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Original article

Comparative Study between Greater Palatine Canal Injection by Epinephrine and Conventional Method on Intraoperative Bleeding during Endoscopic Sinus Surgery

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Abstract:

Aim: This study aimed to compare between the effectiveness among GPC injection by epinephrine and conventional method of lateral nasal wall injection by epinephrine in reducing surgical field bleeding and decreasing surgical time under hypotensive general anaesthesia during ESS. **Patients and methods:** After ethical approval, this comparative, prospective double blinded randomized controlled trial was done in Otorhinolaryngology department in Beni-Suef University from October 2019 to April 2021 on patients diagnosed with bilateral CRS or bilateral sinonasal polyposis unresponsive to medical treatment hospital to undergo endoscopic sinus surgery. The study included 40 patients Group (A) underwent Conventional injection and Group (B) GPC injection (opposite side).

Results: The total amount of blood was significantly higher among group (A) than group (B) subjects with mean (190.9 ± 44.5) ml versus (117.33 ± 26.4) ml respectively, (P-value 0.001). Surgical time was significantly more among group (A) than group (B) with a mean equal to (54.88 ± 7.7) minutes versus (35.78 ± 4.47) minutes respectively, (P-value 0.001). Bleeding grade was significantly higher among group (A) than group (B). SBP and DBP was lower among group (B) than group (A) at t 15, 30, 45 minutes. **Conclusion:** No hemodynamic instability and no serious complications were observed with this simple technique of GPC injection method. Based on these current findings, GPC injection is efficient, safe and simple proposed approach along with hypotensive general anaesthesia for optimizing surgical field, reducing intraoperative bleeding, operative time and increasing surgeon satisfaction during ESS.

1. Introduction:

When operating in the restricted space of the ESS, bleeding is a common consequence in rhinological procedures. There is a lot of blood in the nasal cavity, and this stage of the operation is halted by it. Blood obscures the surgeon's view, raises the risk of complications, lengthens the operation, and may even cause the procedure to be abandoned halfway through [(1)].

When medicinal treatment fails to alleviate symptoms of chronic rhinosinusitis (CRS) or sinonasal polyposis, endoscopic sinus surgery (ESS) is the best option. In order to avoid serious consequences such orbital penetration, optic nerve injury, extraocular muscle damage, skull base injury, and cerebral injury, controlling the bleeding is of paramount importance during this treatment. Reduced surgical vision increases the risk of injury to normal mucosa. These mucosal injuries may cause postoperative synechiae to form. As a result, this may lead to issues like sinus ostia occlusion [(2)].

In nasal procedures, doctors choose a spot where blood won't pool. Several methods, including topical vasoconstrictors, the reverse Trendelenburg position, the use of steroids, premedication with beta-blockers, intravenous anesthetic, and sodium

nitroprusside, have been used by surgeons in the pursuit of this aim. Despite the surgeons' best efforts, some patients still lose a substantial amount of blood during ESS despite the use of these techniques [3].

Injecting epinephrine through the greater palatine canal (GPC) causes vasoconstriction of the third portion of the maxillary artery that passes throughout the pterygopalatine fossa (PPF), which in turn reduces the amount of blood that flows into the sphenopalatine artery, the main vessel of the nasal cavity, via the sphenopalatine foramen (SPF). As a result, the nasal cavity's mucosal blood flow decreases [4].

The greater palatine foramen (GPF) on the hard palate was used as a reference point for injecting the GPC with the epinephrine. GPF is positioned anterior to the tuberosity of the maxilla, postero-medial to the third maxillary molar tooth, and antero-medial to the pterygoid hamulus and maxillary tuberosity. The greater palatine foramen has caused a downturn [5]. The aim of this study was comparing the effectiveness among GPC injection by epinephrine and conventional method of lateral nasal wall injection by epinephrine in reducing surgical field bleeding and decreasing surgical time under hypotensive general anaesthesia during ESS.

2. Patients and Method:

This is a comparative, prospective double blinded randomized controlled trial. The study was done in Otorhinolaryngology department in Beni-Suef University from October 2019 to April 2021 on patients diagnosed with bilateral CRS or bilateral sinonasal polyposis unresponsive to medical treatment hospital to undergo endoscopic sinus surgery.

Inclusion criteria:

patients diagnosed with symmetrical bilateral CRS or bilateral sinonasal polyposis, unresponsive to medical treatment, aged 18 years or more in both genders were included in the study.

