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Original Article

ประสิทธิผลของการฉีดยาชาในกระดูกเพื่อเสริมการชา ในการผ่าฟันกรามล่างซี่ที่สามคุด

The effectiveness of intraosseous injection for supplemental anesthesia in impacted lower third molar surgery

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บทคัดย่อ **การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาความสำเร็จของการชาโดยการฉีดยาชาในกระดูกเพื่อเสริมการชาในการผ่าฟันกรามล่างซี่ที่สามคุดด้วยยาชาอาร์ติเคน 4 เปอร์เซ็นต์ผสมอิพิเนฟริน 1:200,000 รวมถึงศึกษาผลต่อการเปลี่ยนแปลงอัตราการเต้นหัวใจ และความเจ็บปวดในขณะฉีดยาชา โดยทำการศึกษาแบบกึ่งทดลองทางคลินิก มีผู้ป่วยเข้าร่วมวิจัยทั้งหมด 36 รายที่มีอาการเจ็บปวด หรือมีความรู้สึกไม่สบาย ระหว่างขั้นตอนการกรอกระดูกและ/หรือการแบ่งฟันในการผ่าฟันกรามล่างซี่ที่สามคุด ทำการฉีดยาชาเสริมด้วยเทคนิคการฉีดยาชาในกระดูก โดยใช้ยาชาอาร์ติเคน 4 เปอร์เซ็นต์ผสมเอพิเนฟริน 1:200,000 ปริมาตร 0.6-0.9 มล. เดินยา 30 วินาที และวัดผลความสำเร็จในด้านการชาโดยประเมินจากการที่ผู้ป่วยไม่มีอาการเจ็บปวดระหว่างขั้นตอนการกรอกระดูกและการแบ่งฟันจนกระทั่งเอาฟันออกหมด ประเมินผลต่ออัตราการเต้นหัวใจด้วยเครื่องตรวจวัดความอิ่มตัวออกซิเจนของฮีโมโกลบินจากชีพจร โดยวัดชีพจรก่อนฉีดยาชาและทุก ๆ 1 นาทีหลังฉีดยาชา เป็นเวลา 5 นาที ส่วนการวัดความเจ็บปวดในขณะฉีดยาชาใช้มาตรวัดแบบตัวเลขด้วยคำพูด ผลการศึกษาพบว่าอัตราความสำเร็จในการฉีดยาชาในกระดูกเพื่อเสริมการชามากกว่าร้อยละ 90 โดยใช้การทดสอบทวินามในการแปลผล พบว่าค่าความน่าจะเป็นอยู่ที่ 0.298 ($p = 0.289$) อัตราการเต้นหัวใจภายหลังการ**

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ฉีดยาชาจะเพิ่มขึ้นมากที่สุดในนาทีแรก (ค่ากลาง = 4.241 ± 9.30%) ความเจ็บปวดขณะฉีดยาชาพบว่ามีค่ามัธยฐานและค่าพิสัยที่อยู่ระหว่างควอไทล์ที่ 1 และที่ 3 มีค่าเท่ากับ 2 และ 3.5 ตามลำดับ สรุปได้ว่าการฉีดยาชาในกระดูกถือเป็นเทคนิคที่มีประโยชน์สำหรับเสริมการชาในหัตถการการผ่าฟันกรามล่างซี่ที่สามคุด

คำสำคัญ: **การฉีดยาชาในกระดูก การเสริมการชา อาร์ติเคน**

Abstract **The objective of the study was to determine anesthetic success of intraosseous injection for supplemental anesthesia in impacted lower third molar surgery by using 4% articaine with epinephrine 1:200,000. The heart rate effect and pain during injection were also evaluated. The clinical-based, quasi-experimental study was conducted in 36 patients who experienced discomfort or pain during the process of bone removal and/or tooth sectioning in lower third molar surgery received intraosseous injection using 4% articaine with 1:200,000 epinephrine, 0.6-0.9 ml in 30 seconds. The anesthetic success was evaluated by absence of pain during bone removal and tooth sectioning until complete tooth removal. The heart rate effect was measured by pulse oximeter before injection and in 1-minute intervals for 5 minutes. The pain during injection was recorded by using verbal numerical rating scale. For the results, the anesthetic success of intraosseous injection for supplemental anesthesia was over 90% (binomial test; $p = 0.289$). The heart rate was maximally increased in the first minute (mean = 4.241 ± 9.30%) after injection. The median and interquartile range of verbal numerical rating scale of pain during injection were 2 and 3.5, respectively. For conclusion, the intraosseous injection is an advantageous anesthetic technique. It can be used as a supplemental injection to conventional inferior alveolar nerve block for impacted mandibular third molar surgery.**

