [3]. Therefore, it becomes essential to choose an anesthetic combination with enough volume for the longest-lasting and most potent effect. To improve the block's quality and lengthen its duration, an adjuvant may be added to LA in PBB (Benedetti and Agostini, 1994) [4].

Adrenaline, sodium bicarbonate, clonidine, ketamine, magnesium sulfate, dexmedetomidine, as well as the addition of hyaluronidase to the LA mixture, have been carried out in order to increase PBB efficiency and accelerate its onset. Additionally, neuromuscular blockers have been shown to improve PBB quality, including vecuronium, atracurium, cis-atracurium, and rocuronium [5–13].

Opioids have an antinociceptive impact on the central and/or spinal cord levels. Activation of peripheral opioid receptors has the potential to activate their antinociception. Peripherally administered opioids provide more effective and long-lasting analgesia with a lower dose of the drugs while avoiding the adverse effects of opioids such as pruritus, nausea, vomiting, and respiratory depression (Stein and Lang 2009) [14]. Several investigations have shown that adding fentanyl to LA in PBB accelerates the start of the block and lengthens its sensory and motor duration (Abo El Enin et al., 2009) [15].

We performed this randomized, blinded, controlled study in patients undergoing vitrectomy surgeries

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under PBB. To determine the effects of adding fentanyl to LA on globe and lid akinesia, quality of PBB, duration of the block, postoperative analgesia, and satisfaction of the patients and the surgeon during the surgery,

2. Patients and methods

This research was carried out at Minia University Hospital between January 2013 and October 2013 after departmental approval. In this research, informed consent was obtained from each patient; then, 40 patients of both sexes between the ages of 40 and 80 years, with ASA physical status classes (I–III), were scheduled prospectively to have vitrectomy procedures owing to vitreous hemorrhage under PBB.

Patients with a history of seizures, coagulation disorders, eye infections, patients whose axial length of the eye exceeded 26 mm, and patients with complicated vitreous hemorrhage, such as retinal detachment, extensive epiretinal membranes, drooping nucleus, were all excluded from the study.

A 10 ml syringe was used to prepare the injected solutions, coded as I and II. These codes were unlocked at the end of the study, and the groups were as follows:

Code I (control group): They got 9.5 ml, which was composed of 0.5% bupivacaine (6 ml), 2% lidocaine (1.5 ml), 45 IU hyaluronidase (in 1.5 ml lidocaine), and 0.5 ml saline.

Code II (fentanyl group): They got 9.5 ml (a combination of 0.5% bupivacaine (6 ml), 2% lidocaine (1.5 ml), 45 IU hyaluronidase (in 1.5 ml lidocaine), and 0.5 ml (25 mcg) fentanyl).

The trial was blinded as neither the patient nor the attending anesthesiologist who performed the block and followed-up patients knew the group allocation. Patients were randomly assigned using a computer-generated table.

2.1. Preoperative assessment and preparation

- A thorough medical background.
- Heart rate, arterial blood pressure, and breathing rate for a general checkup.
- Physical examination of the abdomen, heart, chest, and other systems.
- Regular diagnostic procedures include a full blood count, a liver and renal function test, a blood sugar test, and a chest x-ray.
- Detecting staphyloma, the axial length of the eye, hemorrhage, and retinal detachment using ophthalmic ultrasonography and biometry.

2.2. The anesthetic technique (PBB)

- A cannula for intravenous access was placed. The patient was told to focus their attention on a fixed point of the ceiling while lying on their back.
- Tetracaine eye drops with a 0.5% concentration were used for topical anesthesia.
- A 25 mm long (25 G) needle linked to a 10 ml capacity syringe was used.
- Two injections were administered, the first at the junction of the outer third and the inner two-thirds of the lower orbital rim at the inferotemporal point in the orbital floor (1–1.5 cm medial to the lateral canthus).
- The lower lid was everted, and the eye was in the neutral position, then the 25 G needle was introduced by the perconjunctival route.
- The needle was aimed toward the bottom of the orbit. The globe was gently lifted superiorly during insertion using the non-dominant hand index and middle finger in an attempt to push the globe away from the needle. Additionally, this pressure was intended to force the injectate back behind the globe. Following a gentle negative aspiration, 5 ml of the LA solution were given.
- The second injection was performed at a 45° angle between the caruncle and medial canthus until the needle's tip touched the ethmoid bone. At that point, the needle shifted to a 90° angle with the hub at the level of the iris, the remaining 4.5 ml was injected.
- Then, to lower the intraocular pressure, help the anesthetic solution spread, and cause akinesia of the extraocular muscles, the globe is softened intermittently with intermittent digital pressure.