Exclusion criteria:

patients younger than 18 years, patients with unilateral disease, patients with asymmetry in the disease severity between left and right sides as detected by preoperative CT, patients with uncontrolled severe systemic illness as hypertension, coronary artery disease, arrhythmias, diabetes mellitus and hyperthyroidism, patients who have uncontrolled bleeding disorders.

Sample size and technique:

The sample size was determined using the G power algorithm. The statistical analysis compared the disparity between two independent means (the two groups) using a two-tailed t test. This was an A priori power analysis. The sample size with confidence level 95 percent and power 80 percent was done. With a total sample size of 80, this research divided its participants

evenly between two groups of 40 people: those who received conventional treatment (group (A)) and those who received GPC injection (group (B)). Inclusion and exclusion criteria were used to choose patients.

In this research, epinephrine was injected into the lateral nasal wall of just one side of the nose (group A) and into the GPC (group B) in the other side of the same patient to compare intraoperative hemorrhage and operational time during ESS. The surgeon performing the operation and the primary researcher scoring the operative area were both unaware of the laterality. A different surgeon who was not involved in the operation or the evaluation of blood loss administered the injection.

Preoperative assessment:

Full history regarding chronic rhinosinusitis., nasal polyps and systemic diseases and complete Otorhinolaryngology examination, routine investigations involving electrocardiography for patients above 40 years old, coagulation profile, complete blood count, blood glucose level, liver and renal function tests were performed. Sinus and nasal cavity CT scan. Using the CT grading system developed by Lund and Mackay (1993), we were able to determine whether or not the sinuses were fully clear (score 0), somewhat opaque (score 1), or completely opaque (score 2) on both sides, and whether or not the osteomeatal complex was obstructive (score 2). Symmetric disease was defined as a difference of 3 points or less between the two sides, therefore patients with such conditions were included in the research [(6)].

Data collection methods and tools:

Every 15 minutes of work after injection, the surgical field was evaluated for bleeding according to the Boezaart et al., 1995 scale for endoscopic grading of intraoperative bleeding, and the results were compared between the two sides [(7)]. According to Al Kadri et al., 2011 using sensitive electronic scale, the amount of blood loss in milliliters in packs used on each side was determined by subtracting the weight of dry packs from the weight of these packs after using them [(8)].

Each side's blood loss was recorded in the suction jar separately by deducting the quantity of fluid needed for washing from the total collection. The net blood loss (ml) was calculated as the sum of blood amount in packs plus the calculated blood from jar. We monitored the blood pressure and heart rate were monitored every 15 minutes on each side. Both sides of the operation were timed independently. The degree of surgeons' happiness was measured using the Seven-point Likert scale developed in 1932 [(9)].

Ethical consideration:

The study was explained to participants. An informed consent was taken from participants. The protocol was approved by the ethical committee of Beni-Suef University faculty of medicine No.FMBSUREC/03092019/Kaleny.

Surgical technique:

The procedure was performed using a 4 mm diameter, 0 and 30 degrees Karl storz nasal endoscope under hypotensive general anesthesia. Group A received the standard treatment of injecting 2 ml of epinephrine 1:200,000 into the submucosa of the lateral nasal wall at the anterior end of the middle turbinate. The surgical area was then evaluated.

Group B (the opposite side) received a Greater palatine canal (GPC) injection to stem the flow of blood during surgery, and the bleeding area was evaluated. By using a mouth gag, we were able to examine the hard palate and locate the greater palatine foramen (GPF) depression was positioned anterior to the tuberosity of the maxilla, postero-medial to the third maxillary molar tooth, and antero-medial to the pterygoid hamulus and maxillary tuberosity. The 25-gauge needle of a sterile syringe with 2 ml of 1:200.000 epinephrine was inserted. About 25 mm from the tip, the needle was curved at an angle of 45 degrees. On one side, the syringe was inserted posterosuperiorly through the GPF and GPC till the curved needle tip. Aspiration was negative; therefore, an injection was performed.

There was no danger to the maxillary artery or the infraorbital nerve from overpenetration of the needle into the PPF since it could be bent to accommodate the angle formed by the GPC relative to the axis of the hard palate. An ESS was performed, which included an uncinectomy, middle meatal antrostomy, anterior ethmoidectomy, posterior ethmoidectomy, frontal sinusotomy, and sphenoidotomy if necessary.

