Publisher
MEDRESEARCH
www.medresearch.in

Pediatric Review - International Journal of Pediatric Research

2020 Volume 7 Number 7 September-October

E-ISSN:2349-3267
P-ISSN:2349-5499

Research Article

Vaccination

No pain, much to gain!!

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DOI: https://doi.org/10.17511/ijpr.2020.i07.01

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Background: Vaccination is an integral aspect of a pediatrician's practice. The fear associated with pain is a common problem. Alleviating this pain, not only puts the child at ease but also reduces the apprehension some parents have. Our objective was to evaluate local analgesic use during childhood immunization, its efficacy, and assessing how it serves as an advantage to the patient, the parents/guardian, and the medical personnel. **Methodology**: It was a randomized study. Data was collected for a period of 1 year, from August 2018 to August 2019. Children from birth to 18 years were divided into 2 groups: case (local anesthetic i.e Lidocaine aerosol applied) and control (no local anesthetics applied). They were immunized as per NIS/IAP. The pain was assessed by a standard pain chart (Modified Behavioural Pain Scale (BPS). **Result:** Totally (including IM, SC, and ID injections), the Local anesthesia group Median pain score was 6 and the No Local anesthesia group Median pain score was 8. There was a significant difference in pain scores between the two groups. **Conclusion:** The present study showed that local anesthetics could be applied quickly and with ease. There was a significant difference in pain scores between the two groups (higher score being in the group in which local anesthetics weren't used). The reduction in the pain score, in turn, showed a significant difference in the attitude of the child, parent, as well as medical personnel.

Keywords: Vaccination, Pain, Local anesthetic

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How to Cite this Article

Ranganath KR, Prabhu SM, Kumar PT, Govindaraj M. No pain, much to gain!!. Pediatric Rev Int J Pediatr Res. 2020;7(7):317-325.
Available From
https://pediatrics.medresearch.in/index.php/ijpr/article/view/600

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Manuscript Received	Review Round 1	Review Round 2	Review Round 3	Accepted
2020-06-13	2020-06-29	2020-07-24		2020-09-07

Conflict of Interest	Funding	Ethical Approval	Plagiarism X-checker	Note
No	Nil	Yes	7%	

Introduction

Immunization has been called the greatest public health achievement of the 20th century by the Centers for Disease Control and Prevention (CDC) [1]. Currently, children have very minimal risk of severe complications of tuberculosis, paralysis from polio, cervical cancer from human papillomavirus, mental retardation, and profound hearing loss from Haemophilus influenza, meningitis, etc due to the implementation of routine immunization programs.

Vaccinations not only protect a child from diseases, but they also keep the community safe by eliminating or reducing these diseases that can spread from one to the other in a population. Because of this community protection, individuals who cannot be vaccinated due to certain contraindications and persons who fail to elicit an adequate immune response to the vaccine are protected indirectly as they are not exposed to these diseases.

In recent years, many individuals are uncertain about vaccinations, due to fear of side effects and unable to recognize the enormous health and economic benefits that vaccines provide. Many parents delay vaccinations or decide against vaccinating their children. This increases the risk of contracting vaccine-preventable diseases and disrupting herd immunity, and also reduces the trust in the capacities of health care systems to protect people.

Vaccine hesitancy is related to a range of both psychological and demographic determinants, such as attitudes toward vaccinations, social norms, and trust in science. For parents, vaccinating their children could mean that parents have to experience their child's discomfort side effects. For the child, a major concern is the pain and discomfort associated with the vaccine.

Hence, there is a need to alleviate these fears of both parent/guardian as well as child to encourage routine immunization. Pain management is an integral part of this. The present study aims to study the effects of regular use of local anesthetics in routine immunization with regards to the patient, the parent/guardian, and the medical personnel.