*Signs of a successful block were

(1) Ptosis (drooping of the upper lid with the inability to open the eye).
(2) There is little to no eye movement in any direction (akinesia).
(3) Inability to fully shut the eye once it has opened.

2.3. Parameters assessed

2.3.1. Primary outcome

2.3.1.1. Duration of the motor block (akinesia).

From the time of local anesthetic injection until the block completely recovered. It was measured every 30 min until full recovery from the block.

2.3.2. Secondary outcomes

2.3.2.1. Onset and intensity of the motor block (akinesia).

The patient was instructed to look medially, laterally, superiorly, and inferiorly to assess ocular akinesia. Lid akinesia was assessed by measuring the orbicularis oculi muscle's strength. They were assessed every 2 min until 10 min after the injection.

*Ocular akinesia was assessed using a scoring system for the motion range of the extra-ocular muscles after the block (Akinesia score) [16].

0 = Total akinesia which means no movement (0–1 mm motion in one to two main directions).
1 = Relative akinesia means slight movement (1 mm motion in each of the main directions or 2 mm motion in two of the main directions).
2 = No akinesia which means full movement (2 mm motion range in each of the main directions or more than 2 mm motion in two main directions).

2.3.3. While akinesia of the orbicularis muscle was assessed as follows

0 = Complete akinesia
1 = Partial movement in one or both margins of the eyelid.
2 = Normal movement in one or both margins of the eyelid.

2.3.3.1. Surgeon satisfaction score. Once the surgery was completed, the surgeon was questioned about the quality of the block. The score was from 0 to 2 as the following:
0 = Unsuccessful (Failed to work).
1 = Acceptable (Block is incomplete but surgery could proceed).
2 = Perfect (Effective block).

2.3.3.2. Patient satisfaction score. It was assessed by asking the patient at the end of the surgery it was as follows.
1 = Complete dissatisfaction.
2 = Some dissatisfaction.
3 = Complete satisfaction.

2.3.3.3. Hemodynamics and oxygen saturation. Heart rate (beat/min), mean arterial blood pressure (mmHg), and oxygen saturation were monitored throughout the study period. They were recorded before and after the block every 10 min till the end of the operation.

2.3.3.4. Duration of the surgery.
2.3.3.4.1. Postoperative pain. The Visual Analogue Pain Scale (VAPS) [17] was used to evaluate the level of pain felt postoperatively. The VAPS consists of a straight, vertical 10-cm line; where (0 cm) represents "no pain" and (10 cm) represents "worst pain" imaginable. It was used to measure pain every hour up to 6 h postoperatively. Patients received first dose of analgesia if VAPS was ≥4 in the form of a nonsteroidal injection (ketorolac 30 mg) IV.

The time from the end of surgery to first request for postoperative analgesia was recorded.

2.3.3.5. Complications occurred related to the drugs used or the technique was recorded. 1 – Inadvertent brain stem anesthesia: The patient may suffer aphasia, disorientation, unconsciousness, hemiplegia, convulsions, and cardiac or respiratory arrest a few minutes following the injection.

2 – Retrobulbar hemorrhage: The cause is an inadvertent puncture of the blood vessels in the retrobulbar region. Complete motor block of the globe, proptosis, a drooping upper lid, and an elevated IOP appear all at the same time. The bleeding may progress anteriorly, causing subconjunctival blood and ecchymosis of the eyelids.

3 – Puncture of the globe: As soon as the perforation has occurred, the patient will have immediate ocular pain and become restless. Retinal detachment and hemorrhage are possible complications.

4 – Muscle complications such as injury to extraocular muscles.

5 – Visual complications such as diplopia and blindness.

6 – Oculocardiac reflex.

7 – Intravascular injection and anaphylaxis.