Statistical analysis:

Statistical Package for the Social Sciences (SPSS) version 22 was used for coding, entering, and analyzing the data. The frequency distribution was used to illustrate the qualitative data. The average and standard deviation of the numbers were included for clarity. Quantitative factors were compared using the Mann-Whitney U test. Chi-square analysis was performed to compare qualitative information. The relationship between the quantitative variables was investigated using a correlation test. All tests were significant if their p-value was less than 0.05.

3. Results:

Data was collected from (40) patients who entered our hospital of Bni-Suef university and were diagnosed with persistent CRS or bilateral sinonasal polyposis with their needing to undergo ESS. Every patient had one side injected by epinephrine via conventional method of lateral nasal wall injection (group A) and the other side was injected by epinephrine via GPC approach (group B). Age of patients ranged from (30-60) years, mean of age is (42.45± 7.1) years. About (72.5%) of subjects were males. Most of study group patients (80%) who underwent surgery, had symmetrical bilateral sinonasal polyposis and (20%) had bilateral chronic rhinosinusitis. The activity of the disease of bilateral sides was assessed with Lund and Mackay, 1993 (6) CT scoring. There was no statistically significant difference regarding this scoring with P-value 0.910, illustrating the presence of almost similar diseases on both sides.

The total amount of blood was significantly higher among group (A) than group (B) subjects with mean **(**190.9 ± 44.5) ml versus (117.33 ± 26.4) ml respectively, (P-value 0.001). Surgical time was significantly more among group (A) than group (B) with a mean equal to (54.88 ± 7.7) minutes versus (35.78 ± 4.47) minutes respectively, (P-value 0.001) (Table 1)

Table (1): Summation of total blood in ml and the intraoperative time in both conventional and GPC injection:

Outcomes (Mean± SD)	Group(A) Conventional injection (no=40)	Group(B) GPC injection (no=40)	P value
Total amount of blood	190.9 ± 44.5	117.33 ± 26.4	0.001*
Intraoperative time	54.88 ± 7.7	35.78 ± 4.47	0.001 *

Bleeding grade was significantly higher among group (A) than group (B) at 15, 30 minutes. In group (A) means of bleeding grade were (2.63 ± 0.49), (3.13 ± 0.33) respectively at 15, 30 minutes while the means of group (B) were (2.05 ± 0.22), (2.08 ± 0.27) respectively. P-value was 0.001 at 15, 30 minutes showing statistically significant in difference of mean bleeding grade among both sides, with significantly better mean bleeding grade in group (B) at 15, 30 minutes. The mean bleeding grade was better in group (B) (3.33 ± 0.58) than in group (A) (3.45 ± 0.5) at 45 minutes with no significant difference (P-value 0.71). The overall average of bleeding grade in group (A) was (3.1 ± 0.57) and it was (2.12 ± 0.36) in group (B). The difference among both

sides was statistically significant with P-value 0.001, illustrating better overall bleeding grade mean in group (B) than in group (A) (Table 2).

Table (2): Bleeding grade according to Boezaart et al., 1995 [7] scale (surgical field's quality) and the overall bleeding grade in both groups:

Bleeding grade	Group	Mean	SD	Median	P-value
15 min.	**(A)** **(B)**	2.63 2.05	0.49 0.22	3 2	0.001*
30 min.	**(A)** **(B)**	3.13 2.08	0.33 0.27	3 2	0.001*
45 min.	**(A)** **(B)**	3.45 3.33	0.5 0.58	3 3	0.71
60 min.	**(A)** **(B)**	3.63 ---	0.5 ---	4 ---	-----
Boezaart grading	**(A)** **(B)**	3.1 2.12	0.57 0.36	3 2	0.001

Regarding the Likert scale of surgeon satisfaction, it illustrated that high proportion of category group (A) (67.5%) had dissatisfied surgeon opinion. In contrast, the majority of group (B) (72.5%) had satisfied surgeon opinion (Table 3).

Table (3): Likert scale regarding surgeon satisfaction.

