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### **The clinical experience in a private general dental practice in Italy.**

I have established my dental practice in Verona since 1989. The office is in the down town area. The population I serve belongs mainly to a high social economical level. This fact reflects the epidemiological findings that the demand of services is mainly orientated on remake of previous dental works in the adult age group, and minimal invasive and aesthetic dentistry in the younger age group.

The mean DMFT in the dentate population visiting my practice is 1,9 in the age group 12 to 35, and 5.3 in the age group 35 to 75 years old. The oral hygiene level is very high. Periodontal diseases are mainly connected with general health problems, and only few patients suffer of severe periodontal disease as a consequence of poor oral hygiene.

In such a scenario the demand for preventive dental services is very high. The concern of our patients in an early diagnosis of dental disease is very high. In an internal audit on a sample of 150 patients, 92% were concerned of early diagnosis, and 93% would rather have minimally invasive treatments than wait and have later in time conventional treatments.

This change of attitudes in our clientele is partly a consequence of new communication strategies such intra oral cameras and informed consent, and partly the consequence of a changed perception of health in the population. Awareness and freedom of choice for the self leads the attitudes of our patients.

Another important aspect of the population visiting my dental office is the high percentage of old and old-old patients. In the urban area of down town Verona the population over 65 is 25% of the whole population.<sup>1</sup>

This aspect of the population residing in down town Verona reflects the general trend of aging population in Northern Italy. The medical training and the post graduate course in Gerodontology I achieved with Prof. Robin Heath at the University of London, as a consequence, are for me very useful.

My work today is connected with the work of other Medical Consultants, Psychotherapists and Physiotherapists, and this is because of the awareness that health and healing are threatened by risks we are exposed to. The protection to counter balance those risks is the aim of treatment. Therefore, it is necessary that diagnosis discloses all risks, expressed and hidden, and treatment offers the protection against those risks.

In our practice, dental diagnosis is oriented by three major aspects: 1) the analysis of structural changes in the oral environment; 2) the oral reflection of the imbalance in metabolic function; 3) the oral reflection of emotional imbalance on neurovegetative homeostasis.

Therefore, treatment is the planning of a protection scheme which consists on structure, metabolism and neurovegetative homeostasis.

Recently we have introduced a systemic psychological approach to oral diseases, according to the constellation technique of Dr Bert Hellinger<sup>2</sup>. It offers an incredible opportunity for the patients to understand the psychosomatic involvement in the genesis their conditions.

The demand of prevention from our clientele has also changed the dental materials we use.

At present my practice tries to perform a complete metal free dentistry and utilize non toxic and biocompatible materials.

In order to comply with the needs and demands of our clientele, I have achieved the Master at the Forum Odontologicum of Lausanne with Prof. Sami Sandhouse and I am completing a Post graduate course in Homotoxicology at the Scuola di Omeopatia Clinica e Discipline Integrate.

### **Change in Paradigm.**

Greene Vardiman Black, the father of modern Dentistry said that “a sharp explorer should be used with some pressure and if a very slight pull is required to remove it, the pit should be marked for restoration even if there are no signs of decay.<sup>3</sup> Today we are also aware that caries is regularly found beneath a seemingly intact enamel surface <sup>4</sup>.

The primary goal of operative dentistry is to maintain primary oral health, defined as the absence of disease of the teeth, periodontium, and mucosa.<sup>5</sup>

The greatest change in the way I see my work has been operated by technology because of the wider possibility of observation. The possibility to perform an early diagnosis of dental lesions and the assessment of risks, produced a shift in the offer of dental services which matches with the demand from the patients. The change in the dental paradigm is to me the awareness that any pathology has an early rise that can be recognized and successfully treated before tissue disruption. The goal of operative dentistry for primary oral health could no longer remain an unreachable ideal.

In the psyconeuroimmunological concept<sup>6</sup>, diseases are generated by the unbalance of immune system as a consequence of a process in which central nervous system affects via neurovegetative pathways the endocrine system. The unbalance at these different levels generates the structural changes in anatomical structure of organs and apparatuses. Therefore, the treatment at a metabolic level is successful if no tissue disruption has taken place yet. This is the rationale of dietary control in preventive dentistry, and it is also part of the rationale for the use of ozone. Ozone is therefore effective in the remineralisation of early lesions not because it alters the dental structure, but as it alters the metabolic processes taking place in and around tissues.

