Clinical Evaluation of Desensitizing Treatment for Incisor Teeth Affected by Molar-Incisor Hypomineralization

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Background: *Sensitivity complaints are commonly observed in teeth affected by MIH (molar incisor hypomineralization).* ***Aim***: *This study aimed to evaluate the hypersensitivity observed in MIH-affected teeth and the effect of desensitizing agents applied with and without ozone to incisors affected by MIH.* ***Study Design***: *The first part of the study included 120 teeth from 42 patients with MIH. These 42 patients included 33 children with 92 incisor teeth with a Vas score of ≥30, and these 92 incisors were included in the second part of the study. The patients included in the second part were divided into three main groups and six subgroups. The main groups included the following: fluoride, CPP-ACP and CPP-ACP with fluoride. Each main group was divided into two subgroups: one with ozone use and one without ozone use.* ***Results***: *Girls exhibited significantly more sensitivity compared with boys ($p<0.05$). There were significant decreases in hypersensitivity compared to baseline in all of the groups ($p<0.05$). There were no differences among the groups at the end of the study ($p>0.05$).* ***Conclusion***: *The results of this study revealed that gender is an important factor in the sensitivity of teeth with MIH. Desensitizing agents effectively reduced the hypersensitivity of teeth with MIH. CPP-ACP paste was found to be more effective, and ozone therapy prolonged the effect of CPP-ACP paste.*

Keywords: *Hypersensitivity, MIH, CPP-ACP, Children*

INTRODUCTION

The term molar incisor hypomineralisation (MIH) defines a situation in which hypomineralization of one or more first permanent molars is clinically noted and in which incisors are frequently affected.[1] For a clinical diagnosis of MIH, the four first permanent molars and eight incisor teeth should be examined for demarcated opacities.[2]

Sensitivity complaints are commonly associated with MIH. Hot and cold or sweet drinks and meals, toothbrushing and even air flow may lead to hypersensitivity in patients with MIH.[1-3] Due to this sensitivity, patients may have difficulty maintaining adequate oral hygiene, and in severe MIH cases, affected molars face the risk of caries, especially immediately after eruption.[4,5]

To increase mineralization and eliminate sensitivity, remineralization therapy is recommended as soon as an MIH defect is identified.[6,7] Topical fluoride application in either gel or varnish form may be used to inhibit sensitivity and demineralization.[8] Recently, dental products containing casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) have also been recommended for remineralization and inhibition of sensitivity.[1,9] However, to our knowledge, there is no study in the literature addressing the elimination of sensitivity in teeth affected by MIH.

Ozone has been widely used for disinfecting drinking water for over 100 years.[10] More recently, ozone has been used as a disinfecting agent for removable prosthetics[11] and dental units,[12] as an antibacterial agent during caries removal[13] and in root canal treatment.[14,15] Several studies have shown that ozone also increases the diameter of dentin tubules, which could facilitate the ingress of minerals.[16,17]

This study aimed to evaluate the short-term desensitizing effect of desensitizing agents applied with and without ozone to incisors affected by MIH.

MATERIAL AND METHOD

A research protocol was submitted to the Ethics Committee of the Ankara University Faculty of Dentistry in Ankara, Turkey, and oral and written informed consent was given by parents/guardians of the study participants.

The study was conducted in two parts. The first part of the study was conducted on a population of children diagnosed with MIH during a visit to our clinic between January 2011- March 2011. In total, 42 children aged 7-12 with 120 anterior teeth affected by MIH were included in this part of the study. Subjects were grouped according to sex, lesion color (white-cream, yellow-brown) and tooth location (mandible, maxilla). Only patients with one or more pairs of lesions were included. Teeth diagnosed with MIH were evaluated for sensitivity to cold stimuli by two practitioners using a

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Table 1. Sensitivity Scores

		Sensetivity						Mann-Whitney U		
		n	Mean	Median	Min	Max	ss	Mean Rank	U	p
Position	lower	63	6,1	7,0	0,0	10,0	3,2	65,2	1501	0,119
	upper	57	5,3	5,0	0,0	10,0	2,9	55,3		
Color	White-cream	87	5,4	5,0	0,0	10,0	3,1	57,1	1137	0,077
	Yellow-brown	33	6,5	7,0	0,0	10,0	2,7	69,5		
Gender	Boys	40	4,9	5,0	0,0	10,0	3,1	50,5	1199	0,025
	Girls	80	6,1	6,0	0,0	10,0	3,0	65,5		

