

Clinical Evaluation of Caries Removal Efficacy of Polymer Burs

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Abstract:-Background and objectives: The ultimate goal of conservative dentistry is to remove only the infected portion of carious dentine and to preserve as much as possible sound tooth structure. The present study was conducted to evaluate and compare the caries removal efficacy of Polymer burs and ART.

Materials and methods: A total of forty children aged between 4-9 years with open carious lesions were selected for the study. They were randomly allocated to Group 1- Polymer bur (n=40) and Group 2 – ART (n=40). The efficacy of caries removal was assessed using caries detector dye (Sable and Seek). The pain perception was assessed using the Wong-Baker faces pain rating scale.

Results: These results indicated no statistically significant difference in the efficiency of caries removal in both groups. Pain perception was less in ART group compared to the polymer bur group.

Conclusion: Polymer burs did not improve the efficacy of caries removal and the pain perception was higher when compared with ART.

Keywords:- selective caries removal, polymer burs, ART, infected dentin.

I. INTRODUCTION

Dental caries is a microbial disease affecting human dentition since pre-historic times. It is characterized by cavitation of enamel through a complex interaction over time between acid-producing bacteria and fermentable carbohydrates. As soon as caries destroy the enamel it penetrates the dentin and destroys the dentinal tubules.^[1]

Macroscopically, dentinal caries can be divided into two layers having different microscopic and chemical structures. Superficial layer, the infected dentin, and the deeper layer, the affected dentin.^[2] Infected dentin is soft, composed of necrotic bacterial mass and bacterial products which is dry, softened, and leathery inconsistency. Deeper layer, the affected dentin is free from bacterial contamination, partially demineralized, non-necrotic, and capable of physiological remineralization.^[3-5]

In partial removal of carious dentin, the infected dentin is removed whereas the affected dentin is preserved for remineralization. The rationale behind the partial removal of caries is a proper restoration prevents the progression of carious by prohibiting external nutritional supply for the bacteria. Subsequently, in response to caries, the odontoblastic process forms calcium phosphate precipitates (whitlockite crystals) to occlude the dentinal tubules creating an odontoblastic reaction zone. The arrest of caries progression had been observed over ten years when the bacteria were isolated from the source of nutrition.^[4] However, a balance between tissue preservation and infected dentin removal should be maintained to prevent caries progression.

Unfortunately, the conventional treatment of caries removal using high-speed hand-piece is often inaccessible to most of the child population and may lead to avoidance of dental treatment.^[6, 7] Noise, vibrations, over-heating, and pressure effects on pulp were commonly encountered during cavity preparation using the classical burs that may incorporate fear and anxiety in children and their parents. Moreover, it reduces the regenerative potential of pulp-dentin complex.^[8] Anusavice et al^[9] stated that the removal of infected dentin does not elicit pain sensation but while cutting the sound healthy dentin often evoked mild pain sensation.

Polymer bur, a single-use self-limiting bur, was first described by Boston in 2003.^[10] The development of self-limiting caries removal technique would be of greater clinical importance, as it is strictly restricted to the infected part of carious dentin, without extending into sound dentin. Hence, the possibility of pulp exposure is infrequent even in deep carious lesions.^[10]

The polymer burs have the potential to prepare cavities without the need for local anesthesia.^[11] Unlike the spiral cutting edge of conventional carbide burs, the polymer bur has shovel-like straight cutting edges and is made up of medically graded polyether ketone-ketone with a Knoop hardness value of 50 kg/mm² which is greater than that of infected dentin (0 kg/mm²-30kg/mm²) and lesser than that of healthy dentin (70 kg/mm² - 90 kg/mm²).^[11] Accordingly, on encountering healthy dentin, the bur loses its cutting

efficiency and the blades will abrade instead of abrading health/ affected dentin. These burs are described as “dentin safe” and “self-limiting burs”.^[10]

The bur blades are primarily designed to remove carious dentin by plowing, during which carious dentin is first locally compressed by the blades then the compressed wall of softened carious dentin is pushed along the sound dentin surface with the blades rupturing eventually at this surface level and the loosened fragments are carried to the surface.^[12, 13] Polymer bur is a more patient-friendly conservative approach in dentinal caries removal along with instilling a positive attitude of children towards dentistry.