2.4. Statistical analysis

Utilizing the SPSS program (Statistical Package for Social Sciences) software version 20, the obtained data were entered, tabulated, and statistically evaluated. For numerical data, the mean and standard deviation were used, and for categorical data, the number and percentage were used.

When analyzing quantitative data that was regularly distributed between the two groups, the Independent Sample T Test was used. When analyzing data that was abnormally distributed between the two groups, the Mann-Whitney U test was used. The Chi-square test was used to compare qualitative data between groups.

P values equal to or under 0.050 were regarded as significant.

3. Results

Age, sex distribution, ASA categorization, and operative time comparison between the two groups revealed statistically insignificant findings as in (Table 1).

3.1. Operative data

3.1.1. The onset of motor block

When compared to the control group, the fentanyl group's motor block started much more quickly. Because the fentanyl group's mean was 2.7 ± 1.38 min, but the control group's mean was 5.15 ± 1.6 min, with a P value of 0.001 (Figure 1).

3.1.2. The intensity of the block (globe and lid akinesia)

Using an akinesia scoring system for the globe and eyelids, the ocular movement was evaluated in the

Table 1. Patients' characteristics in the two groups.

Variables	Control group	Fentanyl group	*P*-value
Age: (years)	58.25 ± 9	55.15 ± 8.69	0.275
Sex:	8 (40%)	10 (50%)	0.752
Male.	12 (60%)	10 (50%)	
Female.			
ASA classification	0 (0%)	5 (25%)	0.081
Class I.	17 (85%)	12 (60%)	
Class II.	3 (15%)	3 (15%)	
Class III.			
Operative time (min)	63.25 ± 13.6	71.25 ± 15.38	0.089

Data are presented as means, standard deviations, numbers, and percentages. Comparing quantitative data between the two groups using an independent sample t-test. The Chi-square test was used for Sex and ASA.

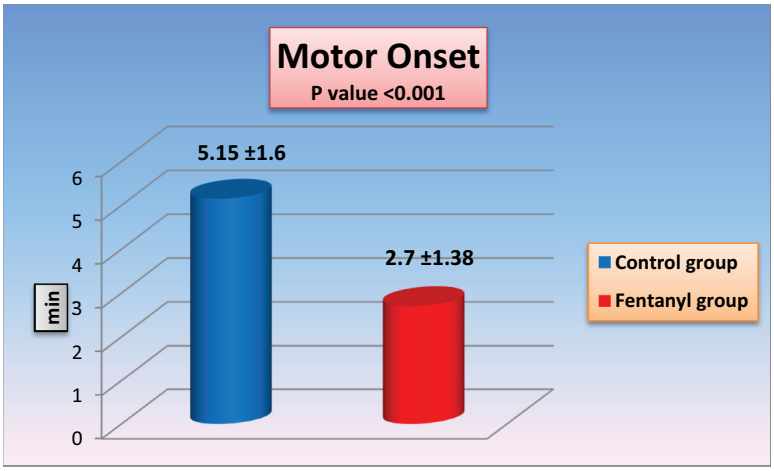

Figure 1. Motor onset in the two groups.

two groups 2, 4, 6, 8, and 10 min after injection of the anesthetic combination.

3.1.2.1. Globe akinesia. The fentanyl group reached a score of 0 more rapidly significantly than in control group as the following:

In the fentanyl group: 13 patients (65%) reached a score of 0 (complete akinesia) after 2 min,15 patients (75%) after 4 min,18 (90%) patients after 6 min, and all the patients reached a score of 0 after 8 min.

In the control group, only 2 patients (10%) reached a score of 0 after 2 min, 4 patients (20%) after 4 min, 7 patients (35%) after 6 and 8 min and after 10 min 13 patients (65%) reached score 0, while the remaining 7 patients still have score 1. These data are illustrated in (Table 2).

3.1.2.2. Lid akinesia. The fentanyl group reaches the score 0 more rapidly than the control group significantly but more delayed than the globe akinesia.

In the fentanyl group: More than half of patients (55%) reach complete akinesia in the first 2 min. The percentage increased to reach 70% of patients after 4 min, 80%, and 90% at 6 and 8 min, and all patients reach complete akinesia after 10 min.