***Keywords*:** **intraosseous injection, supplemental anesthesia, articaine**

Introduction

Pain control is one of the most important factors for a success in surgical removal of lower third molars. The most common method to achieve pain control is inferior alveolar nerve block (IANB), also known as conventional technique, direct mandibular nerve block or Halstead technique. This technique must be based on precise anatomical knowledge regarding to correct location of mandibular foramen, the bony anatomical landmark surrounded by soft tissue. However, many researches reported 15 to 20 % failure rate of IANB in controlling pain during surgical removal of impacted third molar.[1] The positive signs of lower lip numbness and tongue after IANB do not always refers to successful pulpal anesthesia.[2] The failure of IANB is related to anatomical variations, such as accessory mylohyoid nerve, bifid mandibular canal and retromolar foramen, inflammation and anxiety of patients.[3] If patient is left with pain or discomfort feeling during surgical removal, psychic trauma can

occur from a single distressing experience or being in overwhelmed event. Psychic trauma can develop into post-traumatic stress disorder.[4]

Several techniques have been introduced to improve anesthetic efficacy, such as intrapulpal, intraligamentary, infiltration, re-IANB and intraosseous (IO) injections.[3,5] The IO is frequently used to supplement failed or partially successful conventional technique. The technique for IO is described by depositing local anesthesia into cancellous bone that supports the tooth. At first, the cortical bone around the root of the tooth is punctured by a needle followed by injecting the solution into the affected area.[6] The success rate of IO showed 75% anesthetic success in mandibular first molars area.[7] And 90% success of using IO as supplemental injection.[8] The anesthetic effect of IO occurred immediately after the injection. The duration of expected anesthesia is 15 minutes in plain solution and 30 minutes in vasoconstrictor-containing solution. The cardiovascular absorption of local anesthesia after IO is more rapid and result in elevation of heart rate (HR). However, vasoconstrictor (epinephrine) is added to improve anesthetic efficacy. The main purposes of adding epinephrine are to decrease the perfusion to injection site, lower the anesthetic blood level (less systemic toxicity), increase amount of local anesthesia depositing around the nerve for longer period of time and decrease bleeding at the site of administration. The IO with epinephrine-containing local anesthesia is not contraindicated in healthy patient but not recommended in patient with cardiovascular risk.[6]

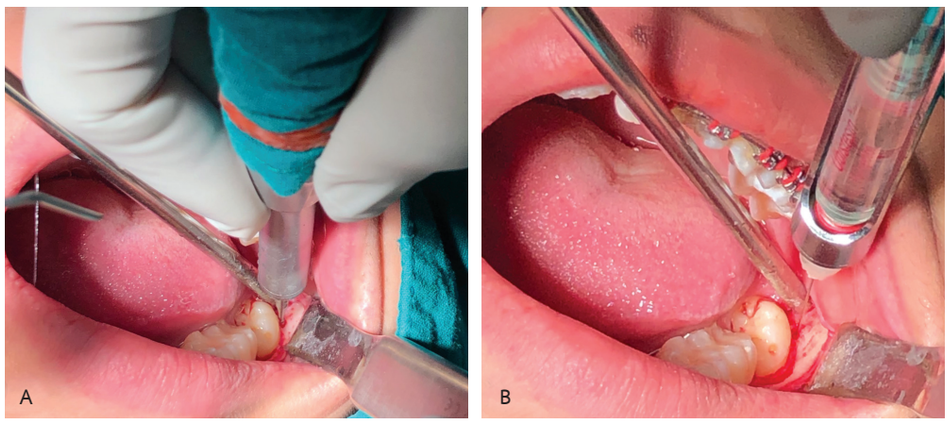
Researchers have mostly studied IO in case of pulpitis and there are a few studies about IO of lower third molar surgery. Therefore, the purpose of this study is to determine anesthetic success of IO for supplemental anesthesia in the impacted lower third molar surgery by using 4% articaine with epinephrine 1:200,000. The HR effect and pain during injection were also evaluated.