Common Vaccines Administered in India [2]

Vaccine	When to give	Dose	Route	Site
For Infants				
BCG	At birth or as early as possible till one year of age	0.1 ml (0.05 ml until 1 month age)	Intra-dermal	Left upper arm
Hepatitis B-Birth dose	At birth or as early as possible within 24 hours	0.5 ml	Intra-muscular	Antero-lateral side of mid-thigh
OPV-0	At birth or as early as possible within the first 15 days	2 drops	Oral	Oral
OPV 1,2 and 3	At 6 weeks, 10 weeks, and 14 weeks (can be given till 5 years of age)	2 drops	Oral	Oral
Pentavalent 1,2 and 3	At 6 weeks, 10 weeks, and 14 weeks (can be given till one year of age)	0.5 ml	Intra-muscular	Antero-lateral side of mid-thigh
Rotavirus#	At 6 weeks, 10 weeks, and 14 weeks (can be given till one year of age)	5 drops	Oral	Oral
IPV	Two fractional doses at 6 and 14 weeks of age	0.1 ml	Intra-dermal two fractional dose	Intra-dermal: Right upper arm
Measles / MR 1st dose$	9 completed months-12 months (can be given till 15 years of age)	0.5 ml	Sub-cutaneous	Right upper arm
JE-1*	9 completed months-12 months	0.5 ml	Sub-cutaneous	Left upper arm
Vitamin A (1st dose)	At 9 completed months with measles-Rubella	1 ml (1 lakh IU)	Oral	Oral
For Children				
DPT booster-1	16-24 months	0.5 ml	Intra-muscular	Antero-lateral side of mid-thigh
Measles / MR 2nd dose$	16-24 months	0.5 ml	Sub-cutaneous	Right upper arm
OPV Booster	16-24 months	2 drops	Oral	Oral
JE-2	16-24 months	0.5 ml	Sub-cutaneous	Left upper arm
Vitamin A** (2nd to 9th dose)	16-18 months. Then one dose every 6 months up to the age of 5 years	2 ml (2 lakh IU)	Oral	Oral
DPT Booster-2	5-6 years	0.5 ml	Intra-muscular	Upper arm
TT	10 years and 16 years	0.5 ml	Intra-muscular	Upper arm

*JE Vaccine is introduced in select endemic districts after the campaign.

**The 2nd to 9th doses of Vitamin A can be administered to children 1-5 years old during biannual rounds, in collaboration with ICDS.

#Phased introduction, at present in Andhra Pradesh, Haryana, Himachal Pradesh and Orissa from 2016-7 expanded in Madhya Pradesh, Assam, Rajasthan, and Tripura in February 2017 and planned in Tamil Nadu and Uttar Pradesh in 2017.

$Phased introduction, at present in five states namely Karnataka, Tamil Nadu, Goa, Lakshadweep, and Puducherry (as of Feb' 2017).

Pain Assessment In Children

Assessment of pain in children is a tedious task and requires patience and skill. Children, especially younger children, due to the difficulty to communicate, are more difficult to tackle. Wong et al presented a technique to systematically assess pain in children called Q.U.E.S.T: [3]

Q: Question the child

U: Use pain rating scores

E: Evaluate the behavior

S: Sensitize parents

T: Take action!

01. **Question the child:** The child has to be questioned in a comfortable environment, in the company of the parent/caretaker. An easy language (sore, ouch, hurt) will be understood well by the child and developmentally appropriate questions are required so that the child comprehends the questions and gives appropriate answers. The use of dolls and toys will put the child at ease. Non-verbal children may pose difficulty and are very vulnerable to having their pain underestimated.
02. **Use pain rating scales:** Many pain rating scales have been developed. A suitable one may be used.
    - Faces
    - Numeric
    - Behavioral
    - Behavioral/physiological
03. **Evaluate the behavioral and physiological changes:** Behavioral and physiological changes must be evaluated. Vitals such as heart rate, respiratory rate, blood pressure, etc must be checked and recorded. Other things to notice are any alterations in the sleep pattern, skin color, presence of excessive sweating, etc.
04. **Take action/evaluate results:** Once a thorough history and examination have been done, appropriate actions must be taken.
    - Appropriate analgesia maybe be administered in the correct dose
    - Comfort measures like the presence of a parent/caregiver, light music, cartoons, etc
    - Regular monitoring of the child to assess any reduction/increase in pain, the action of the drugs, etc
    - The findings must be documented clearly

Modified Behavioural Pain Scale (BPS) [4]

Parameter	Finding	Points
Facial expression	Definite positive expression (smiling)	0
	Neutral expression	1
	Slightly negative expression (grimace)	2
	Definite negative expression (furrowed brow, eyes closed tightly)	3
Cry	Laughing or giggling	0
	Not crying	1
	Moaning, quiet vocalizing gentle or whimpering cry	2
	Full lunged cry or sobbing	3
	Full lunged cry more than baseline cry (scored only if a child is crying at baseline)	4
Movements	Usual movements and activity	0
	Resting and relaxed	0
	Partial movement (squirming, arching limb, tensing, clenching)	2
	Attempt to avoid pain by withdrawing the limb where the puncture is done	2
	Agitation with complex/generalized movements involving the head, torso, or other limbs	3
	Rigidity	3

Where:

- Slightly negative expressions include brow bulging and nasolabial furrow.
- Negative expressions include brow bulging, nasolabial furrow, eyes closed, tight open lips with or without a reddened face.