Surgeon satisfaction	Group(A) (no=40)	Group(B) (no=40)	Significance
Dissatisfied	27(67.5%)	-	**χ2**=49.15
Somewhat Dissatisfied	2 (5%)	2(5%)	
Neither satisfied or dissatisfied	7 (17.5%)	1 (2.5%)	**P**=0.001*
Somewhat satisfied	4(10%)	2(5%)	
Satisfied	-	29 (72.5%)	
Very satisfied	-	6 (15%)	

χ2=Chi-square test was used

A significant difference was found regarding systolic blood pressure (SBP) among groups of study. SBP was lower among group (B) than group (A). At 15, 30, 45 minutes, SBP means were (82.18 ± 1.7), (82.18 ± 1.7), (82 ± 0) respectively among group (B) while they were (86.93 ± 1.5), (86.95 ± 1.5), (87.2 ± 1.4) respectively in group (A) with P-value 0.001 at 15, 30 minutes and P-value 0.004 at 45 minutes. A significant

difference was found regarding diastolic blood pressure (DBP) among groups of study. DBP was lower among group (B) than among group (A). At 15, 30, 45 minutes, DBP averages were (42.12 ± 1.4), (42.1 ± 1.4), (42 ± 0) respectively among group (B) while they were (47.82 ± 1.4), (47.80 ± 1.4), (47.8 ± 0) respectively in group (A) with P-value 0.001 (Table 4).

Table (4): Perioperative systolic and diastolic blood pressure and its significance:

Systolic blood pressure	Group	N	Mean	SD	Median	Mannwhitney test significance
15 min.	**(A)** **(B)**	40 40	86.93 82.18	1.5 1.7	87 82	P=0.001*
30 min.	**(A)** **(B)**	40 40	86.95 82.18	1.5 1.7	87 82	P=0.001*
45 min.	**(A)** **(B)**	38 3	87.2 82	1.4 0	87 82	P=0.004*
60 min.	**(A)** **(B)**	8 -	87	1.2	87	-
Diastolic blood pressure	Group	N	Mean	SD	Median	Mannwhitney test significance
15 min.	**(A)** **(B)**	40 40	47.82 42.12	1.4 1.4	47 42	P=0.001*
30 min.	**(A)** **(B)**	40 40	47.80 42.1	1.4 1.4	47 42	P=0.001*
45 min.	**(A)** **(B)**	38 3	47.8 42	0 0	47 42	P=0.001*
60 min.	**(A)** **(B)**	8 -	47.6	0	47	-

Regarding the heart rate, a significant difference was present relating to pulse rate among groups of study. Heart rate (HR) was lower among group (B) than in group (A). At 15, 30, 45 minutes, means of HR were (52.15 ± 1.4), (52.1 ± 1.4), (52.12 ± 0) respectively among group (B) while they were (57.38 ± 1.4), (57.35 ± 1.4), (57.35 ± 0) respectively in group (A) with P-value 0.001.

There was a positive correlation among SBP and bleeding grade with significant correlation at 15 minutes (r=0.510, P=0.001) and at 30 minutes (r=0.730, P=0.001) but there was insignificant correlation at 45 and 60 minutes. There was a positive correlation among DBP and bleeding grade with significant correlation at 15 minutes (r=0.50, P=0.001), at 30 minutes (r=0.760, P=0.001) but there was insignificant correlation at 45 and 60 minutes.

There was a positive correlation among HR and bleeding grade with significant correlation at 15 minutes (r=0.560, P=0.001), at 30 minutes (r=0.77, P=0.001) but there was insignificant correlation at 45 and 60 minutes.

Only 2 subjects suffered from palatal discomfort in the site of GPC injection. No recorded cases with other complications as local ulceration at injection site, tachycardia, arrhythmia, face paraesthesia, visual field defect or blindness, infratemporal fossa or PPF abscesses or meningitis.

4. Discussion:

Successful ESS, performed on patients with unresponsive sinonasal polyposis or CRS, requires excellent visibility of the surgical region throughout the procedure. Bleeding reduces the quality of the operational field, which in turn increases the time of the surgery and the likelihood of complications [(2)].

Methods such as topical vasoconstrictors, hypotensive methods, steroids, and hemostatic materials have all been utilized to help control bleeding during ESS. Despite the availability of a wide range of bleeding control methods, excessive blood loss remains a problem during ESS [(3)].

PPF infiltration has been used to decrease bleeding during endoscopic sinus surgery (ESS), septorhinoplasty, dental regional anesthesia, and other procedures. Some sinus surgeons have tried using it, but it's not routine [(1)].

The third segment of the maxillary artery is the intended target of the vasoconstrictor injected into PPF through GPC. The mucosa of the nose receives less blood because this method induces vasoconstriction of the maxillary artery and a decrease in blood flow into the sphenopalatine artery, which is a branch of the maxillary artery [(4)].

