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Original Article

Anaesthesia Section

Comparing the Efficacy of Intra-articular Dexmedetomidine versus Buprenorphine for Postoperative Analgesia Following Arthroscopic Knee Surgeries: A Prospective Interventional Study

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ABSTRACT

Introduction: Arthroscopy for knee surgery is the most often used minimally invasive orthopaedic surgical technique. Postoperative discomfort can be caused by irritation to the nerve endings in the synovial tissue, the fat pad in the front of the knee, and the joint capsule that can take place during the excision and resection.

Aim: To compare the efficacy of Intra-Articular (IA) dexmedetomidine versus buprenorphine for postoperative analgesia following arthroscopic knee surgeries.

Materials and Methods: A prospective interventional study was carried out for a period of one and a half years from January 2021 to June 2022 at Department of Anaesthesiology B.L.D.E. (Deemed to be University) Shri B.M. Patil Medical College, Hospital and Research Centre, Vijayapura, Karnataka, India. Around 80 patients of both genders of American Society of Anaesthesiologists (ASA) grade I and II who were scheduled for arthroscopic knee surgeries were randomly divided into two equal groups of 40 each. After the operation was finished, the patients in each group received the respective medications intra-articularly through an arthroscopy port. Group D received Inj. Dexmedetomidine 100 mcg+ Inj. Bupivacaine 0.25%, 20 mL. Injections of buprenorphine 100 mcg and bupivacaine at a concentration of 0.25% , 20 mL were given to the participants in group B. Immediately following surgery, the patient's temperature, pulse, Mean Arterial Pressure (MAP), and Visual Analogue Scale (VAS) score for pain were all monitored and recorded at the 1st, 2nd, 4th, 8th, 12th and 24th hour. Time to first rescue analgesia, the number of patients requiring rescue analgesia within the next 24 h, the visual analog scale at rest, and on mobilisation at 1st, 2nd, 4th, 8th, 12th, and 24 hour were measured. Side-effects like sedation, pruritis, nausea, vomiting, respiratory depression, and hypotension were also monitored. Descriptive statistics were reported as mean (SD) for continuous variables, and frequencies (percentage) for categorical variables. Data were statistically evaluated with IBM Statistical Package for the Social Sciences (SPSS) Statistics for Windows, Version 26.0, IBM Corp., Chicago, IL.

Results: The mean age of the study participants was 38.38±11.30 years among the buprenorphine group and 36.40±12.07 years among the Dexmedetomidine group. Among the Buprenorphine group 52.5% were females and 47.5% were males. There was a statistically significant difference in VAS score at rest and mobilisation between the groups. The mean time for first rescue analgesia was longer for the buprenorphine group 1016.22±137.54 minutes and for the dexmedetomidine group, it was 523.67±117.47 minutes. Rescue analgesia was given to 9 (22.5%) in the buprenorphine and 18 (45%) in the dexmedetomidine group.

Conclusion: In comparison to IA dexmedetomidine, buprenorphine produces analgesia for a longer period of time and reduces the amount of postoperative rescue analgesic that is required.

Keywords: Knee operation, Orthopaedic surgery, Synovial tissue

INTRODUCTION

Arthroscopy is a type of orthopaedic surgery that is becoming more popular for knee operations. Postoperative discomfort can be caused by irritation to the nerve endings in the synovial tissue, the fat pad in the front of the knee, and the joint capsule that can take place during the excision and resection [1-3]. Medication to relieve pain after surgery is essential in order to facilitate early patient mobility, which in turn reduces patient morbidity and speeds up postoperative recovery. In an effort to reduce the amount of postoperative pain that patients experience, researchers have been looking into multimodal ways for administering analgesia. These treatments include IA injections, peripheral nerve blocks, systemic analgesia, and neuraxial analgesia [4].

Buprenorphine is a type of opioid that acts as both an agonist and an antagonist, and its potency is approximately thirty times that of morphine. It is a superior option for use as a postoperative analgesic due to its high affinity for opioid receptors, high lipid solubility, and prolonged duration of action [5]. Dexmedetomidine is a highly selective alpha-2 adrenoceptor agonist that has sympatholytic, sedative-hypnotic, anxiolytic, and analgesic properties. It binds to alpha-2 receptors eight times more strongly than clonidine does [6,7]. The present consensus is that the use of IA dexmedetomidine and buprenorphine are both effective treatments for postoperative analgesia following arthroscopic knee surgeries, with dexmedetomidine being slightly more effective [7,8]. However, opposing viewpoint is that buprenorphine may be more effective than dexmedetomidine [9].