Modified behavioral pain scale = SUM (points for all 3 parameters)

Interpretation:

- Minimum score = 0
- Maximum score = 10

Problems Faced During Immunization: Over the years, vaccines have successfully eliminated major diseases like smallpox and brought many others like polio and mumps close to elimination. Credited as one of the greatest contributions to global health, 79% of the people worldwide believe that vaccines are safe and effective [5]. However, there are problems/concerns concerning vaccines that exist even today:

01. **Lack of trust in the practice of 'vaccination':** According to the Wellcome Global Monitor 2018, a study into global attitudes on immunization, vaccine hesitancy, fuelled by various misconceptions, is on the rise and is leading to the resurgence of diseases like measles that were close to elimination in many countries [6]. Few such misconceptions are:
    - **Those vaccines are not required against diseases that are rare:** It is vaccinating a large enough part of any given population that has helped to make many rare diseases so. In instances where such complacency has resulted in a decline in immunization levels, these diseases have returned quickly. Not being protected by vaccines also increases the risk of infection when traveling to regions where these diseases are not fully controlled.
    - **Those vaccines, in general, or multiple vaccines at the same time can wear out immunity:** Vaccines introduce only small amounts of weakened or killed viruses or bacteria into the immune systems that are otherwise exposed to many foreign substances. Hence, to the large number of antigens that their bodies already effectively respond to, vaccines add only a few more. This does not overload or cause harm in any other form to immunity, as has also been confirmed by many studies over the years.
02. **Side effects of vaccines:** All vaccines are fully tested for safety and effectiveness at preventing the diseases they target before being approved for use. Yet, like all medicines, vaccines also have side effects ranging from fainting caused simply by the anxiety of needles to serious allergic Reactions, in very rare cases. However, the most common ones are [7]:
    - mild pain, redness or swelling at the injection site,
    - mild fever,
    - high fever in young infants after the first dose of a vaccine, and/or febrile seizures that are, however not dangerous

While the physical discomfort brought on by the above side effects may also cause a passing phase of emotional distress in children and their parents/caregivers as well, the risk of contracting a vaccine-preventable disease is far greater than that of having a serious side effect from the vaccine itself.

Claims that vaccines cause autism or other disorders have also been carefully researched and disproved over the years. For instance, the allegation that thimerosal, a preservative added to vaccines caused autism was rejected by the Institute of Medicine after a thorough review in 2004 [7].

Objective of Study

- To study the efficacy of local anesthetics during routine vaccination

Material and methods

- Source: All children, from birth to 18 years, vaccinated in Dr. B. R. Ambedkar Medical College on an OPD basis
- Sample size: 100

Eligibility criteria

01. **Inclusion criteria:**
    - All intramuscular, intradermal, and subcutaneous injections were administered over the arm/anterior aspect of the thigh.
02. **Exclusion criteria:**
    - History of allergy to local anesthetics
    - History of uncertain drug sensitivities
    - Active dermatitis or an open wound at the application site

Methodology

- It is a randomized study. Data was collected for a period of 1 year from August 2018 to August 2019. Children from birth to 18 years were divided into 2 groups:

Case (local anesthetic i.e Lidocaine aerosol applied) and control (no local anesthetics applied).

- They were immunized as per NIS/IAP.
- The pain was assessed by a standard pain chart (Modified Behavioural Pain Scale (BPS).

Statistical analysis

- Data were entered into a Microsoft Excel datasheet and were analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. A Chi-square test was used as a test of significance for qualitative data. Continuous data were represented as mean and standard deviation. Mann Whitney U test was used as a test of significance to identify the mean difference between two quantitative variables.
- **Graphical representation of data:** MS Excel and MS word was used to obtain various types of graphs such as bar diagram.
- **p-value** (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.
- **Statistical software:** MS Excel, SPSS version 22(IBM SPSS Statistics, Somers NY, USA) was used to analyze data.