This concept, which changes our perspective of conservative dentistry, is very promising. The challenge to me is to accept to treat dental caries as a metabolic disease, at a very early stage, with non – invasive methodologies, and not as a cancer. If dental caries are conceived as a metabolic process, then the bi-directionality of the process, expressed by re-mineralisation and de-mineralisation of enamel, dentine and root cementum, is the phenomenon with which future dentistry has to deal<sup>7</sup>.

Some Colleagues argue that stained grooves are not carious lesions, and the most skilled of them add that they characterize grooves in fillings, inlays and crowns with such stains. The facts are different. Clinical data show that many stained pits and fissures are carious.<sup>8</sup> To assure primary oral health all lesions have to be treated at the earliest stage interacting with pathogenic metabolic pathways.

### **Introducing ozone in the dental practice**

Our experience in early diagnosis and minimally invasive dentistry concepts and technologies (intra oral cameras, dyes, Diagnodent, saliva tests, air abrasion, Carisolv, fissurotomy burs, glass ionomers, flowable composites etc.) and the attitude of our patients towards preventive dentistry has made the encounter with Ozone a real *coup de foudre*.

Prof. Edward Lynch from Queen's University Belfast, presented his work on remineralisation of root caries with ozone at the annual meeting of ECG European College of Gerodontology in December 2001 in London. I was the President of ECG that year, and during the gala dinner we had a long conversation. As a consequence once back home I ordered a Healozone unit.

I have been extensively using the Healozone machine for more than two years, and in the following pages I will describe my and my patients experiences.

The fields of utilization of Healozone in my practice are the following.

- 1- Treatment of deciduous teeth lesions
- 2- *Au lieu* of sealants at the eruption of permanent dentition and as prophylaxis in population at risk of rampant carious lesions.
- 3- Treatment of primary pits and fissure carious lesions (PFCLs)
- 4- Treatment of primary root carious lesions (PRCLs)
- 5- Lesion sterilization before placing an inlay
- 6- Lesion sterilization before placing a filling
- 7- Treatment of sore lesions

## **Methodology application**

The utilization of ozone for every day use has been standardized in order to obtain coherent data.

Every value is registered on a data base which performs the analysis of samples as we increase the number of patients treated with Healozone.

As a baseline, any deciduous and primary lesion is evaluated following this methodology:

- clinical classification index, (Ekstrand, 1998)
- video camera at 40 X
- cleaning of the surfaces with air abrasion using alumina oxide with 27,5 micron at 2.5 PSI in primary fissure carious lesions (PFCLs).
- cleaning of the surfaces with a nylon brush in primary root carious lesions
- standard readings using qualitative laser fluorescence with DIAGNOdent® (KaVo, Germany)

All Patients receiving ozone are recalled after 30, 60 and 90 days to check the remineralisation.

The Studies that follow represent our clinical experience on selected groups of patients.

## **Intra Oral Camera**

Since their first introduction in the dental field, Intra Oral Cameras have been marketed with the concept that they improve communication between patients and dental staff. We have been taught that 83% of all learning is visual and that live action is better than stills.

In my clinical experience, intra oral camera is also virtually essential to dentists and Hygienists to see the signs of disease and to perform a clinical diagnosis.

Fluoridation has changed the number and type of lesions we encounter in our work. The new model of carious lesions has been widely illustrated in the literature<sup>9</sup> since the early 90's. Clues of the presence of decay in grooves and smooth surfaces depend more on direct visual analysis than traditional tools such as X rays and a probe<sup>10</sup>. Since I believe that the luckiest of patients is the one whose carious lesions are stopped at the earliest stage, the use of the intra oral camera becomes essential for a correct diagnosis, coupled

with laser fluorescence and other risk indicators such as ph measurement of stimulated saliva.

### Cleaning the surfaces

To have reproducible Diagnodent readings all dental surfaces have to be cleaned from chromogenic and non chromogenic proteins deposits and food debris each single time. In my practice I use air abrasion spray at low pressure (2.5 PSI). The same results can be achieved using a bicarbonate spray. In primary root carious lesions we use a nylon brush to gently clean the surface, on hard, leathery and soft lesions.

### Diagnodent

Diagnodent readings have a range from zero to 99. The higher the score, the higher the gradient in mineralisation through the dental tissues, which indirectly witnesses the presence of demineralisation and decay<sup>11 12</sup>. The monitoring of the effect of ozone is performed by registering a standard value for each tooth prior to the ozone treatment as well as for control lesions, and the computerized imaging system also maps the exact spots. . Further readings are performed at intervals of 30, 60 and 90 days on the very same areas. The value of each reading is recorded as *unchanged* if no variation occurred in respect to the standard initial reading; as *decreased* if the value is lower than initial reading; as *increased* if the value is higher than the initial reading.