Materials and methods

This study was approved by the Ethics Review Board of Rangsit University (no. RSUERB20119-042). Written informed consent was obtained from every subject. The inclusion criteria included 1) the healthy patient age between 18 to 40 years old, 2) impacted lower third molar with no extensive carious lesion, non-inflamed tissue, 3) the overlying bone must be removed and followed by tooth sectioning and 4) the patient who had sign of lip numbness after IANB, but still felt pain or discomfort during removing bone or tooth sectioning. The exclusion criteria were the patient who allergic to articaine or anti-oxidant of vasoconstriction agent (sodium metabisulfite), on medications that affected the pain reception within 2 weeks before the procedure, pregnancy or nursing.

Seventy patients had all profound lip numbness after conventional IANB with 4 % articaine with epinephrine 1:200,000 (Ubistesin; 3M, USA). Out of 70, 36 patients with pain/discomfort during bone removal or tooth sectioning were included in this study. Before the IO, the HR was measured by pulse oximeter (Rossmax SB 100; Rossmax, Switzerland) and defined as the baseline HR.

The IO was performed at exposed cancellous bone area. If there was no exposure of cancellous bone, distobuccal bone of lower third molar would be decorticated with 018 round carbide bur to reach the cancellous bone (Fig.1A). The patients were injected with 0.6-0.9 ml of 4% articaine with epinephrine 1:200,000 in 30 seconds by 27-gauge needle with conventional syringe (Hu-Friedy; Hu-Friedy Manufacturing Company, USA) (Fig.1B). The pain during injection was assessed by verbal numerical rating scale (VNRS) and



รูปที่ 1 *การฉีดยาชาในกระดูกเพื่อเสริมการชาในการผ่าฟันกรามล่างซี่ที่สามคุด*
A: การกรอกระดูกบริเวณด้านแก้มไกลกลางของฟันกรามล่างซี่ที่สามโดยการใช้หัวกรอคาร์ไบด์รูปทรงกลมขนาด 018 กรอไปจนถึงกระดูกโปร่ง
B: การฉีดยาชาเข้ากระดูกด้วยยาชาอาร์ติเคน 4 เปอร์เซ็นต์ผสมเอพิเนฟริน 1:200,000 ปริมาตร 0.6-0.9 มล.

Fig. 1 *The intraosseous injection for supplemental anesthesia in impacted lower third molar surgery*
A: The distobuccal bone of lower third molar would be decorticated with 018 round carbide bur to reach the cancellous bone.
B: The intraosseous injection with 0.6-0.9 ml of 4% articaine with epinephrine 1:200,000.

the HR after injection was immediately recorded, and then recorded every 1 minute for 5 minutes. Anesthetic success was evaluated by absence of pain during bone removal and tooth sectioning until complete tooth removal. The additional supplemental injection was required if there was persistent pain during operation after IO. It would be considered as anesthetic failure. The duration after IO until complete tooth removal, complications and adverse effects were recorded.

The success rate of IO for supplemental injection in surgical removal lower third molar was analyzed by binomial distribution with test proportion = 0.9, significance level = 0.05, using SPSS 21.0, SPSS Inc., Chicago, IL, USA. The percentage of HR change (postinjection HR compared with baseline HR) in 1- minute intervals were calculated. The mean of percentage of HR change and the pain during IO were presented using descriptive statistics.

ตารางที่ 1 ผลสำเร็จของการฉีดยาชาเสริมด้วยเทคนิคการฉีดยาชาเข้ากระดูกโดยการทดสอบแบบทวินาม

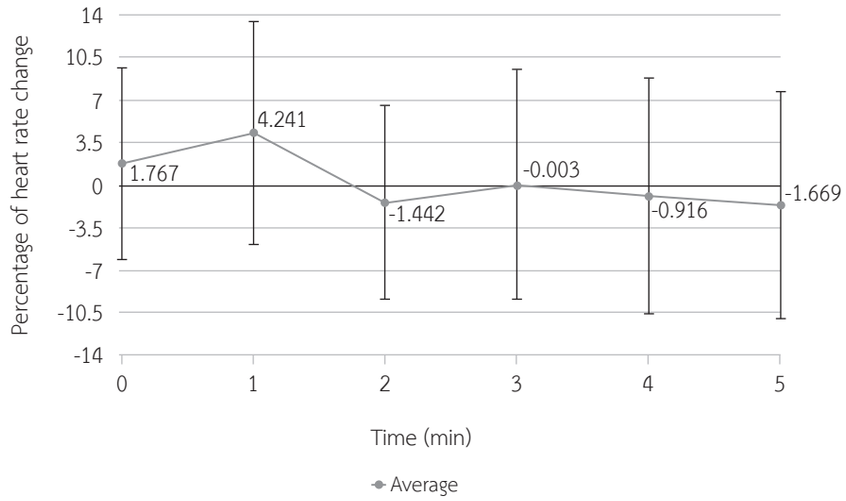
Table 1 Anesthetic success of supplemental intraosseous injection with binomial test.