Visual Analog Scale (VAS). Subjects were asked to rate their pain according to the VAS, a 10-cm band featuring 6 different faces representing different levels of pain, from "no pain" (0) to "unbearable pain (10) (fig. 1.). The visual images of the VAS were designed to make it easier for children to accurately express the severity of their hypersensitivity. In total, 33 patients with 92 teeth reported VAS sensitivity scores of ≥30 and were included in the second part of the study.

The second part of the study was conducted on line using Holland's model (1997). Subjects were randomly divided into 3 groups of approximately equal size. For ethical reasons, the study did not include a placebo (control) group. Each group was divided into 2 subgroups, and desensitizing agents were applied, as follows:

Group 1:

1A: Fluoride Varnish (n=15): A few drops of Biflorid 12 (Voco, Germany) were applied with a cotton pellet using a gentle but firm rubbing motion. After 120 seconds, excess material was wiped away.

1B: Ozone + Fluoride varnish (n=15): Teeth were treated with ozone gas delivered using an OzonyTronX (Mymed GmbH, Rosenheim, Germany) oxygen activation generator for 120 s at a setting of 1 with the mushroom-tip (GI probe) supplied with the generator. Following ozone application, a few drops of Biflorid 12 were applied as described above.

Group 2:

2A: CPP-ACP Paste (n=15): A small amount of GC Tooth Mousse (Recaldent™, Australia) was applied as described above for fluoride varnish.

2B:Ozone + CPP-ACP paste (n=15): Teeth were treated with ozone gas as described above. Following ozone application, GC Tooth Mousse was applied as described above.

Group 3:

3A: Fluoride-containing CPP-ACP paste (n=16): A small amount of MI Paste Plus (Recaldent™, Australia) was applied as described above for fluoride varnish.

3B: Ozone + Fluoride-containing CPP-ACP paste (n=16): Teeth were treated with ozone gas as described above. Following ozone application, MI Paste Plus was applied as described above.

Prior to topical application of desensitizing agents, the areas to be treated were cleaned with pumice and isolated with cotton rolls. Patients were also provided with identical toothbrushes, dentifrices and oral hygiene instructions to minimize differences related to oral hygiene.

Responses to cold stimuli were recorded using the VAS before treatment and immediately after, one week after and four weeks after treatment.

At four weeks, following the recording VAS scores, the treatment protocol was repeated, and responses to cold stimuli were recorded immediately and after 8 weeks (three months after the initial treatment).

Statistical analysis was performed using SPSS 15.0. Following data normality tests, the Kruskall Wallis H test with Bonferroni correction was used to analyze the study data, with a level of $p<0.05$ considered statistically significant.