Results

Table-1: Sex distribution of subjects in two groups.

		Group			
		Local Anaesthesia		No Local Anaesthesia	
		Count	%	Count	%
Sex	Female	21	42.0%	28	57.1%
	Male	29	58.0%	21	42.9%

X 2 =2.270, df =1, p =0.132

In the Local Anaesthesia group, 58% were male and 42% were female, and in the No Local Anaesthesia group, 42.9% were male and 57.1% were female. There was no significant difference in gender distribution between the two groups.

Table-2: Age distribution of subjects in two groups.

		Group			
		Local Anaesthesia		No Local Anaesthesia	
		Count	%	Count	%
Age	<1 year	30	60.0%	35	71.4%
	1 to 5 years	19	38.0%	13	26.5%
	>5 years	1	2.0%	1	2.0%

X 2 =1.500, df =2, p =0.472

In the Local Anaesthesia group, 60% were in the age group <1 year, 38% were in the age group 1 to 5 years and 2% were in the age group >5 years, and in the No Local Anaesthesia group, 71.4% were in the age group <1 year, 26.5% were in the age group 1 to 5 years and 2% were in the age group >5 years. There was no significant difference in Age distribution between the two groups.

Table-3: Route distribution of subjects in two groups.

		Group			
		Local Anaesthesia		No Local Anaesthesia	
		Count	%	Count	%
Route	IM	38	76.0%	34	69.4%
	ID	10	20.0%	10	20.4%
	SC	2	4.0%	5	10.2%

X 2 =1.498, df =2, p =0.473

In the Local Anaesthesia group, route of administration was IM in 76%, ID in 20%, and Subcutaneous in 4%, and the No Local Anaesthesia group, route of administration was IM in 69.4%, ID in 20.4% and Subcutaneous in 10.2%.

Table-4: Median Pain Score comparison between two groups.

		Pain score			P-value
		Mean	SD	Median	
Group	Local Anaesthesia	5.8	1.7	6	<0.001*
	No Local Anaesthesia	7.4	1.3	8	

Mann Whitney U test: In the Local Anaesthesia group, the Median pain score was 6 and, in the No, Local Anaesthesia group, the Median pain score was 8. There was a significant difference in pain scores between the two groups.

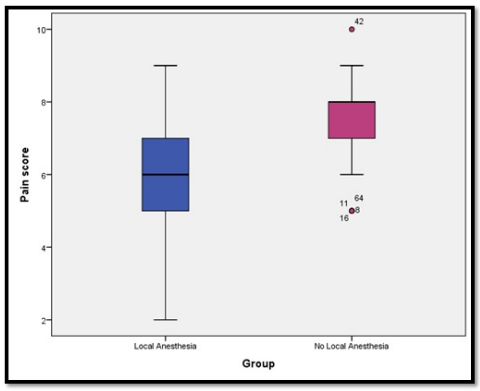

Fig-1: Box plot showing Median Pain Score

Comparison between two groups.

Table-5: Pain Score distribution comparison between two groups.

		Group			
		Local Anaesthesia		No Local Anaesthesia	
		Count	%	Count	%
Pain score	2	1	2.0%	0	0.0%
	3	2	4.0%	0	0.0%
	4	8	16.0%	0	0.0%
	5	13	26.0%	5	10.2%
	6	12	24.0%	7	14.3%
	7	5	10.0%	10	20.4%
	8	5	10.0%	17	34.7%
	9	4	8.0%	9	18.4%
	10	0	0.0%	1	2.0%

X 2 =26.99, df =8, p =0.001*

In the Local Anaesthesia group, the majority of subjects had a pain score of 5 (26%) and in the No Local Anaesthesia group, the majority of subjects had a pain score of 8 (34.7%).

There was a significant difference in pain scores between the two groups.

Table 6: Pain Score comparison between two groups among those with IM Route of administration.