Only 5% of patients in the control group had full akinesia during the first 2 min. This number then rose to 10% at 4 min, 25% at 6 min, 35% at 8 min, and only 50% at 10 min.

Therefore, the fentanyl group and the control group had substantial differences according to our findings. These numbers are shown in (Table 3).

Table 2. Globe akinesia score in the two groups.

Globe akinesia score	Control group	Fentanyl group	*P*-value
After 2 min:	2 (10%)	13 (65%)	<0.001
0	2 (10%)	4 (20%)	
1	16 (80%)	3 (15%)	
2			
After 4 min:	4 (20%)	15 (75%)	<0.001
0	3 (15%)	3 (15%)	
1	13 (65%)	2 (10%)	
2			
After 6 min:	7 (35%)	18 (90%)	<0.001
0	2 (10%)	2 (10%)	
1	11 (55%)	0 (0%)	
2			
After 8 min:	7 (35%)	20 (100%)	<0.001
0	9 (45%)	0 (0%)	
1	4 (20%)	0 (0%)	
2			
After 10 min:	13 (65%)	20 (100%)	0.004
0	7 (35%)	0 (0%)	
1	0 (0%)	0 (0%)	
2			

Score 0 = total akinesia. Score 1 = relative akinesia. Score 2 = no akinesia. Data are expressed as numbers and percentages. Mann-Whitney test was used.

Table 3. Lid akinesia score in the two groups.

Lid akinesia score	Control group	Fentanyl group	*P*-value
After 2 min:	1 (5%)	11 (55%)	<0.001
0	1 (5%)	6 (30%)	
1	18 (90%)	3 (15%)	
2			
After 4 min	2 (10%)	14 (70%)	<0.001
0	3 (15%)	4 (20%)	
1	15 (75%)	2 (10%)	
2			
After 6 min:	5 (25%)	16 (80%)	<0.001
0	2 (10%)	3 (15%)	
1	13 (65%)	1 (5%)	
2			
After 8 min:	7 (35%)	18 (90%)	0.002
0	6 (30%)	1 (5%)	
1	7 (35%)	1 (5%)	
2			
After 10 min:	10 (50%)	20 (100%)	0.014
0	5 (25%)	0 (0%)	
1	5 (25%)	0 (0%)	
2			

Score 0 = total akinesia. Score 1 = relative akinesia. Score 2 = no akinesia. Data are expressed as numbers and percentages. Mann-Whitney test was used.

3.2. Postoperative data

3.2.1. The duration of the block (primary outcome)

There were statistically significant differences between the two groups, as shown by the longer time in the fentanyl group (3.38 ± 0.78 h) compared to the control group (2.25 ± 0.44 h), as demonstrated in (Figure 2).

3.2.2. The time of the first analgesic request

The time of first analgesic request was significantly longer in the fentanyl group than the control group as its mean was 3.45 ± 0.68 h in the fentanyl group while in the control group; it was 1.85 ± 0.67 h with a P value <0.001 as shown in Figure 3.

3.2.3. Postoperative VAPS (visual analogue pain score)

Statistically significant differences were evident between both groups as regards the median VAPS at

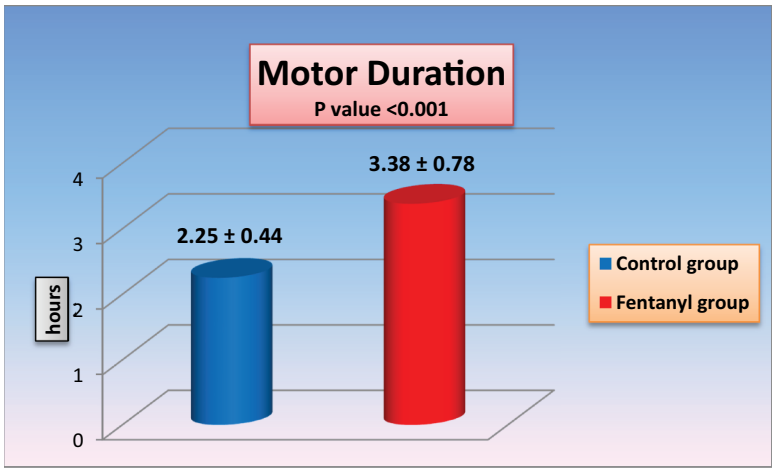

Figure 2. Motor duration in the two groups.