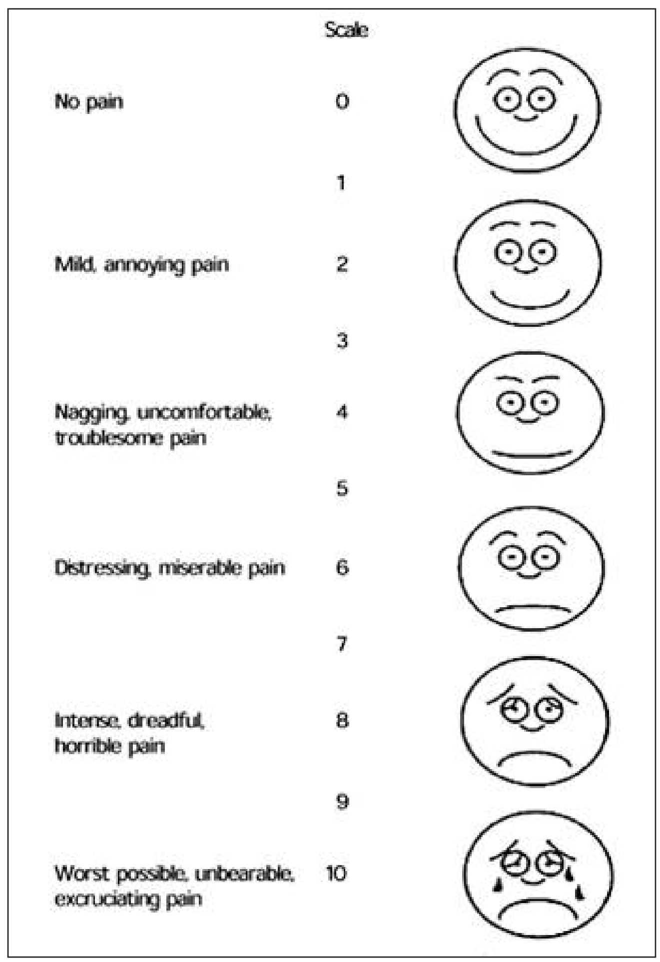

Figure 1. Visual Analog Scale of Pain

Table 2. Score Differences between baseline and immediately after treatment among groups

	Application	n	Mean	Median	Minimum	Maximum	SS	Mean Rank	Chi-Sq.	p	
								Kruskal-Wallis Test			
Line Base	1A-Floride	15	0,93	1	-1	3	1,28	26,03	14,81	0,011	1A-2A 1A-2B 1A-3A
	1B-Ozone Floride	15	2,47	2	-1	7	2,42	46,17			
Immediately After Treatment	2A-Tooth mousse	15	3,13	3	0	7	2,03	55,70			
	2B-Ozon tooth mousse	15	3,40	3	0	6	1,88	59,73			
	3A-MI Paste Plus	16	2,38	2	0	6	1,75	47,13			
	3B-Ozone MI Paste Plus	16	2,38	1,5	-1	9	2,45	44,34			

RESULTS

According to the results of the first part of the study, girls showed statistically more sensitivity than boys. ($p<0.05$). Sensitivity scores were slightly lower for upper incisor teeth than for lower incisor teeth and slightly higher for teeth with yellow-brown lesions than for those with white-cream lesions, but these differences were not statistically significant ($p>0.05$) (Table 1).

According to the results of the second part of the study, hypersensitivity decreased significantly in all groups at all time periods tested when compared to baseline levels ($p<0.05$).

Immediately after treatment, the Tooth-mousse, Ozone + Tooth mousse and MI paste plus groups showed significantly greater reductions in hypersensitivity when compared to the fluoride group ($p<0.05$) (table 2).

One week after treatment, the Tooth-mousse, Ozone + Tooth mousse and MI paste plus groups showed significant greater reductions in hypersensitivity when compared to the fluoride group ($p<0.05$), and the Tooth-mousse and Ozone + Tooth-mousse groups showed significantly greater reductions than the Ozone + Fluoride group ($p<0.05$) (table 3).

At the end of 4 weeks, the Tooth-mousse and Ozone + Tooth-mousse groups showed significantly greater reductions in hypersensitivity when compared to the fluoride group; the Tooth-mousse group showed significantly greater reductions in hypersensitivity when compared to the Ozone+ MI paste plus; and the Ozone + Tooth-mousse group showed significantly greater reductions in hypersensitivity when compared to the Ozone + Fluoride, MI paste and Ozone + MI paste groups ($p<0.05$) (table 4).

No statistically significant differences in hypersensitivity reduction were observed between any of the groups immediately after retreatment or at the end of the study (4 weeks after retreatment/3-months after initial treatment) ($p>0.05$) (table 5, table 6).

DISCUSSION

The present study found all desensitizing methods tested to significantly reduce hypersensitivity in teeth with MIH after three months of clinical follow-up.

It has been suggested that the color of hypomineralized enamel defects may reflect differences in hardness, porosity and mineral content. Previous studies have shown yellow-brownish defects to have lower Knoop hardness values and greater porosity than white defects and normal enamel.[2,19] Although the present study found slightly greater sensitivity among teeth with yellow-brown defects compared to those with creamy-white defects, the difference was not statistically significant.