Various studies had been conducted to assess the efficacy of Polymer burs. Although there are paucities in studies comparing them. Hence, the present clinical study was designed to evaluate and compare the efficacy of two different caries removal techniques -Polymer bur (SmartBurs II) and Atraumatic Restorative Treatment (ART) for deep carious lesions involving dentin in primary molars.

II. METHODOLOGY

Written informed consent was obtained from the parent/ guardian after being informed about the nature of the study. The Ethical Clearance for the study was obtained by the Institutional Ethics and review committee.

A total of eighty primary molars were selected from children aged between 4-9 years based on the following inclusion and exclusion criteria. The inclusion criteria were Cooperative children, Children with no history of any systemic diseases, Children with at least two teeth having Class I occlusal carious lesions as confirmed by IOPA. The exclusion criteria were uncooperative children, symptomatic teeth (mobility, fistula, abscess), restored or fractured teeth, developmental anomalies, multi-surface carious lesions.

The selected teeth were randomly allocated to two groups

- Group A (n=40) - Polymer bur group
- Group B (n=40) - ART group

All clinical procedures were done by a single operator under complete isolation.

A. GROUP A (POLYMER BUR GROUP):

Polymer burs (Smart Bur II) were used at a slow speed without water coolant, running in a circular motion starting from the center of the lesion to the periphery as recommended by the manufacturer. Caries removal by the bur was stopped when the polymer bur becomes abraded and blunted macroscopically. The number of burs used was decided by the clinician.

B. GROUP B (ART GROUP):

Caries was removed using a sterile sharp spoon excavator. Concurrently dentin hardness was checked and caries removal was terminated after obtaining hard dentin as detected with a probe at the base of the cavity.

C. CLINICAL EVALUATION:

In both groups, the efficacy of caries removal was evaluated clinically by tactile and visual criteria.^[9] In addition, caries removal was verified using caries detector dye. Using an applicator tip the caries detector dye was painted into the walls and base of the cavity. The solution was rinsed off with saline after 10 seconds. The observation was classified as complete, partial and incomplete, and numerically scored based on the criteria proposed by Munshi et al.^{[14].}

In both, the groups after complete removal of caries the cavities were restored with Type IX GIC, which was mixed according to the manufacturer’s instructions.

Immediately after the treatment, patients were asked to choose the face that best describes their pain based on Wong-Baker faces pain rating scale (fig 1).

Scoring criteria for assessment of caries removal efficacy[14]

Score	Definition
0	Caries removed completely.
1	Caries present in the base of the cavity.
2	Caries present in the base and/or one wall.
3	Caries present in the base and/ or two walls.
4	Caries present in the base and /or more than two walls.
5	Caries present in the base, walls, and margins of the cavity.

D. Statistical analysis:

Descriptive statistical analysis was done by the mean and standard deviation for quantitative variables and frequency and percentages for categorical variables. The association between categorical variables was analyzed using the Chi-square test. The data were analyzed using SPSS statistical software version 20.

III. RESULT

In the present clinical study, a total of 40 primary molars were selected from children aged between 4-9 years with a mean age of 6.1 years. Among them 12 (60%) were girls and 8 (40%) were boys. Age distribution between the groups is shown in graph 1. The distribution of teeth between the groups were shown in table 1.