Hence, the present study was conducted to compare the effectiveness of IA dexmedetomidine and buprenorphine for postoperative analgesia in patients scheduled for arthroscopic knee surgeries.

MATERIALS AND METHODS

This was a prospective interventional study carried out in the Department of Anaesthesiology, B.L.D.E. (Deemed to be

University), Shri S.M. Patil Medical College, Vijayapura, Karnataka, India. The study period was one and a half years (January 2021 to June 2022). Ethical clearance was obtained from the Institutional Hospital Ethical Committee approval (IEC/NO-09/2021) before commencing the study. Signed informed permission was also taken from the patients.

Inclusion and Exclusion criteria: Patients aged 18 to 60 years of either gender with ASA Grade I or II [10] who were selected for elective arthroscopic knee surgeries (meniscectomy, ligament repair, removal of loose bodies, and arthroscopic debridement), were included in the present study. Patients who refused to take part in the study, pregnant women, patients such as with H/o cardiorespiratory disorders, hepatic and renal diseases, convulsions and neurological deficits or spinal deformities and psychiatric diseases, or those who are known to have an allergy to buprenorphine, dexmedetomidine, and local anaesthetics were excluded from the study.

One group received Inj.Dexmedetomidine 100 mcg + Inj. Bupivacaine 0.25%, 20 mL. The other group received injections of Buprenorphine 100 mcg and Bupivacaine at a concentration of 0.25%, 20 mL.

Sample size calculation: It was anticipated that patients in group B and group D who have undergone arthroscopic knee surgery will require rescue analgesia at a rate of 20% and 50%, respectively [10], therefore, a sample size of 40 individuals from each group was estimated (i.e., a total sample size of 80 assuming equal group sizes) in order to achieve a power of 80% for detecting a difference in proportions between two groups at a two-sided p-value of 0.05. The formula used $n=(z\alpha+z\beta)^2$ 2 p*q/MD, where, Z=Z statistic at a level of significance, MD=Anticipated difference between two proportions· P=Common Proportion, and q=100-p.

Around 80 patients were randomly divided into two groups of 40 each, by computerised randomisation. A computerised list of 80 patients was created by assigning each patient a unique identifier. Using a random number generator, a random number was assigned to each patient. List of patients was sorted by their assigned random number and divided into two groups of 40 each. It was ensured that the two groups were balanced in terms of gender, age, and any other relevant characteristics. Signed informed permission was taken from all the patients.

Study Procedure

Patients were selected for the research project after undergoing a preoperative comprehensive evaluation, which included the following components: The patient's history of any underlying medical conditions, as well as any prior experiences with surgery, anaesthesia, or hospitalisation, were all taken into account. The patient's general condition was evaluated, along with their vital signs, which included their heart rate, blood pressure, respiratory rate, height, and weight. Additionally, a systemic examination of the patient's cardiovascular system, respiratory system, central nervous system, and the vertebral system was performed, as well as an airway evaluation using the Mallampati grading system [11].

After the implantation of all usual monitors {Non Invasive Blood Pressure (NIBP), Oxygen Saturation (SpO2), Electrocardiogram (ECG)}, {2 to be subscribed}, premedication was administered to each and every patient in both groups in the form of intravenous injections of glycopyrrolate 0.2 mg (1 mL) and midazolam 1 mg (mL). Vital signs were collected both before and after the administration of premedication. Patients in both groups were given an injection of bupivacaine heavy (0.5%) in order to establish spinal anaesthesia. This was done while taking all the necessary antibacterial and sterile measures. During the entire intraoperative period, temperature, pulse, MAP, and SpO_2 were all tracked and recorded. After the surgery was finished, the patients in each group received the medications listed below intra-articularly through an arthroscopy port. This was done after the surgery was finished.

Group D received Inj. Dexmedetomidine 100 mcg +Inj. Bupivacaine 0.25%, 20 mL.