	N	Observed prop.	Test prop.	*p*-value (1-sided)
Anesthetic success	31	0.86	0.9	0.289
Anesthetic failure	5	0.14		
Total	**36**	**1.00**		

Results

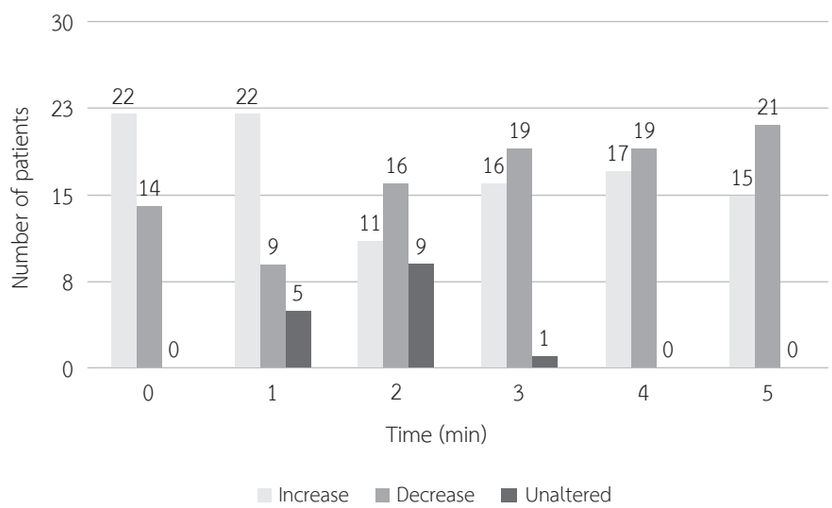
The 36 patients, 24 (66.7%) females and 12 (33.3%) males, were participated in this study. The ages ranged from 18 to 40 and the mean age was 23.8 ± 4.99 years old. The modified Corah's dental anxiety scores were rated between 5-14 (median = 8) which was classified as low to moderate anxiety.

The IO was carried out in 36 patients, 31 (86.1%) patients achieved anesthesia and surgery could be performed without pain or discomfort. According to



รูปที่ 2 *ร้อยละเฉลี่ยของอัตราการเต้นของหัวใจที่เปลี่ยนแปลงในระยะเวลา 5 นาทีภายหลังการฉีดยาชาเข้ากระดูก*

Fig. 2 *The mean percentage of heart rate change after intraosseous injection in 5 minutes monitoring.*