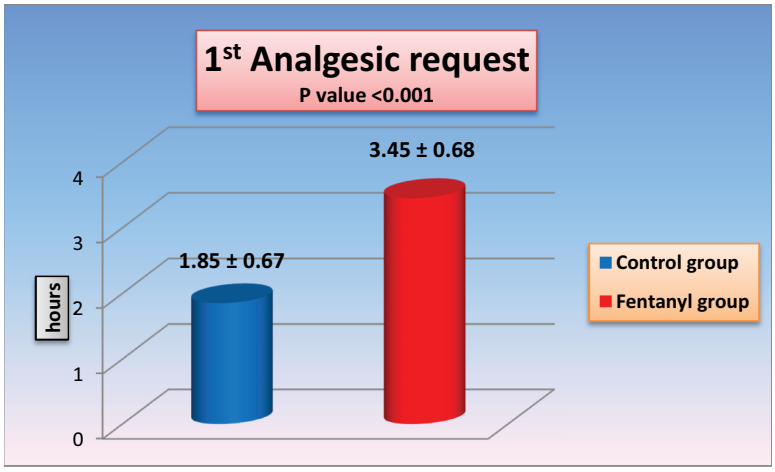

Figure 3. The first analgesic request in the two groups.

Table 4. Visual Analogue Pain Scale in the two groups.

	Control group	Fentanyl group	*P*-value
Vas 1 h:	2.7 ± 1.03	0.4 ± 0.59	<0.001
Vas 2 h:	3.15 ± 1.92	1.75 ± 1.06	0.011
Vas 3 h	1.1 ± 1.8	3.95 ± 1.31	<0.001
Vas 4 h	0.75 ± 0.64	1.85 ± 2.51	0.759
Vas 5 h	1.25 ± 0.79	0.85 ± 1.39	0.023
Vas 6 h	1.65 ± 0.75	0.55 ± 0.67	<0.001

Data are expressed as mean ± standard deviations. Mann-Whitney test was used.

1, 2, 3, 5, and 6 h postoperatively. The fentanyl group had a lower median pain score than the control group. Postoperative analgesia was given in both groups when VAPS ≥ 4 as shown in (Table 4).

3.2.3.1. Quality of the block. After the procedure, the surgeon was questioned about the PBB's quality. Figure 4 illustrates the considerable difference between the two groups, with the fentanyl group's block being perfect in 85% of the patients and acceptable in 15% of the patients, and the control group's block being perfect in 40% of the patients and acceptable in 60% of the patients.

3.2.3.2. Patient satisfaction score. The patient was questioned after surgery to determine the patient satisfaction score. In the fentanyl group, 85% of patients reported total satisfaction, while 15% of patients reported some level of dissatisfaction. In the control group, 40% of patients reported total satisfaction, while 60% reported some level of dissatisfaction. Figure 5 illustrates the substantial difference between the two groups that was discovered by comparing them, with a P value of 0.003.

3.2.3.3. Complications related to the drugs used or the technique. No complications were detected in all cases.

4. Discussion

PBB is a safer block, but the la must be spread from extraconal to intraconal to deliver the proper anesthesia and akinesia of the globe. As a result, additional injections or high volume may be necessary. The posterior segment surgeries are lengthy, and the pain after surgery may sometimes be quite bad. Therefore, during vitrectomy surgeries, we must increase the

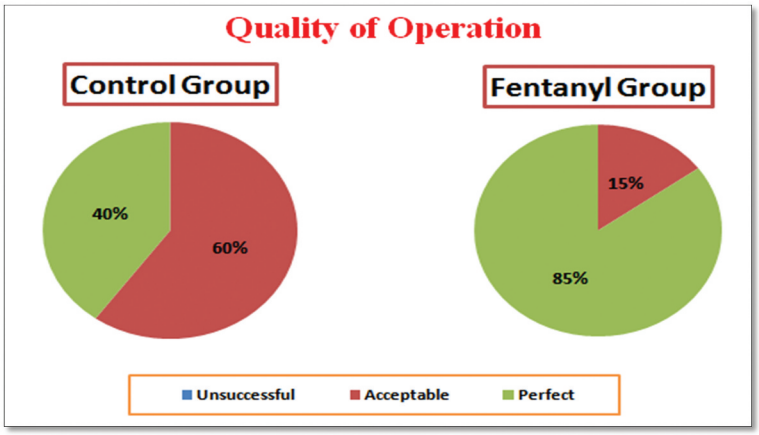

Figure 4. Quality of operation (block) in the two groups.