To prevent injury to the maxillary artery and infraorbital nerve, the needle used for infiltrating PPF into the ESS is curved at a 45° angle for the first 25 mm from its tip. This allows the needle to align with the angle formed by the GPC and the axis of the hard palate, preventing further needle penetration into the PPF [(10)].

Avoiding cardiac problems during ESS relies mostly on taking precautions against hemodynamic changes. Hemostasis is not compromised by hemodynamic changes or an increase in bleeding when using epinephrine at a concentration of 1:200,000 rather than 1:100,000 [(11)].

This study was prepared to notice the result of GPC infiltration with 1:200,000 epinephrine under hypotensive general anaesthesia on operative bleeding and operative time during ESS, comparing it with conventional method of infiltration of nasal lateral wall with 1:200,000 epinephrine under hypotensive general anaesthesia. The collecting data supports GPC injection efficacy along with hypotensive anaesthesia in reducing intraoperative bleeding and operative time.

This study was done on 40 patients with 20% bilateral CRS and 80% bilateral sinonasal polyposis which are almost symmetrical on both side based on Lund and Mackay, 1993 (6) CT scoring with P-value 0.91. They were in the age range from 30 to 60 years (mean age 42.45 ± 7.1 years).

The majority of GPC injected group (72.5%) had satisfied surgeon opinion while high proportion of conventional injection group (67.5%) had dissatisfied surgeon opinion. At 15, 30 minutes, the averages of bleeding grade were significantly better on GPC injected side (2.05 ± 0.22), (2.08 ± 0.27) respectively compared to the other side with conventional injection (2.63 ± 0.49), (3.13 ± 0.33) respectively with P-value 0.001. At 45 minutes, the mean bleeding grade was better on GPC injected side (3.33 ± 0.58) than that on the other side (3.45 ± 0.5) without significant difference (P-value 0.71).

The overall average of bleeding grade on GPC injection side was (2.12 ± 0.36) and that on conventional injection side was (3.1 ± 0.57) with P-value 0.001, showing significant better overall bleeding grade mean on GPC injection side than on conventional injection side.

There are previous prospective, blind and randomized controlled trials that support the hypothesis of effectiveness of GPC injection with different concentrations of epinephrine in improving surgical field significantly.

In the study of Paudel and co-workers in 2018**,** unilateral PPF injection with 2 ml 1:80,000 adrenaline was given preoperatively through GPF for 36 patients who needed ESS. The bleeding grade of PPF injected side had a mean of 2.23 ± 0.49 and that of the other control side had a mean of 3.23 ± 0.56 with P-value < 0.001 illustrating significant better surgical field on PPF infiltrative side **(1).**

Bhardwaj and co-helpers in 2018 did their study on 30 subjects. unilateral GPC infiltration with 2 ml 1:100.000 epinephrine was given. Mean of bleeding grade at 45 and 60 minutes on GPC infiltration side was 2 and that of

other non infiltrated side was 3, with P-value < 0.0001 [(2)].

Mathew and his colleagues in 2017 approved that the mean of total surgical grade on test PPF infiltration side was 9.0 ± 3.5 and on the other control side was 10.9 ± 3.5 with P-value 0.034 when unilateral infiltration of PPF with 2 ml 1:80,000 epinephrine was given for 32 patients [(3)].

Shanker and co-workers in 2017 reported that the average bleeding grade on infiltrated side was 3.5 and on non-infiltrated side was 3.76, with P-value < 0.05 up to 120 minutes when unilateral GPC injection with 2 ml of 1:80,000 adrenaline was given for 55 patients [(5)].

Shenoy and co-helpers in 2017 recorded that the mean bleeding grade on PPF infiltration side was 2.2 and on non-infiltrated side was 3.2 with P-value 0.001 up to 135 minutes when unilateral PPF infiltration with 2 ml 1:80,000 epinephrine was given to 68 subjects [(4)].

Vinod in 2015 approved that unilateral PPF infiltration with 2 ml of 1:100,000 epinephrine, which was given to 26 subjects, caused significant lesser bleeding grade on PPF infiltrated side with epinephrine with maximum efficacy during first 60 minutes than that of the other side infiltrated with saline, with P-value < 0.01 [(12)].

Wormald and his colleagues in 2005 did their work on 55 patients. unilateral infiltration of PPF with 2 ml of 1:80,000 epinephrine was given. PPF infiltrated side had a bleeding grade mean of 2.59 ± 0.22 compared with the other non-injected side with a mean of 2.99 ± 0.23 with P-value 0.01 up to 3.5 hours [(13)].