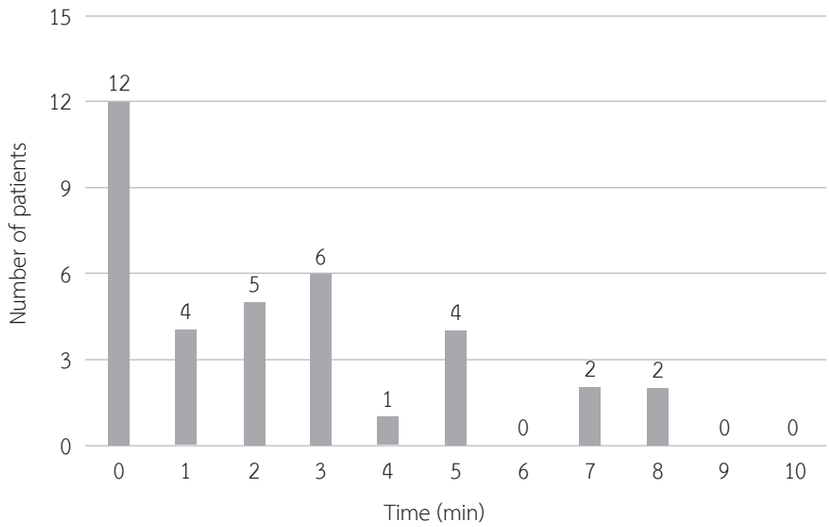


รูปที่ 3 *จำนวนผู้ป่วยที่มีการเปลี่ยนแปลงของอัตราการเต้นของหัวใจในทุก ๆ 1 นาที*

Fig. 3 *The number of patients which heart rate change in 1-minute intervals.*

Table 1, the binomial test indicated that the proportion of anesthetic success of 0.86 was not less than the expected 0.9, $p = 0.289$ (1-sided). The others required additional supplemental injection within a few minutes after IO. For the anesthetic success cases, the mean duration after IO until complete tooth removal was 32.1 ± 16.4 minutes.

According to the Fig. 2, the mean percentage of HR change increased immediately after IO. The most increased of mean percentage of HR change was observed at the first minute (mean = 4.24 ± 9.30%). At the second to fifth minute, the mean percentage of HR change was decreased from baseline. From the Fig. 3, the increasing of HR was observed in 61.1% of patients in the first minute after IO. Then at the second to the fifth minute, most patients were presented with decreased HR. For 5 minutes of HR monitoring, the range of increased HR was 1-19 bpm and decreased



รูปที่ 4 *การกระจายตัวของผู้ป่วยแบ่งตามระดับความเจ็บปวดขณะฉีดยาชา ประเมินโดยใช้มาตรวัดแบบตัวเลขด้วยคำพูด*

Fig. 4 *Patients distribution according to their pain during injection using verbal numerical rating scale.*

HR was 1-18 bpm.

The pain during IO was observed using VNRS. The range of VNRS was 0-8 (Fig. 4). Most patients (12 patients, 33.3%) reported no experience of pain during IO. The median and interquartile range were 2 and 3.5, respectively. The supplemental anesthesia by IO caused none to mild pain at the time of injection. None of adverse effect and complication was reported in this study.

Discussion

The removal of an impacted mandibular third molar may cause pain during the operation, despite profound anesthesia of IANB. The failure of IANB may occurr due to the following factors: anatomical variations such as accessory innervation; especially mandibular third molar,[9] inflammation reaction, anxious, and apprehensive patients with lowered pain threshold.[10] The failure of IANB is the main reason for requiring supplementary injection.

The IO is commonly used as supplement injection in failed or partially successful cases from conventional anesthetic technique. The technique for IO is described by depositing majority of anesthetic solution into cancellous bone that supports the tooth. The IO can provide anesthesia of a bone, and root structure of single tooth or multiple teeth in a quadrant, degree of anesthesia depends on site of injection and volume of aesthetics deposit. The advantages of IO injection are immediate onset, short duration and use small dosages of anesthetic agent.[6]

The IO is a supplementary technique for pain relieved during surgical removal of lower third molar impacted tooth. It can be performed without additional equipment at surgically exposed cancellous bone area. In this study, if cancellous bone was not observed, surgical round bur was used to decorticate at distobuccal area of impacted tooth. Failure to access to cancellous bone was observed in some cases, such as in buccoversion impacted tooth which closed contact to buccal cortical bone, therefore cancellous bone was limited or in elderly patient with constricted cancellous bone. When needle penetrated, the feeling of dense bone was detected. Deeper access in the same area or drilling another adjacent site should be considered. According to

the observation of our study, the IO could be performed more easily if cancellous bone could be penetrated by bur once or the cancellous bone was already exposed, than drilling to reach cancellous bone multiple times. In difficult cases, leakage of anesthetic agent during injection was seen.

In our study, the anesthetic success of supplementary IO was over 90% as same as several studies. Dunbar et al found the combination of the IANB and IO resulted in higher success rate than IANB alone in anesthesia of the molar tooth. The anesthetic success in first molar after only IANB and IANB with IO were 42% and 90%, respectively.[8] Guglielmo et al evaluated an IO in mandibular first molars as a supplement to the IANB. They recorded a high incidence of pulpal anesthesia (100% in first and second molar, and 97% in second premolar).[11]