Overall, no statistically significant differences were registered in the efficacy of caries removal between both groups. In the polymer bur group, 17.5% (score 0) of teeth showed complete caries removal whereas in the ART group in 15% (score 0) of primary molars complete caries excavation was observed. Score 1 was observed in 17.5% in polymer bur group and 27.5% in ART group, score 2 in 32.5% (group 1 and 2) and score 3 in 17.5% (group 1 and 2) respectively. Whereas, score 4 was observed in 15% in the polymer bur group and 7.5% in the ART group. Table 2 and graph 2 shows the comparison of caries removal in both groups.

In the polymer bur group, the mean value was 1.95 ± 1.29 and in the ART group, it is 1.75 ± 1.14 . The values were insignificant between the groups (table 4 and graph 4).

Significant differences were found when comparing Wong Bakers pain rating scale. Pain experienced by the children was higher in the polymer bur group than in the ART group. The mean value of Wong Bakers faces pain rating scale is 1.80 ± 1.81 in the polymer Bakers group and 1.47 ± 1.26 in ART which is statistically significant (graph 3). The values are given in table 4 and graph 4.

IV. DISCUSSION

In dentistry, caries removal is developing towards a biologically more conservative approach. The ultimate goal of Conservative dentistry is the selective removal of carious dentin which had lost the capability of remineralization reducing the risk of pulp exposure, preserving hard tissues (caries-affected dentine), and inhibiting bacterial cariogenic activity as well.^[15]

Moreover, authors in the literature^[16, 17] suggest that the affected dentin which is capable of remineralization is highly impermeable to dentinal fluid transudate. If the dentinal fluid is stimulated during caries removal using carbide bur, in turn, it stimulates the underlying nerve fibers with resultant pain and sensitivity during and after the procedure.^[16, 17]

However, practitioners acceptance of selective caries removal is still minimal, with potential harm from lingering bacteria or the shorter lifespan of restorations placed on carious dentin mentioned as reasons for this opposition.^[16]

The present clinical study was conducted to evaluate and compare the caries removal efficacy of two different selective caries removal methods: Polymer bur (SmartBurs II, SS White, Lakewood, NJ, USA) and Atraumatic Restorative Treatment (ART). In addition, the perception of treatment was evaluated in both methods.

Forty children aged between 4-9 years with open carious lesions in primary molars were recruited for the study and the selected teeth were randomly allotted to both groups.

The Polymer bur was specially manufactured to perform selective removal of infected dentin, with Knoop hardness less than that of affected dentin. There are two Polymer burs commercially available, SmartBurs II (SS White, Lakewood, NJ, USA) and Polybur-1 (Komet, Mediteam, Sweden). They are available in different sizes. SmartBurs II is available on 004, 006, 008, and Polybur-1 is available on 014, 018, 023. SmartBurs II was designed to be used in a micromotor handpiece at a speed of 500-800 rpm whereas Polybur-1 is recommended to be used at 2000-8000 rpm.^[20]

Carounanidy Usha and RanjaniR^[20] conducted an in-vitro study, comparing the efficacy of SmartBurs II and Polybur-1 in 10 mandibular molars and concluded that both the polymer burs were equally effective in removing deep

dentinal caries. Hence, considering the speed, in our study, we chose to evaluate the efficacy of SmartBurs II.

Several studies have been conducted to evaluate the effectiveness of Polymer burs in selective caries removal. Contradictory results have been reported about the efficacy and pain perception of patients using polymer bur.

In our study, we evaluated the caries removal efficacy of both the methods using caries detector dye, and the subjective pain perception was measured using Wong-Baker faces pain rating scale.

Before the application of caries detector dye, caries removal was confirmed by tactile criteria as they are widely used criteria to assess complete caries removal.^[21, 22] A sharp instrument (straight probe or explorer) with gentle force is passed on the occlusal surface of the teeth. The presence of a catch or a tug-back sensation indicates the presence of dental caries. The differences between infected dentin and affected dentin such as the hardness, toughness, and resilience help us to determine the relative efficiency of caries excavation, clinically without the aid of additional material.^[22]

Kidd et al^[24] in their microbiological assessment of clinical parameters, concluded that tactile criterion is shown to be sufficient for removing the majority of the infected dentine. The major drawback of tactile criteria is that the clinician's judgment and experience are completely responsible for the decision to remove caries.