In our study, non-significant difference was observed comparing bleeding grade among both groups at 45 minutes with the increase of bleeding grade. This may be due to the lower epinephrine concentration used than other studies, the increase of peripheral vasodilatation of hypotensive general anaesthesia with increasing blood flow to the nasal mucosa and also it may be due to the increase in surface area of the damaged tissues where surgeon was working.

On contrary, results of Valdes and co-works in 2014 showed that no statistically significant difference of bleeding grade among both sides was found with mean 2.34 ± 0.583 on PPF infiltrated side and 2.27 ± 0.525 on non-injected side with P-value 0.161 when unilateral infiltration of PPF with 2 ml 1:100,000 adrenaline was given for 45 cases [(14)].

In our study, the mean quantity of collected blood was 117.33 ± 26.4 ml for GPC injected side and 190.9 ± 44.5

ml for conventional method infiltration side with P-value 0.001; illustrating significant difference of bleeding among both sides, favoring GPC injected side with less total blood loss.

Bhardwaj and co-helper in 2018 mentioned that mean of net blood loss on GPC infiltration side with 2 ml 1:100.000 epinephrine was 72.6 ± 23.1 while on the other side was 101.6 ± 29.8, with P-value < 0.0001 illustrating significant less blood amount on GPC infiltrative side [(2)].

In the study of Dadgarnia and co-workers in 2016, 50 patients underwent septoplasty who were divided randomly into 2 groups. The monotherapy group received transnasal injection and combination therapy group received transnasal injection and GPC injection on both sides with 2 ml 1:100,000 epinephrine. Mean of net blood loss in subjects who received GPC infiltration was 34.64 ± 26.66 and that in transnasal infiltration group was 100.48 ± 20.90, with P-value < 0.001 illustrating significant lessening of bleeding with using GPC injection during septoplasty [(15)].

Eloy and his colleagues in 2014 did their study on 42 patients underwent ESS. Combined group of 20 patients received transnasal injection and GPC infiltration with 2 ml 1:100,000 adrenaline on both sides and control group of 22 patients who received transnasal injection only. Trending towards lessening of blood loss was observed in GPC infiltration group not significantly. Estimated blood loss mean in combined group who received GPC infiltration was 346.5 ± 267.0 and that in control transnasally infiltrated group was 492.9 ± 424.5, with P-value 0.194 [(16)].

Padrnos and co-helpers in 1968 recorded that successful method for controlling posterior nasal hemorrhage in 10 of 11 patients was via 3 ml 1:100,000 adrenaline injected through GPC, with complete hemorrhage control within 3 minutes, with no requirement of packing [(17)].

On contrary, results of Valdes and co-works in 2014 showed no statistically significant difference of net blood loss among both sides with mean 165.07 ± 141.548 on GPC infiltrated side with 2 ml 1:100,000 adrenaline and 153.62 ± 117.882 on the other side with P-value 0.630 [(14)].

In our study, operative time was reduced significantly by GPC injection. The mean surgery time was 35.78 ± 4.47 minutes in the GPC injected side, while in the conventional injected side it was 54.88 ± 7.7 minutes, with P-value 0.001.

Bhardwaj and his colleagues in 2018 recorded that mean operative time of GPC injected side was 93.9 ± 17.8 while on other control side was 107 ± 18.6, with P-value 0.007, illustrating significantly less operative time on GPC infiltrative side [(2)].

In the study of Dadgarnia and co-workers in 2016**,** surgical time in combination therapy group with addition of GPC infiltration was 47.08 ± 8.91 and that in monotherapy transnasal group was 49.52 ± 14.1, with P-value 0.470, illustrating less operative time in combination therapy group but not significant [(15)].

On the contrary, results of Valdes et al., 2014 illustrated that no statistically significant difference of operative time among both sides was present with mean 38.67 ± 20.713 on GPC injected side and 37.80 ± 20.923 on the other side with P-value 0.994 [(14)].