Sovatdy et al studied the IANB by IO with Quick-Sleeper® at retromolar area. The success rate of IO, as a primary anesthesia, was compared with conventional IANB. The profoundness of IO was sufficient in 32% of the case, whereas conventional IANB had 72% success rate.[12] Thus IO may be not suitable for primary injection in retromolar region. In this area, the cortical bone is thick, as a result, it is difficult to access to the cancellous bone for deposit the anesthetic solution. On the other hand, the high success rate was observed in our study because of the accessibility to the cancellous bone directly. Consequently, flap reflection should be considered for IO in retromolar area. However, the study of Farhad et al demonstrated that IO is suitable for primary anesthetize the tooth with pulpitis. The success rate of IO (56.7%) was significantly higher than those of IANB (23.3%) for pulpal anesthesia of mandibular posterior teeth with symptomatic irreversible pulpitis.[13]

In the failed IO cases, we repeated IO and/or applied different alternative technique such as intrapulpal or intraligamentary injection which depended on step of operation. The IO could be performed when there was pain during bone preparation. However, intrapulpal injection was done in pulpal exposure cases. If there was an access to periodontal ligament, the intraligamentary injection would be carried out. However, pain control was insufficient in these failed cases, in spite of multiple reinjection were done. So, the pain should be adequately controlled before the pain was generated, therefore the performing of IANB combine with IO should be done at the beginning of operation, after flap operation. This consideration may be more advantage than performing IO after the pain occurred. For this purpose, the study will be continued further.

In anesthetic solution, epinephrine helps to improve anesthetic efficacy which increase duration and reduce systemic toxicity. However, it has effect on increasing in HR. Many studies reported that IO might have cardiovascular effect from epinephrine contained in anesthetic solution.[14-16] Replogle et al reported that most of subjects (67%) receiving epinephrine-containing lidocaine as supplemental injection experienced increase in HR. The mean HR change was 28 bpm. On the other hand, mean HR was increased only 4 bpm on 13% of subjects who received mepivacaine plain solution. Although in case of increased HR, it was transient.[15] However, the effect on HR in different concentration of epinephrine in anesthetic solution was not different. As the study of Pereira et al reported IO with 4% articaine with epinephrine 1:100,000 and epinephrine 1:200,000 in treatment of symptomatic irreversible pulpitis. They found that mean HR was not significant different for overall 90 minutes procedure, except at the 20-minute.[16]

The study of Susi et al reported that the rate of deposition had an effect on the HR. They studied the IO with 1.4 ml of 2% lidocaine with epinephrine 1:100,000 by Wand and conventional syringe in different rate of anesthetic deposition. In the fast rates (45 seconds), the HR was increased 21-28 bpm, while the HR was increased 10-12 bpm with the slow rates (4 minutes and 45 seconds) of deposition. They stated that fast rates of deposition resulted in a significantly higher HR change when compared with slow rates whether using Wand or conventional syringe.[17]

Exogenous epinephrine from epinephrine-containing anesthetic solution in routine dental procedure has a minimal cardiovascular effect.[18] Whereas pain, stress and anxiety induce endogenous epinephrine releasing which results in significant change of cardiovascular parameters.[19] In our study, we used 0.6-0.9 ml of 4% articaine with epinephrine 1:200,000 in 30 seconds for the IO as a supplementary injection in lower third molar surgery. The baseline HR was measured when patients had been experiencing pain. Because of pain, sympathetic activity was stimulated resulting from endogenous epinephrine releasing. The baseline HR may be higher than usual. The increased HR persisted until the pain was relieved from IO. As a result of the pain control, endogenous epinephrine was decreased which caused the lower HR change in the second to fifth minute of monitoring. We concluded that the small amount of epinephrine in anesthetic solution has a minimal effect of the HR change.

From previous studies demonstrated that IO is not a painful injection technique. Pereira et al studied the pain during primary IO in different epinephrine concentrations in symptomatic irreversible pulpitis of mandibular molars. Their subjects in both groups reported mild pain during injection.[16] As well as the study of Kiattavorncharoen et al reported only mild pain during IO with QuickSleeper® in lower third molar surgery. It was not different from conventional technique.[20] In our study, the median (IQR) of VNRS was 2 (3.5) which represented none to mild pain that similar to the previous study.

Conclusion

The results of this study support the use of IO as a supplemental injection for pain control in surgical removal of lower third molar impaction. In the cases of failed IANB, IO shows efficient success rates, easy administration, immediately onset, patient comfort, and duration long enough for completing the operation. The IO causes slightly effects on cardiovascular system. However, the use of IO should be aware in compromised patient.

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