Injections of Buprenorphine 100 mcg and Bupivacaine at a concentration of 0.25%, 20 mL were given to the participants in group B.

Immediately following the surgery, duration of surgery, patient's temperature, pulse rate, MAP, and VAS score for pain were all monitored and recorded at 1, 2, 4, 8, 12, and 24 hours.

Adverse effects were documented, including nausea, vomiting, bradycardia, reduction of respiration, pruritis, and urine retention. Before their surgeries, all of the patients were given instructions on how to use the 10 cm VAS, which ranges from 0 (no pain) to 10 (the worst pain imaginable) [12]. The VAS consists of a line that is 10 centimetres long and is marked every one centimetre along its length. The patient writes a line on the VAS that corresponds to the level of pain that he or she is experiencing. A score of '0' indicates that there is no pain, whereas a score of '10' indicates the most excruciating pain imaginable. The patient's markings on the scale are converted into a numerical representation of the level of pain experienced While determining VAS score the number 0 indicates that there is no pain, the numbers 1-3 indicate mild pain, the numbers 4-6 indicate moderate pain, the numbers 7-9 indicate severe pain, and the number 10 denotes the most excruciating suffering imaginable.

Tramadol 100 mg was administered intravenously as a rescue analgesic in cases where patients reported experiencing pain. Measurements were taken of the amount of time it took to administer the first rescue analgesia, the number of patients who required rescue analgesia within the following 24 hours, and the VAS for pain while the patient was at rest and while they were mobilising at the 1st, 2nd, 4th, 8th, and 24 hours recorded. All of these factors were taken into consideration.

STATISTICAL ANALYSIS

The information collected was transferred to a spreadsheet created in Microsoft Excel, and statistical analysis was carried out with the assistance of a SPSS statistical programme designed for use in the social sciences (version 26.0). Diagrams, counts, and percentages, as well as the mean and standard deviation, were used to display the findings. The independent t-test was used to compare regularly distributed continuous variables in between two groups. On the other hand, the Chi-square test and Fisher's-Exact test were used to compare the categorical variables of the two groups. A significance level of $p < 0.05$ was regarded to indicate a statistically significant difference. All statistical tests were carried out using a two-tailed approach".

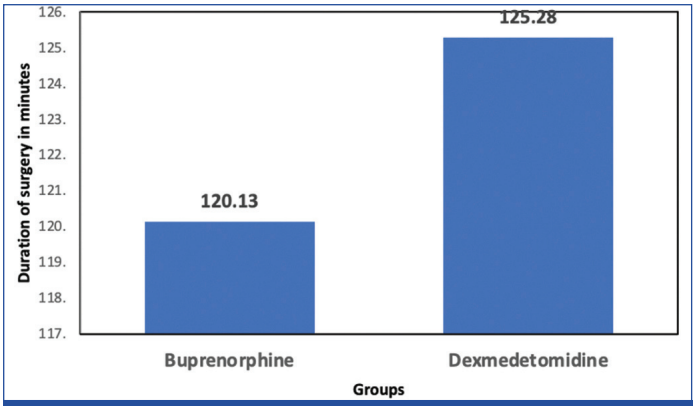
RESULTS

The mean age of the study participants, gender wise distribution and ASA grades were similar between the groups [Table/Fig-1].

The mean surgery duration of the study participants 120.13±2.19 minutes among buprenorphine group and 125.28±1.05 minutes among Dexmedetomidine group. There was no statistical significance between the groups p=0.67 [Table/Fig-2].

Variable	Group B (n=40	Group D (n=40)	p-value
Age (in years)	38.38±11.30	36.40±12.07	0.45
Gender			
Female	21 (52.5)	19 (47.5)	0.65
Male	19 (47.5)	21 (52.5)	
ASA grade			
I	21 (52.5)	25 (62.5)	0.36
II	19 (47.5)	15 (37.5)	

[Table/Fig-1]: Distribution of study variables among the study participants (N=80). Chi-square test



[Table/Fig-2]: Distribution of duration of surgery (in mins) among the study participants (N=80).
Independent t-test p=0.67

There was no statistical significance difference in pulse rate between the groups at 1, 2, 4, 8, 12 and 24 hours [Table/Fig-3].