		Pain score			P-value
		Mean	SD	Median	
Group	Local Anaesthesia	5.7	1.8	6	<0.001*
	No Local Anaesthesia	7.4	1.4	8	

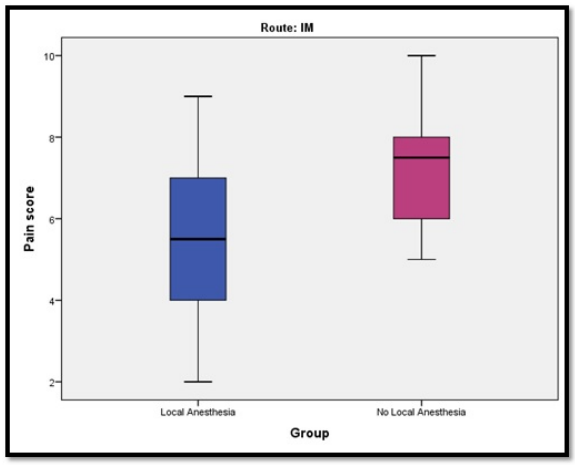

Fig-2: Box plot showing Pain Score comparison between two groups among those with the IM route of administration.

Table-7: Pain Score comparison between two Groups among those with ID Route of administration.

		Pain score			P-value
		Mean	SD	Median	
Group	Local Anaesthesia	6.3	1.4	6	0.043*
	No Local Anaesthesia	7.6	1.0	8	

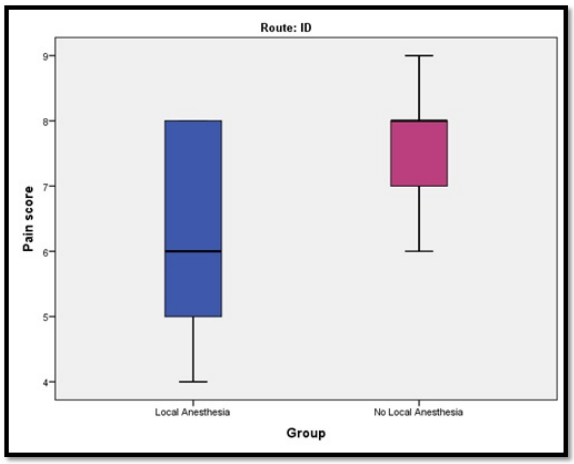

Fig-3: Box plot showing Pain Score comparison between two groups among those with ID Route of administration.

Table 8: Pain Score comparison between two groups among those with SC Route of administration.

		Pain score			P-value
		Mean	SD	Median	
Group	Local Anaesthesia	5.0	0.0	5	0.043*
	No Local Anaesthesia	7.6	1.1	8	

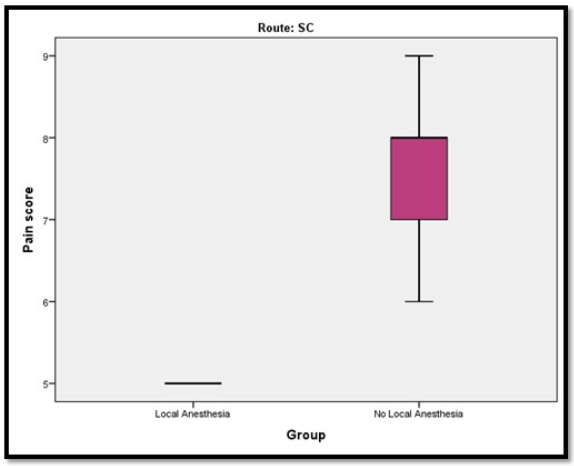

Fig-4: Box plot showing Pain Score comparison between two groups among those with SC Route of administration.

In the Local Anaesthesia group, the Median pain score in the IM group was 6, in the ID group was 6 and in the SC group was 5. In the No Local anesthesia group, the Median pain score in the IM group was 8, in the ID group was 8 and in the SC group was 8.

There was a significant difference in pain scores between the two groups among those who received IM and ID injections, but no significant difference in pain scores was observed for the SC route.

Discussions

Immunizations in children, especially the associated pain, pose difficulties and distress for the children receiving the immunizations, their parents, and the providers who must administer them. Some children experience intense anxiety regarding vaccinations, a reaction that may result in non-adherence to the recommended vaccination schedule.

It is integral to provide a suitable environment for the child, before the administration of the vaccine to reduce the associated anxiety. Certain steps that can be taken are choosing an appropriate site of injection, appropriate length of the needle, parental reassurance, distraction techniques, and sucrose solution instilled directly into the mouth or administered on a pacifier reduces evidence of distress reliably in children [8].