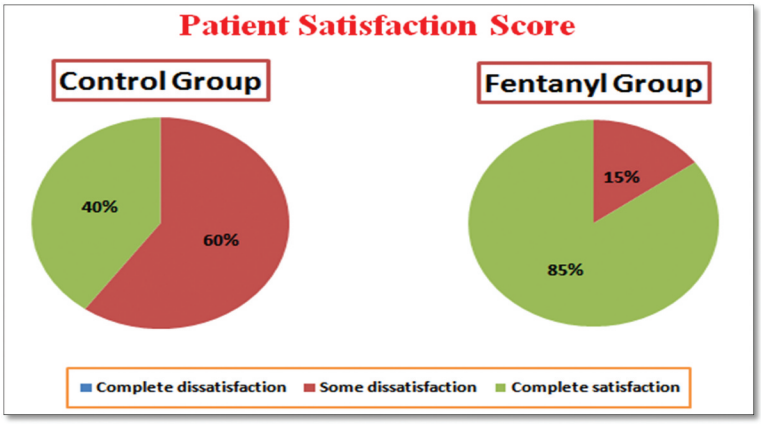

Figure 5. Patient satisfaction score in the two groups.

intensity of the block, lengthen its duration, and offer postoperative analgesia (Ripart et al., 2001) [18].

To accomplish the above goals in our investigation, double injection for PBB via the medial and inferotemporal routes was performed with 9.5 ml of the anesthetic combination, which included 6 ml of bupivacaine 0.5% and 1.5 ml of lidocaine 2% plus 45 IU of hyaluronidase (in 1.5 ml of lidocaine) and 25 mcg of fentanyl were also added.

In this study, two injections were given in the medial and inferotemporal regions using a transconjunctival anesthetic technique. PBB performed using both medial and inferotemporal approaches offers the best exposure of LA to the tissue compartments enclosing the superior, inferior, and medial muscle groups as well as the orbital apex, despite the medialmedial route having been described as a safe and effective first-line treatment for PBB.

The perconjunctival method of administering PBB may have the advantage of lowering the risk of infection (due to the closed space as opposed to percutaneous injection), reducing the risk of skin hematoma and topical anesthetic implemented to the conjunctival sac reduces the discomfort with injection as the needle passes through the mucous membrane, further enhancing patient satisfaction, according to Lindsay and Christopher (2013) [19], who investigated this method. In Lindsay and Christopher's investigation, LA (5 mL lignocaine 2%, 5 mL ropivacaine 1%, and 10–15 U in 1 mL of hyaluronidase) was injected inferotemporal through the perconjunctival channel using a 25-gauge, 25 mm bevel needle. LA solution was gently and gradually administered until the upper lid drop occurs till covering the cornea; if the anesthetic was not powerful enough after 5 min, 5 mL more was injected medially to the caruncle.

Van den Berg's 2005 [20] study also concluded that PBB using the combination of inferotemporal and medial percaruncular (inferior-medial) injections produced faster ocular akinesia with less need for supplementation, but less effective lid akinesia when especially in comparison to the combination of inferotemporal and superonasal (inferior-superior) techniques.

In contrast to our results, Ghali and Hafez (2010) [21] conducted a study that contrasted the double-injection PBB method with single-injection percutaneous methods employing a small needle for cataract extraction. In the single-injection group, patients received a percutaneous injection of 5–7 mL of the LA solution in the same line with the inferior lacrimal canaliculus in the inferior orbital border. In the group that got two injections, 4 mL of LA was percutaneously injected at the junction of the medial and lateral two-thirds of the lower orbital border and 4 mL was additionally percutaneously administered lateral to the supratrochlear notch. The single-lateral injection approach offers the advantages of being easier to conduct with less pain, using a lesser volume of anesthetic, and only requiring a single puncture rather than multiple punctures. The researchers concluded that the single-injection approach for percutaneous PBB with a small needle is an appropriate alternative to the double-injection technique of PBB for cataract extraction since both provide equivalent sufficient akinesia.