In this study, caries removal was qualitatively assessed using caries detector dye (Sable & Seek-Ultradent) and numerically evaluated depending on the staining of the base and walls of the cavity.^[14]

Rubber dam application was omitted to avoid any possible complications related to clamp placement. In addition, and in accordance to the manufacturer's instructions, polymer bur does not necessitate complete isolation. Allen et al^[11] stated that when dentin removal is limited to the superficial layer (infected dentin), sparing the odontoblast reaction zone, caries removal could be completed without the need for local anesthesia.

The results of this study indicated no significant difference between the caries removal efficacy of Polymer bur and ART in dentin caries in primary molars. In this study, complete caries removal was achieved in 17.5% of teeth in the Polymer bur group and 15% in the ART group but the values are insignificant.

The lower caries removal efficiency of SmartBurs II reported by Rima Maarouf^[19] is in agreement with our results. The study revealed that Polymer bur was less efficient in caries removal than ART.

These findings are inconsistent with those of Celiberti et al^[25] who evaluated the effectiveness of Polymer bur, laser, steel bur, and hand excavation methods for caries eradication in eighty extracted primary molars. In comparison to hand excavation and chemo-mechanical

procedures, Polymer bur and Er: Yag laser left the most decayed dentine. The study concluded that hand excavation is the most suitable method for carious dentin excavation in primary teeth.

Zakirulla et al^[26] compared three different techniques of caries removal (ART, smart burs, carbide burs) in primary mandibular second molars and concluded that polymer bur exhibited greater efficiency in caries removal than hand excavators.

Ferraz et al^[27] evaluated the effectiveness of steel bur, hand excavation, and Polymer burs in thirty extracted sound human third molars and stated that Polymer burs were proved to be the most conservative method of caries removal than steel burs and hand excavation technique.

The incomplete removal of carious tissue in the Polymer bur group might be due to its self-limiting efficiency. Every time, if the Polymer bur comes in contact with healthy or affected dentin, the cutting efficiency of the bur was lost and became dull and abraded. This could be detected macroscopically. The clinician has to check the bur blades repeatedly during the procedure and have to replace the bur with a new one when it is abraded.

In clinical practice, particularly when treating children this frequent replacement of the bur during the treatment procedure not only increases treatment duration but also the patient's tolerance threshold and compliance is reduced, which is a primary challenge for delivering pediatric patients.

Preparation of carious dentin without direct access required the use of an airtor. In small cavities, the polymer bur readily touched the enamel and became dull, whereas in large cavities it necessitated the use of many burs.

Subjective responses to pain perception, that is, those reported by the patients were evaluated in the study. It was recorded because, in children, subjective perceptions of dental treatment have a significantly higher impact on future attitudes toward dental visits and treatments. Varying levels of pain during treatment and varying needs to invasively intervene are thought to have an impact on dental anxiety.^[6]

Immediately after restoration, in both the groups, children were questioned about their pain perception. A printed Wong-Bakers faces pain rating scale was shown to each child and they were asked to choose an image that suits their feeling. The Wong-Baker scale consists of six smileys representing different emotions with numerical scores ranging from 0 – 10. 0 refers to no pain and 10 refers to highest pain.

For convenience description, we classified pain perception as no pain (score 0) mild pain (score 1& 2), moderate pain (score 3& 4), and severe pain (5). 40% of children in the polymer bur group and 30% in the ART group experienced no pain. In the polymer bur group 32.5% had mild pain and 22.5% had moderate pain whereas in the ART group 47.5% stated mild pain and 15% stated moderate

pain. Severe pain was reported by 5% of children in the Polymer bur group and 2.5% in the ART group.