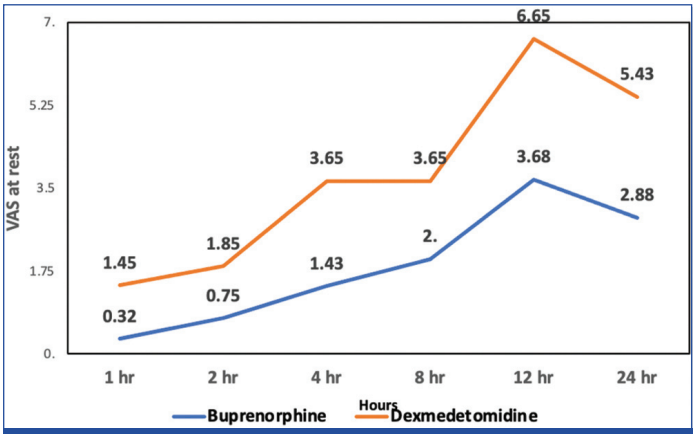
There was no statistical significance difference in MAP between the groups p>0.05 [Table/Fig-4]. There was a statistically significant difference in VAS score at rest between the groups p<0.001** [Table/Fig-5]. At 1 hour p<0.001**, at 2 hour p<0.001**, at 4 hour p<0.001**, at 8 hour p<0.001**, at 12 hour p<0.001** and at 24 hour p<0.001**.

Pulse rate (in hours)	Buprenorphine (B)	Dexmedetomidine (D)	p-value
1	78.20±8.39	78.68±7.27	0.78
2	77.93±7.37	79.57±6.01	0.29
4	78.90±7.48	78.90±6.22	1.00
8	79.32±7.93	79.87±7.08	0.74
12	79.25±7.97	80.73±6.06	0.35
24	79.48±8.70	78.33±5.83	0.49

[Table/Fig-3]: Distribution of pulse rate (beats/min) among the study participants (N=80).
Independent t-test

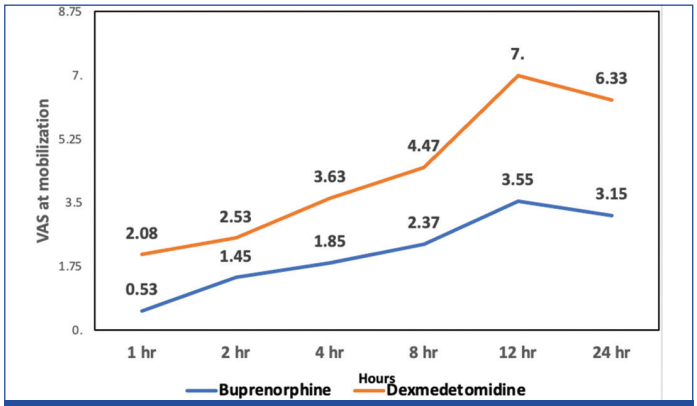
MAP at time interval (in hours)	Buprenorphine (B)		Dexmedetomidine (D)		p-value
	Mean	SD	Mean	SD	
1 h	133.10	13.14	135.03	13.45	0.52
2 h	131.03	14.89	134.15	12.60	0.31
4 h	125.05	10.07	124.47	13.31	0.71
8 h	125.80	9.50	123.37	12.68	0.45
12 h	125.15	9.66	127.85	8.92	0.46
24 h	130.73	5.32	131.95	8.57	0.71

[Table/Fig-4]: Distribution of MAP among the study participants at 1, 2, 4, 8, 12 and 24 hours. (N=80).
Independent t-test



[Table/Fig-5]: Distribution of VAS at rest among the study participants (N=80).
Independent t-test
At 1 hour p<0.001**, at 2 hour p<0.001**, at 4 hour p<0.001**, at 8 hour p<0.001**, at 12 hour p<0.001** and at 24 hour p<0.001**.

There was statistical significance difference in VAS score at mobilisation between the groups (p<0.001)** [Table/Fig-6].