Additionally, Singh et al. (2008) [22] found that single-injection PBB is just as efficient as the conventional double-injection method.

To boost the strength of the block in the event of a vitrectomy surgery, which is more time-consuming and painful than cataract procedures, we employed a double injection in our trial.

In PBB studies, a variety of anesthetic volumes have been used. The efficacy of the block in a particular patient may be evaluated using a whole upper eyelid drop, and it has been shown that the anesthetic volume has no impact on the akinesia score. By increasing the anesthetic volume until a full drooping of the top eyelid occurs, the block success of each patient may be evaluated. According to Frow et al. (2000) [23], this titration until the total upper eyelid drop may reduce the risks associated with excessive volume injection while guaranteeing the injection of the proper quantities to cause akinesia.

We utilized a volume of (9.5 ml) anesthetic combination in our investigation, since Ripart et al. (2001) [18] mentioned that LA injected into the extraconal region must travel a great distance before it reaches the cone and affects the neurons responsible for the eye's motor, sensory, and autonomic innervation. Additionally, the risk that inadequate retinal perfusion or ischemia compression of the optic nerve would arise from high intraocular pressure after the block is decreased by globe compression post-block and the injection of hyaluronidase, both of which help in the diffusion of LA.

Other different LA combinations may be used for PBB; however, in the present investigation, we chose an LA solution that included different amounts of the LA bupivacaine (0.5%) and lidocaine (2%) (2:1).

One of lidocaine benefits is that it takes effect quickly, but because of its significant neurotoxicity and intermediate duration of action, it can only be used for brief procedures (Felfernig et al., 2010) [24]. The most often used long-acting LA is bupivacaine. It has many benefits, such as prolonged surgical anesthetic and significant postoperative analgesia (Misiolek et al., 2005) [25].

In vitreoretinal surgery, where appropriate akinesia is a medical need and a higher incidence of postoperative pain is often linked, bupivacaine has been recommended to give more effective and long-lasting analgesia than ropivacaine (Casati et al., 2002) [26]. As

a result, in our study, we mixed a smaller dose of lidocaine for a rapid onset with a larger volume of bupivacaine for a sustained impact.

Previous research has shown that adding hyaluronidase to the LA combination had a considerable positive impact. First, it improves the pH of the LA mixture, producing a good pH/pKa ratio that decreases the onset time for anesthetic action and increases the effectiveness of PBB. Additionally, by hydrolyzing the connection between glucosamine and glucuronic acid, it enhances the dissemination and dispersion of the LA combination. It also helps the LA mixture disperse properly throughout the orbit to prevent proptosis and the rise in intraocular tension that can lead to vitreous loss intraoperative. These effects increase akinesia, hasten the onset of surgical anesthesia, and reduce the need for additional injections (Kallio et al., 2000) [27].

To prolong the effects of LA, it is now routine practice to use various drugs as adjuvants. Clinical investigations show that adjuvants improve the quality of the block and speed the onset of akinesia. The synthetic opioid fentanyl showed its efficacy in combination with bupivacaine.

In our study, we used fentanyl as an adjuvant to LA in PBB in vitrectomy procedures and we found that it has the following effects: it accelerates the onset of motor block, prolongs its duration, improves its quality, and decreases the postoperative pain score and analgesic request.

Potential mechanisms of action for the improved analgesia brought on by the peripheral injection of fentanyl include the following:

First, direct fentanyl activity may occur at the peripheral opioid receptor. Opioid-binding sites have been found in the dorsal roots of primary afferent tissues. Because opioid-binding protein is capable of bidirectional axonal transport, fentanyl could be able to cross the neuronal membrane and act at the dorsal horn. This might be the reason why analgesia lasts long (Nishikawa et al., 2000) [28]. This hypothesis is supported by the research done by Moshourab and Stein in 2012 [29] which demonstrates how the opioid receptor agonist "fentanyl" affects the mechanical coding properties of both C- and A-fiber nociceptors and how this modulation becomes more apparent in chronic inflammation.