Pain perception using Polymer burs must be due to the sound, heat, vibration, and pressure encountered while using micromotor. In ART, hand excavation offers optimal tactile sensation and control as well as less discomfort to the patients than bur excavation. Furthermore, this procedure does not produce as much heat and vibration. Thus, the ART technique renders more efficient and self-limiting caries excavation with lower pain perception.

These results were coherent with a study conducted by Maarouf et al^[19] The study revealed that pain experienced in the ART group was lesser when compared with the Polymer bur group. They selected children with at least one carious primary molar. The study did not evaluate both the techniques in the same children. In our study, we have selected children with at least two decayed primary molars so that pain perception in both techniques could be compared.

Soni H K et al^[18] assessed pain perception of children using visual analog scale and verbal pain scale. The study concluded that Carisolv and Polymer burs were the least painful methods than hand instruments and airtor.

Duman et al^[29] compared Brix 3000 and Polymer burs in young permanent molars. No patient preferences was found.

The major drawback of this self-limiting bur in the clinician's aspect is its cost, because, it is a single-use bur and the number of burs used to remove carious lesions is not limited to one. In the patient's aspect, it is an advantage as it reduces the chances of cross-infection.

Limitations of the study include low sample size, unequal distribution of teeth between the groups. However, further studies need to be conducted, comparing the polymer bur with other minimally invasive techniques. Microbial and also long-term follow-up studies to assess the longevity of the restoration placed after caries excavation with these recently introduced materials.

V. CONCLUSION

Within the limitations of the study, we could conclude that the polymer bur effectively preserved the affected dentin similar to Atraumatic Restorative Treatment.

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	TOOTH NUMBER	FREQUENCY (%)
	POLYMER BUR GROUP	54
55		4(10)
64		5(12.5)
65		5(12.5)
74		7(17.5)
75		5(12.5)
84		3(7.5)
85		6(15)
ART GROUP	54	3(7.5)
	55	4(10)
	64	3(7.5)
	65	9(22.5)
	74	7(17.5)
	75	5(12.5)
	84	6(15)
	85	3(7.5)

Table 1: Distribution of teeth between the groups

	Caries removal					Chi-square value	Significance
	0	1	2	3	4		
Polymer bur	7(17.5)	7(17.5)	13(32.5)	7(17.5)	6(15)	1.966	0.742(N.S)
ART	6(15)	11(27.5)	13(32.5)	7(17.5)	3(7.5)		
Total	13(16.3)	18(22.5)	26(32.5)	14(17.5)	9(11.3)		