[Table/Fig-6]: Distribution of VAS at mobilisation among the study participants (N=80).
Independent t-test

There was statistical significance between the groups. Among Buprenorphine group rescue analgesia were given for 22.50%. Among dexmedetomidine group rescue analgesia were given for 45.0%. There was statistical significance between the groups. Mean time for first rescue analgesia was longer for buprenorphine group 1016.22±137.54 min and for dexmedetomidine group, it was 523.67±117.47 min [Table/Fig-7].

S. no.	Rescue analgesia	Group B (n=40)	Group D (n=40)	p-value
1	Rescue†			
	Yes	9 (22.5)	18 (45.0)	0.03*
	No	31 (77.5)	22 (55.0)	
2	Time for first rescue analgesia (mins)††	1016.22±137.54	523.67±117.47	<0.001**

[Table/Fig-7]: Distribution of rescue analgesia among the study participants (N=80).
p<0.05* statistically significant
p<0.001** statistically highly significant
†Chi-square test
††Independent t-test

Among Buprenorphine group Bradycardia were about (2) 5%. Among Dexmedetomidine group Bradycardia were about (1) 2.5%. There was no statistical significance between the groups with no other adverse events (p=0.56). Other adverse effects such as nausea, vomiting, reduction of respiration, pruritis, and urine retention were nil reported in the present study [Table/Fig-8].

S. no.	Adverse events	Group B (n=40)	Group D (n=40)	χ^2, (Df), p
1	Bradycardia present	2 (5.0)	1 (2.5)	0.346 (1), 0.56
2	Bradycardia absent	38 (95.0)	39 (97.5)	

[Table/Fig-8]: Distribution of adverse events among the study participants (N=80).
Fisher's-Exact test

DISCUSSION

Various methods of postoperative analgesia have been used in knee arthroscopy, with some systemic opioids having potential side-effects such as nausea, vomiting, respiratory depression, drowsiness, and pruritus [5]. As a result, administering local analgesia has become a popular option for managing pain [6]. IA drug administration is one of the most effective and simple techniques for pain management after arthroscopic knee surgery, facilitating early ambulatory activity for the patient [7-9].

Ropivacaine is similar to bupivacaine but is less lipid soluble, resulting in the less central nervous system and cardiac toxicity [10]. IA administration of dexmedetomidine in combination with local anaesthetics can provide postoperative analgesia without significant effects [11]. Buprenorphine is a partial agonist with a higher receptor affinity than morphine, providing intense and prolonged pain relief [13]. The present study compared the efficacy

of IA dexmedetomidine versus buprenorphine for postoperative analgesia following arthroscopic knee surgeries.

In the present study, the mean age of the study participants 38.38±11.30 years among buprenorphine group and 36.40±12.07 years among dexmedetomidine group. There was no statistical significance between the groups. In a study, conducted by Das PB and Samal S, study mean age was 34.16±9.55 years for buprenorphine group and 35.18±9.2 years among dexmedetomidine group [14]. Devi MM et al., found mean age in years was 37.22±13.36 for buprenorphine group and 32.78±11.9 among dexmedetomidine group [15].

In the present study, among buprenorphine group 52.5% were females and 47.5% males and among dexmedetomidine group 47.5% were females and 52.5% were males. There was no statistical significance between the groups. In a study, conducted by Das PB and Samal S, 26 males and four females among buprenorphine group; 25 males and five females among dexmedetomidine group [14]. In a similar study by Devi MM et al., eight females and 10 males were in buprenorphine group; two females and 16 males in dexmedetomidine group [15]. In the present study, among buprenorphine group ASA I were about 52.5% and ASA II were about 47.5% and among dexmedetomidine group ASA I were about 62.5% and ASA II were 37.5%. There was no statistical significance between the groups. In a similar study by Devi MM et al., among buprenorphine group 13 in ASA 1 and five in ASA II [15]. Among dexmedetomidine group 14 in ASA I and four in ASA II.

In the present study, the mean surgery duration of the study participants 120.13±2.19 minutes among buprenorphine group and 125.28±1.05 minutes among dexmedetomidine group. There was no statistical significance between the groups. In a study conducted by Das PB and Samal S, mean surgery duration of the study participants was 49.2±10.4 minutes for buprenorphine group and 50.9±10.5 minutes among dexmedetomidine group [14]. In a study by Devi MM et al., mean surgery duration of the study participants was 2.5±10.4 hours for buprenorphine group and 2.39±7.5 hours among dexmedetomidine group [15]. In Bansal I et al., study, mean duration of surgery was 187.58±9.14 minutes among buprenorphine group and 186.92±9.67 minutes among dexmedetomidine group [16].