The mineral content of hypomineralized opacities in MIH-affected teeth has been shown to gradually decrease from the dentino-enamel junction to the subsurface enamel due to the hypermineralization of the surface that usually occurs with post-eruptive maturation.[6] Given that eruption has been shown to occur earlier in girls than in boys[20,21] and that lower incisors erupt earlier than upper incisors,[22,23] hypersensitivity may have been expected to be lower in girls than in boys and in lower incisor teeth than in upper incisor teeth; however, the present study found hypersensitivity to be slightly higher in girls than in boys and in lower incisor teeth than in upper incisor teeth, although the differences were not statistically significant. Considering that Fagrell *et al* showed bacterial invasion in dentinal tubules underlying hypomineralized enamel, it is possible to suggest that increased sensitivity in teeth that have erupted earlier as opposed to later is due to their extended exposure to the oral environment and thus extended exposure to bacterial invasion.

MIH-affected teeth may be difficult to anesthetize and may exhibit hypersensitivity ranging from mild to severe, and children may respond by avoiding toothbrushing.[25] The present study aimed to improve children's oral health by teaching them how to take proper care of their teeth and oral environment.

Table 3. Score Differences between baseline and one week after treatment among groups

	Application	n	Mean	Median	Minimum	Maximum	SS	Mean rank	Chi-sq.	p	
								Kruskal-Wallis Test			
Baseline	1A-Floride	15	1,07	1	-2	4	1,62	29,10	14,75	0,011	1A-2A 1A-2B 1A-3A 1B-2A 1B-2B
	1B-Ozone Floride	15	1,87	2	-1	7	2,50	37,13			
One week After treatment	2A-Tooth Mousse	15	3,53	3	0	9	2,29	57,93			
	2B-Ozone Tooth Mousse	15	3,80	4	0	9	2,62	59,23			
	3A-MI Paste Plus	16	2,81	2	0	8	2,46	48,13			
	3B-Ozone MI Paste Plus	16	2,50	2	0	6	1,63	47,31			

Table 4. Score Differences between baseline and 4 weeks after treatment among groups

	Application	Kruskal-Wallis Test									
		n	Mean	Median	Minimum	Maximum	SS	Mean Rank	Chi- sq.	p	
Baseline	1A-Floride	15	2,00	1,5	-1	7	2,18	32,79	13,56	0,019	1A-2A
	1B-Ozone Floride	15	2,43	2	-2	7	2,90	36,79			1A-2B
4 weeks After treatement	2A-Tooth mousse	15	4,33	4	0	10	2,77	56,23			3B-2A
	2B-Ozone Tooth mousse	15	4,60	4	1	9	2,26	59,00			1B-2B
	3A-MI Paste Plus	16	3,07	3	0	8	2,25	43,20			3A-2B
	3B-Ozone MI Paste Plus	16	2,47	3	-1	6	2,10	37,70			3B-2B

Early diagnosis plays an important role in planning the ongoing treatment of MIH. The first step following diagnosis should be remineralization and desensitization,[1,26] which should begin as soon as the defective surface is accessible in order to create a hypermineralized surface layer and desensitize the tooth.[6,7] The products examined here are well-known remineralizing agents; however, we aimed to benefit from the desensitizing effects of these products.

Fluoride has been widely recommended to achieve remineralization and desensitization.[1,25] The use of a toothpaste with a fluoride level of at least 1,000 ppm has been recommended for children with MIH, regardless of age.[27,28] In the present study, all children were provided with a toothpaste with a fluoride level of 1,450 ppm (Colgate Total, 12, Palmolive, Company).

Topical fluoride, delivered as a concentrated varnish or gel, has been shown to remineralize enamel, reduce sensitivity and enhance resistance to demineralization by providing a reservoir of fluoride ions for redeposition as fluorapatite during remineralization (8). Anecdotal reports ascribe considerable clinical benefit to the topical application of fluoride on hypomineralized molars in order to achieve surface hardening of demineralized enamel prior to restoration.[7]

Another product that has been recommended recently is Casein Phosphopeptide-Amorphus Calcium Phosphate (CPP-ACP), which has been shown to provide a super-saturated area of calcium and phosphate stabilization on the enamel surface and has been recommended in the form of toothpaste or sugar-free chewing gum for patients complaining of mild pain in response to external stimuli.[29,30]

Recently, CPP-ACP products with fluoride have been introduced on the market. This formulation may be more effective than traditional CPP-ACP, since the interaction of CPP-ACP and fluoride ions can produce an amorphous calcium phosphate that is stabilized by CPP at the tooth surface and soluble calcium, fluoride and phosphate ions to promote remineralization with fluorapatite, thereby increasing acid-resistance.[31] However, although products containing fluoride and CPP-ACP have been mentioned for use in treating teeth with MIH,[1,27] there is no established protocol for their use.