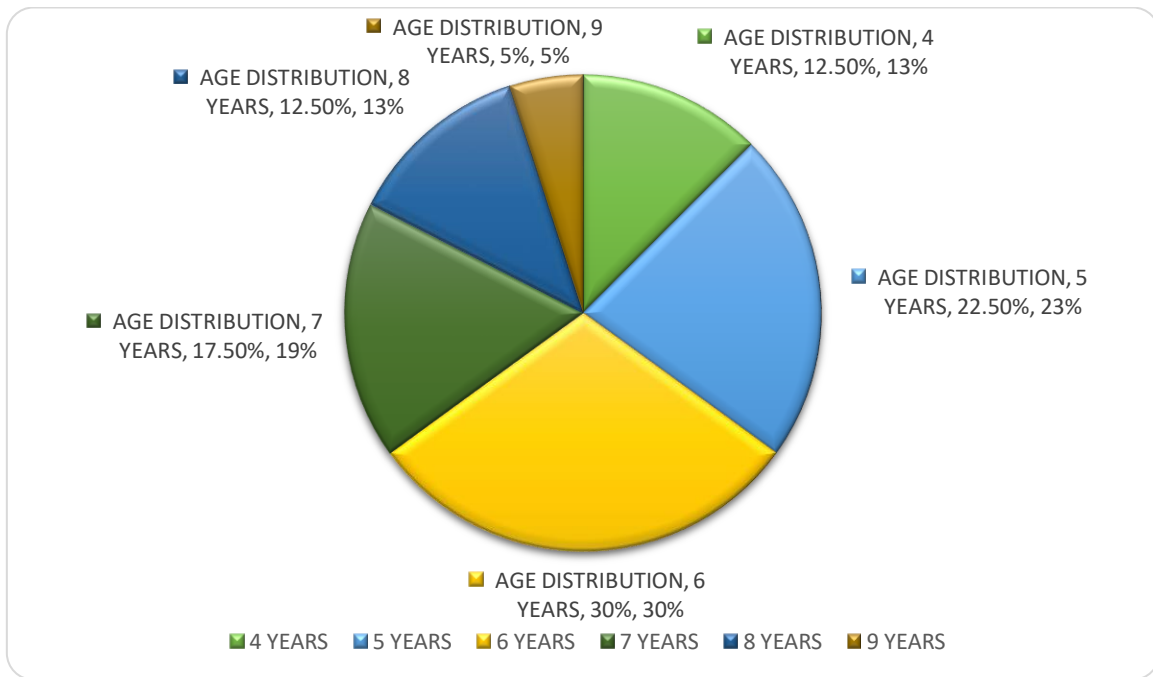
Table 2: Comparison of Caries removal efficacy in Polymer bur group and ART group

	Wong Bakers face scores						Chi square value	Sig.
	0	1	2	3	4	5		
Polymer	16(40)	1(2.5)	12(30)	1(2.5)	8(20)	2(5)	13.670	0.018(S)
ART	12(30)	7(17.5)	14(35)	5(12.5)	1(2.5)	1(2.5)		
Total	28(35)	8(10)	26(32.5)	6(7.5)	9(11.3)	3(3.8)		

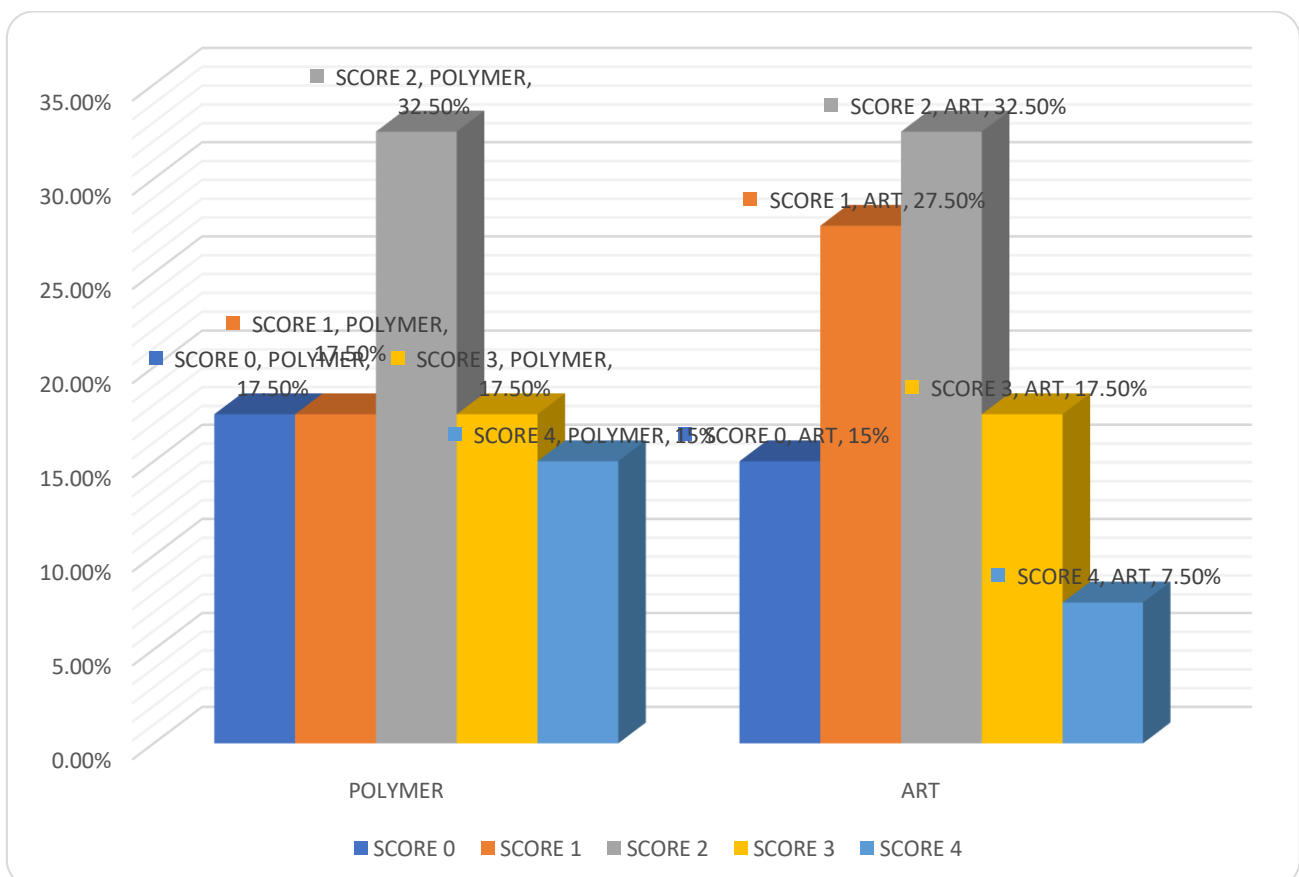
Table 3: Comparison of pain perception in Polymer bur group and ART group