There was no statistical significance difference in pulse rate between the groups. In Das PB et al., study there was no significant change in haemodynamic parameters among the two groups [14]. In a study by Devi MM et al., mean pulse rate of 70.31 ranging from 66.13 and74.5 among buprenorphine group [15]. Mean pulse rate of 69.76 ranging from 65.3 and 74.22 among dexmedetomidine group.

In the present study, between dexmedetomidine group and buprenorphine group MAP did not have any statistical significance in MAP between both groups. In Das PB and Samal S, study there was no significant change in haemodynamic parameters among the two groups [14]. In a study by Devi MM et al., haemodynamic parameters were comparable between the groups and did not show any statistical significance [15]. The VAS scores taken while the groups were at rest were significantly different. Between the groups receiving buprenorphine and dexmedetomidine, Das PB and Samal S, discovered that there was no statistically significant difference in the level of pain experienced when at rest as measured by the VAS at 1, 2, 4, and 8 hours [14]. On the other hand, the VAS score in the IA dexmedetomidine group at rest was considerably higher at the 12th and 24th hours.

There was a statistical significance difference in VAS score at mobilisation between the groups in the present study (p<0.001**). In the study, that was done by Das PB and Samal S, the VAS scores on ambulation were comparable at 1st, 2nd, and 4th hour, but they were considerably higher in the dexmedetomidine group as compared to the buprenorphine group at 8th, 12th, and 24th hour [14].

In the current study, approximately 5% of participants in the buprenorphine group and approximately 2.5% of participants in the dexmedetomidine group experienced bradycardia. In the trial conducted by Das PB and Samal S, only two patients in the buprenorphine group experienced hypotension, in contrast to only one patient in the dexmedetomidine group; however, this difference was not statistically significant [14]. Within the buprenorphine group, rescue analgesia was administered to 22.50% of the patients. In the group that received dexmedetomidine, rescue analgesia was administered to 45% of patients. There was a difference between the groups that was statistically significant. Within the first 24 hours of the trial carried out by Das PB and Samal S, only six patients in the buprenorphine group and 15 patients in the dexmedetomidine group needed rescue analgesia (p=0.03) [14].

In a study, done by Boas RA and Villiger JW buprenorphine offers analgesia that lasts for a longer period of time and reduces the amount of pain experienced. This could be due to the fact that, it only functions as a partial agonist, that it has a high receptor affinity, and that it dissociates slowly from the local peripheral opioid receptor [17]. According to the findings of the present research, the amount of time it took for buprenorphine to produce its first rescue analgesia was noticeably longer than that of dexmedetomidine. According to the research carried out by Das PB and Samal S, the amount of time it took for patients receiving intramuscular buprenorphine (954.2±96.4 minutes) to experience their first instance of rescue analgesia was noticeably longer than the amount of time it took for patients receiving intramuscular doses of dexmedetomidine (628±85.4 min) [14]. Varrassi G et al., also arrived at the same verdict, claiming that 100 micrograms of buprenorphine provided improved postoperative pain management and reduced the requirement for postoperative analgesics [18]. When compared to the number of patients who required rescue analgesia within 24 hours in the buprenorphine group, the number of patients who, required such treatment in the dexmedetomidine group was significantly higher. This is analogous to a study, in which patients who were given buprenorphine intravenously required a decreased overall number of rescue analgesics [19].

Limitation(s)

Due to a lack of adequate time, an extensive study with a longer duration could not be carried out.

CONCLUSION(S)

In the present study, it was observed that compared to IA dexmedetomidine, IA buprenorphine produces postoperative analgesia for a longer period of time and reduces the amount of postoperative rescue analgesic that is required, with a mean duration of analgesia being 1016.22±137.54 min, when compared to IA dexmedetomidine which is 523.67±11.47 min, without any significant adverse effects.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Dec 28, 2022
- Manual Googling: Feb 03, 2023
- iThenticate Software: Feb 20, 2023 (10%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

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