Second, via central opioid receptor-mediated analgesia, peripheral fentanyl absorption into the systemic circulation may intensify the LA effect (Tverskoy et al., 1998) [30].

Synergistic interaction between LA and opioids has been seen as each of them has different mechanisms through which they function. While opioids work on the opioid receptors to increase potassium conductance, LA works specifically on sodium channels to stop the propagation and generation of neuronal action potentials (Li et al., 1995) [31].

Abdelkhalik et al., 2017 [7] examined the effects of adding either ketamine or fentanyl to LA in a single injection PBB on the quality of the block in their investigation. Ninety adult patients slated for vitreoretinal surgery were randomly assigned to one of the three groups. All patients underwent PBB using an LA mixture of 4 ml of lidocaine 2%–containing hyaluronidase and 5 ml of bupivacaine at a concentration of 0.5%, with either 1 ml of saline serving as a control, 30 mcg of fentanyl, or 25 mg of ketamine added in the fentanyl group and the ketamine group, respectively. They found that as compared to the control group, administering either fentanyl or ketamine as an LA adjuvant dramatically speed up the onset of anesthesia, prolonged the duration of lid akinesia, increased the duration of globe akinesia, and lengthened the time for the first request of postoperative analgesia.

The findings of the Nehra et al. (2017) [8] study, which examined the effects of adding fentanyl and clonidine as adjuvants to bupivacaine and lidocaine in the PBB, confirmed our research. A total of 105 adults are having eye operations. The patients were placed into three groups of 35 each at random. PBB with 5 ml lidocaine 2% + 3 ml bupivacaine 0.5% + 1 ml hyaluronidase (250 IU) was administered to all of the patients. In addition, 1 ml of ordinary saline, 25 mcg of fentanyl, and 25 mcg of clonidine were given to the control group, fentanyl group, and clonidine group, respectively. They said that the mean time of the start of globe and lid akinesia occurred substantially more quickly in the fentanyl and clonidine groups as compared to the control group, and the mean duration of globe and lid akinesia in the fentanyl and clonidine groups was also significantly longer. In comparison to the control group, the fentanyl and clonidine groups' mean analgesia duration was much longer.

The effects of administering either fentanyl or magnesium sulfate to PBB in patients for cataract surgery on the quality of globe akinesia were also contrasted in Abu Elyazed & Mostafa's 2017 [9] research. Three groups of 90 adult cataract surgery patients were chosen at random. In the control group, the PBB was carried out using a solution of 4 ml lidocaine 2%, 4 ml bupivacaine 0.5%, and 150 IU hyaluronidase diluted in normal saline to a total volume of 10 ml. The identical combination was received with the addition of 20 mcg of fentanyl and 50 mg of magnesium sulfate (10%) in the fentanyl and magnesium groups, respectively. When compared to the control and magnesium sulfate groups, in the fentanyl group, the onset of lid and globe akinesia was significantly rapid. However, the comparison between the control and magnesium sulfate groups was statistically insignificant. When compared to the control group, the time before the first analgesic request was made was considerably longer in the fentanyl and magnesium sulfate groups.

Additionally, the findings of Abo El Enin et al., 2009 [15] confirmed our findings. They randomly split the 40 ASA I and II patients having vitrectomy into two groups. Group 1 was given a mixture of Mepivacaine, Bupivacaine, and Hyaluronidase 150-mcg; group 2 was given the same combination plus 20 mcg of fentanyl. The findings reveal that the lid and globe akinesia in the fentanyl group started more quickly, and it lasted much longer overall. Compared to the control group, the fentanyl group's analgesia lasted longer. The median VAPS at 1, 2, 3, and 4 h was lower in the fentanyl group than it was in the control group.

5. Conclusion

Fentanyl accelerated the onset and prolonged the lid and globe akinesia in PBB, which improved the analgesic quality during vitreoretinal surgery without causing any complications.

5.1. Limitations of the study

In our study, we choose the fentanyl dose that was used in previous studies but future studies must be done in different doses of fentanyl to reach what is the ideal dose that can give the best result. Also, further studies must be done to compare the addition of different adjuvants to LA to reach what are the best adjuvants that can be added to LA in PBB for vitrectomy.

Disclosure statement

No potential conflict of interest was reported by the authors.

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