		Mean	Standard deviation	t	Sig.
Wong bakers face	Polymer	1.7500	1.70595	0.820	0.032(S)
	ART	1.4750	1.26060		
Caries removal	Polymer	1.9500	1.29990	0.729	0.634(N.S)
	ART	1.7500	1.14914		

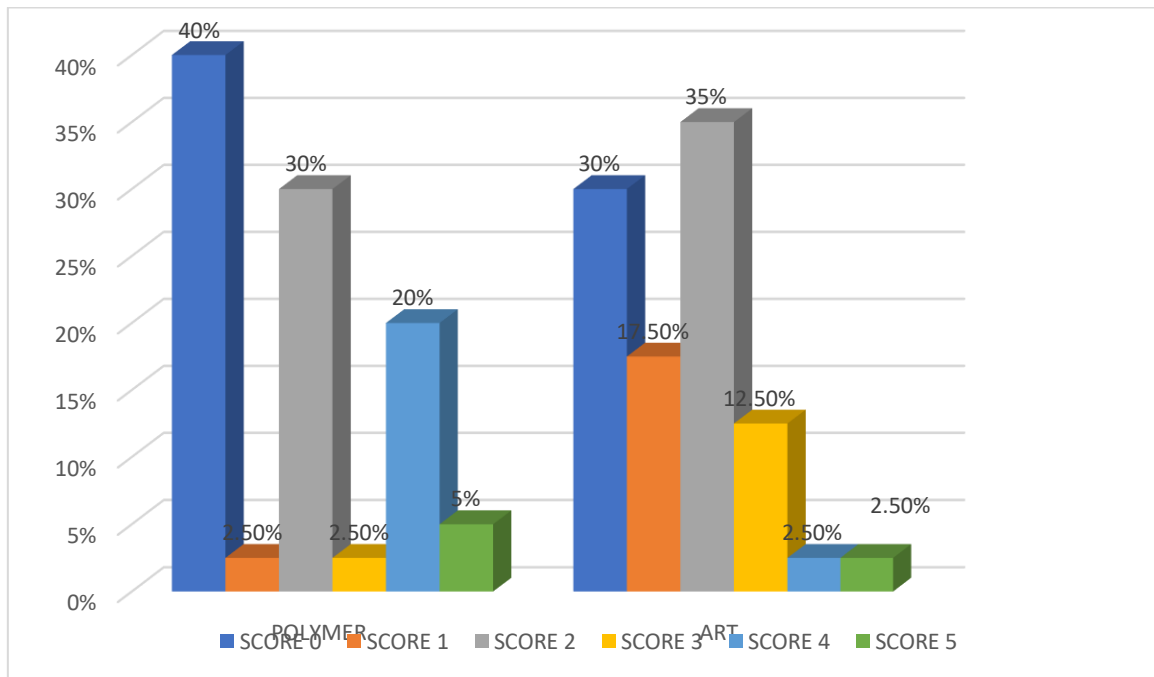
Table 4: Pain perception and caries excavation in Polymer bur group and ART group