Ozone has also been used to eliminate sensitivity, but studies on the subject are limited and have only addressed dentin hypersensitivity.[17,30,32] Azarpazhooh *et al* (2009) found the clinical application of ozone to provide immediate relief of pain, but the relief provided by ozone did not differ significantly from that of a placebo, and Dähnhardt *et al* (2008) found ozone therapy did not reduce dentin hypersensitivity. Moreover, Abdelaziz *et al* (2011) stated that because ozone gas enhances the tubular patency of dentin, it should not be used alone for the treatment of dentinal hypersensitivity, but could be considered a viable adjunct to fluoride-containing desensitizers in enhancing tubular occlusion. In the present study, ozone was used as a pre-treatment method to enhance dentin tubular patency and provide disinfection.

Enamel of MIH-affected teeth is soft and porous in general, and hypomineralized permanent first molars are particularly subject to enamel breakdown due to masticatory forces following eruption.[1] In the present study, MIH-affected incisor teeth were selected for evaluation since they do not generally show enamel breakdown and are easier to standardize than molar teeth with MIH.

In order to achieve better and longer-lasting results, the initial treatment procedures were repeated after 1 month. The results of clinical examination showed that all materials at all time periods resulted in significant reductions in hypersensitivity of MIH-affected teeth. The good results observed in the present study are related to the oral health education provided and the daily usage of fluoride-containing toothpaste.

Table 5. Score Differences between baseline and immediately after retreatment among groups

	Application	Kruskal-Wallis Test								
		n	Mean	Median	Minimum	Maximum	SS	Mean Rank	Chi Sq.	p
Baseline	1A-Floride	15	3,21	3,5	-1	7	2,15	38,32	4,95	0,422
	1B-Ozone Floride	15	2,93	2,5	-2	8	3,10	33,93		
Immediately After Tretreatment	2A-Tooth Mousse	15	4,53	5	0	10	3,16	47,10		
	2B-Ozone Tooth mousse	15	4,87	5	1	9	2,47	51,63		
	3A-MI Paste Plus	16	3,92	3	1	10	2,43	42,35		
	3B-Ozon MI Paste Plus	16	3,62	4	-1	10	2,84	40,54		

Table 6. Score Differences between baseline and 3 months after treatment among groups

	Application	n	Mean	Median	Minimum	Maximum	SS	Mean Rank	Kruskal-Wallis Test Chi Sq.	p
Baseline	1A-Floride	15	3,00	3	0	7	2,08	37,89	9,53	0,090
	1B-Ozone Floride	15	2,86	1,5	0	8	2,93	34,96		
3 months	2A-Tooth mousse	15	4,20	5	-1	10	2,86	49,90		
	2B-Ozone Tooth mousse	15	4,93	5	2	9	2,22	55,73		
	3A-MI Paste Plus	16	3,38	3	0	10	2,69	40,46		
	3B- Ozon MI Paste Plus	16	2,54	3	0	6	2,03	33,81		

CONCLUSION

The results of the present study showed that ozone prolonged the desensitizing effect of Tooth-Mousse and Bifluorid 12, but not that of MI Paste Plus. This may be due to the larger calcium fluoride molecules formed by MI Paste Plus in comparison to the other desensitizing agents. Within the limitations of our study, it is possible to conclude that the professional application of desensitizing agents can have a positive effect on teeth with MIH and that the effects of desensitizing agents containing fluoride and CPP-ACP may be enhanced by the prior application of ozone. Moreover, given the importance of oral hygiene in MIH, the effects of proper oral hygiene and oral health education for MIH patients should also be examined. Finally, long-term clinical studies are needed to develop a treatment protocol for MIH.

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