Concerning about means of vital signs in our study, significant difference was found regarding systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR) among groups of study with lower means of vital signs on GPC injection side than on conventional injection side. At 15, 30, 45 minutes, the averages of SBP were (82.18 ± 1.7), (82.18 ± 1.7), (82 ± 0) respectively at GPC injection side while they were (86.93 ± 1.5), (86.95 ± 1.5), (87.2 ± 1.4) respectively at conventional injection side with P-value 0.001 at 15, 30 minutes and P-value 0.004 at 45 minutes. At 15, 30, 45 minutes, the DBP means were (42.12 ± 1.4), (42.1 ± 1.4), (42 ± 0) respectively in GPC injection group while they were (47.82 ± 1.4), (47.80 ± 1.4), (47.8 ± 0) respectively in conventional injection group with P-value 0.001. At 15, 30, 45 minutes, the HR means were (52.15 ± 1.4), (52.1 ± 1.4), (52.12 ± 0) respectively on GPC injection side comparing to that of conventional injection side with means of (57.38 ± 1.4), (57.35 ± 1.4), (57.35 ± 0) respectively with P-value 0.001. There was a positive correlation among vital signs and bleeding grade with significant correlation at 15, 30 minutes with P-value 0.001.

In the study of Shenoy and co-workers in 2017**,** there was significant difference concerning SBP between PPF infiltrated side and non-infiltrated side with significant lower blood pressure in PPF infiltrated side with mean 65 than in the other side with mean 100. There was a significant positive correlation among variation of blood pressure and surgical bleeding grade [(4)].

Mathew and his colleagues in 2017 reported that there was significant positive correlation among SBP and

bleeding grade with P-value 0.024 and also between DBP and surgical grade with P-value 0.047 and correlation among HR and surgical grade with P-value 0.001 [3].

In the work of Wormald and co-helpers in 2005, there was a significant positive correlation between HR and bleeding grade with P-value 0.004. They found in their study that blood pressure did not significantly alter bleeding grade with P-value 0.724 [13].

On contrary, Dadgarnia and co-workers in 2016 mentioned that there was no significant differences between monotherapy group received transnasal injection and combination therapy group received GPC and transnasal injection regarding SBP, DBP, HR with P-value 0.177, 0.551, 0.173 respectively [15].

Vinod in 2015 recorded no significant difference among PPF infiltration side with adrenaline and other side infiltrated with saline regarding HR with P-value 0.758 and mean blood pressure with P-value 0.683. There was no significant correlation among HR and surgical field grade with P-value 0.110 and also no significant correlation between blood pressure and bleeding grade with P-value 0.11 [12].

Valdes and co-workers in 2014 reported no significant difference between PPF infiltrated side and non-infiltrated side concerning HR and MAP with P-value 0.499 and 0.495 respectively. No correlation was found between surgical field grade and HR or MAP [14].

In our study, only 2 subjects suffered from palatal discomfort. This may be due to initially having less experience with this technique. No other serious complications occurred with GPC injection with 1: 200,000 epinephrine. No tachycardia or arrhythmia occurred which can happen due to intravascular injection. No local ulceration at the injection site occurred. No face paraesthesia occurred which can happen due to injury of maxillary nerve. No visual field defect or blindness occurred which can happen due to injury of infraorbital nerve or ophthalmic artery vasoconstriction. No infratemporal fossa or PPF abscesses or meningitis occurred. This indicated safety of our technique of GPC injection with epinephrine 1: 200,000.

In the study of Shenoy and co-works 2017, three subjects developed tachycardia after GPC infiltration with 1:80.000 epinephrine [4].

From our study and most previous studies, the technique of GPC injection with different concentrations of epinephrine under hypotensive general anaesthesia is simple, effective in

reducing bleeding during ESS and safe with minimal complications. In our study, 1:200,000 diluted epinephrine injected through GPC under hypotensive general anaesthesia produced successful lessening of blood loss and operative period with no hemodynamic instability and no serious complications.

5. Conclusion and recommendations:

Greater palatine canal (GPC) injection by epinephrine 1:200,000 under hypotensive general anaesthesia caused significant lessening in the bleeding during ESS, operative time and improvement of operative field quality with significant lessening in bleeding grade at 15 and 30 minutes, compared to that injected through lateral nasal wall. A significant difference was found concerning blood pressure and heart rate with significant positive correlation among vital signs and surgical bleeding grade at 15 and 30 minutes. No hemodynamic instability and no serious complications were observed with this simple technique of GPC injection method. Based on these current findings, GPC injection is efficient, safe and simple proposed approach along with hypotensive general anaesthesia for optimizing surgical field, reducing intraoperative bleeding, operative time and increasing surgeon satisfaction during ESS.

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