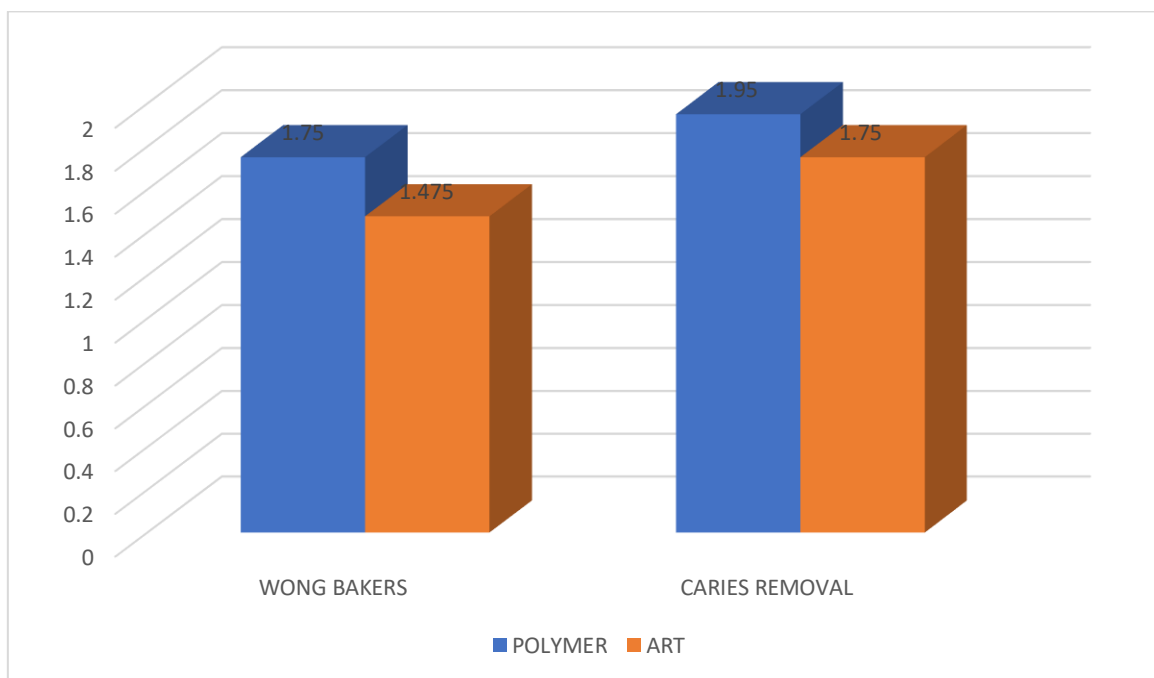
Graph 1: Age distribution of study population



Graph 2: Comparison of Caries excavation in Polymer bur group and ART group



Graph3: Evaluation of pain perception in Polymer bur group and ART group



Graph 4: Pain perception and caries excavation in Polymer bur group and ART group