There is adequate evidence supporting the effectiveness of topical anesthetics in preventing pain in children and adults.[9,10] They also have a good safety margin and are effective for infants and children [11]. There is no interference with the immune response to the vaccines [9,10].

A study by Taddio et al, states that despite an abundance of data that demonstrate the efficacy of local anesthetics for decreasing immunization pain, their adoption in practice has not been determined [12].

Another study done by Shah et al showed that topical local anesthetics, sweet-tasting solutions, and combined analgesic interventions, including breastfeeding, were associated with reduced pain during childhood immunizations and should be recommended for use in clinical practice [13].

A study by Manal et al, involving 107 children enrolled in the group administered with a local anesthetic and 109 children in the placebo group, revealed a significant difference between the MBPS (Modified Behavioural Pain Scale) scores;

Lower in the EMLA (topical anesthetic mixture of Lidocaine (2.5%) and Prilocaine (2.5%) in a cream base) group than in the placebo group. The VAS (visual analog scale) scores at the time of the injection were significantly lower in the EMLA group compared with the placebo group [14].

Lidocaine is a local anesthetic that can be used before immunization. A comparative study by Zhu J et al showed topical lidocaine anesthesia had the same postoperative pain relief and the least adverse events as local and general lidocaine anesthesia [15].

Another study showed that vapor coolant spray significantly reduces immediate injection pain compared with distraction alone, and is equally effective as, less expensive, and faster-acting than EMLA cream [16].

The current study shows the efficacy of the topical Lidocaine in significantly reducing immediate injection-associated pain and there are no significant associated adverse effects for the same. This was very advantageous to abate all the anxiety of the child, the parent, and the health provider.

However, it was found more effective in some individuals than others, with probable contributing factors such as type of vaccine, the route, age, temperament, and parental factors. Hence a further sub-analysis is required under each factor individually.

The pain was assessed using the MBPS, which may not be a very accurate measure of pain in all age groups. This requires the use of other scales such as the Numeric Rating Scale (NRS), visual analog scale, etc to confirm the same.

A further detailed study regarding the variation of onset of action, duration, efficacy, etc of the aerosol for different skin types, ages, climates, etc also needs to be done. In addition, the present study was conducted on a relatively small number of children. All of these limitations warrant further research.

Conclusions

Vaccinations can be one of the most painful procedures for infants and children, resulting in anxiety, which in turn results in decreased adherence to the vaccination schedule. The pediatrician has to develop effective pain-relieving strategies with vaccinations.

The present study presented that, along with simple strategies, the use of a local anesthetic is a cost-efficient and effective pain-management technique. However, the study had a limited number of children (especially those who received the subcutaneous injection), requiring further studies.

Hence, the application of local anesthetic can be effectively incorporated as a routine pain-relieving intervention within routine vaccination appointments. This will be a positive step in not only relieving the child but also the medical personnel involved; preventing any inadvertent mistakes.

What does the study add to the existing knowledge

The use of an aerosol containing Lidocaine, rather than topical gels or creams (such as EMLA), has many advantages.

- NO CONTACT: The Aerosol may be sprayed from a distance, which is helpful in cases of children who do not cooperate and in whom the application of a gel/cream may pose some difficulties.
- 2% Lidocaine is a more CHEAPER commercially available option as compared to EMLA. This is a very integral requirement in a developing country like India.

Authors contributions

Dr. Sameeta Mercy Prabhu: Study concept and design, acquisition, analysis and interpretation of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content and final approval, agrees to be accountable for all aspects of the study.

Dr. Pavan T Kumar: Study concept and design, acquisition, analysis and interpretation of data, administrative, technical and material support, Critical revision of the manuscript for important intellectual content, Study supervision, Agrees to be accountable for all aspects of the study.

Dr. Ranganath: Acquisition, analysis, and interpretation of data, Administrative, technical and material support, critical revision of the manuscript for important intellectual content and final approval, Agrees to be accountable for all aspects of the study.

Dr. M. Govindaraj: Acquisition, analysis, and interpretation of data, administrative, technical and Material support, critical revision of the manuscript for important intellectual content and final approval, agrees to be accountable for all aspects of the study.

Acknowledgements

The authors would like to thank all the patients who have heartily participated in the study and have made the study complete.

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