In my clinical practice a Diagnodent score of 10 or higher is considered a carious lesion.

### Ozone Treatment, Severity Index and Ozone exposure.

When evaluating treatment needs for PFCLs, it has showed useful to match Diagnodent readings with clinical examination using intraoral camera at 40X.

Index	Assessed Treatment Needs	Tx (sec)
1	Lesion requiring drilling and filling (define this as deemed to have infected dentine where clinical infected demineralisation of the underlying dentine is deemed to be present)	40 seconds with O <sub>3</sub>
2	Lesion possibly requiring drilling and filling (defined as possibly deemed to have infected dentine where clinical infected demineralisation of the underlying dentine is possibly considered to be present)	30 seconds with O <sub>3</sub>

3	Lesion requiring a pharmaceutical approach but not drilling and filling (defined as deemed to have infected demineralised dentine which is reversing and getting smaller. This scenario is where clinical remineralisation of the underlying dentine is considered to be in the process of remineralising the demineralised dentine but is not yet complete)	<b>20 seconds with O<sub>3</sub></b>
4	Lesion arrested (defined as deemed to have had infected dentine which reversed and where clinical remineralisation of the underlying dentine is considered to be complete, with no infection remaining in the dentine)	<b>10 seconds with O<sub>3</sub></b>

**Table 1: Clinical Severity Index (Holmes and Lynch 2001)**

In our clinical experience we developed the scheme in table 2.

Severity Index	Diagnodent Scores	Ozone Exposure
1	>31	40"
2	21-30	30"
3	16-20	20"
4	10-15	10"
In deep lesions exposure time 30" per mm. of depth.		

**Table 2: Clinical Severity Index , Diagnodent Scores and Ozone exposure in PFCLs**

It is important to underline that laser fluorescence, reproducible and sensitive, does not supply information about the extension of the lesion under examination<sup>13</sup>. Our experience is that the Diagnodent is technique sensitive, and the clinical classification above is a very useful quantitative method to assess and monitor carious lesions.

### **Ozone Treatment and Safety – The Healozone Kavo Device.**

Some Authors underline the fact that early diagnosis can lead to false positives and consequently to unnecessary treatments that damage dental tissues. Non invasive treatments certainly solve the problem, since no damage to dental tissues is induced by ozone.

The level of ozone released by the appliance is high, up to 2,200 ppm. Potential risks related to ozone have been taken into due consideration in the engineering of the device. The ozone delivery system works under vacuum and it is followed by aspiration and reductant liquid flow. This creates absolute safety conditions for both the patient and the Operator.<sup>14</sup>

## **Limitations in Ozone Treatment**

Ozone acts by contact. Lesions that cannot be reached by the ozone flow, or where the silicon cup does not seal the surface cannot be treated. Limitations are approximal lesions, hidden caries lesions and hardly accessible surfaces in general.

## **Clinical Trials**

Four clinical trials are presented in this chapter. They represent part of our research experience of the effects of ozone. They focus on:

- 1) Deciduous teeth 24 subjects - 48 lesions
- 2) Ozone *au lieu* of Sealants 5 subjects -20 lesions
- 3) Primary fissure carious lesions PFCLs 98 subjects - 352 lesions
- 4) Primary root carious lesions 18 subjects – 30 lesions

## **Statistical analyses**

Statistical analyses of the data were obtained by paired Student t-tests to determine differences between test and control groups, with the threshold of significance chosen at 0.05. Means and standard errors were also recorded.

## **Techniques**

At the end of this chapter some techniques of using ozone are illustrated and discussed. They are:

- 1) Mapping DIAGNOdent values
- 2) Applying ozone on natural crowns and roots
- 3) Treating cavitated lesions with ozone and filling

## **Deciduous Teeth treatment with ozone.**

Treatment of deciduous teeth lesions is challenging, since an increased consciousness of the risks involved in introducing possibly allergenic or toxic material in children mouth is expressed by parents and carers.

Ozone seems to offer an encouraging solution.

## *Material and Methods*

A Sample of 48 lesions in 24 young patients aging 3 to 10 years were selected. Males and females participated to the study. It was necessary that primary carious lesions on deciduous molar, premolar and canine teeth were present in at least two teeth accessible to diagnostic procedures. The lesions should have had four walls of sound enamel. Clinical assessment was performed using a probe. Lesions with stickiness at probing were excluded from the study.

Teeth showed DIAGNOdent readings higher than 10. It was necessary that the subjects were reliable concerning the attendance to recall appointments.

Exclusion criteria were absence of primary carious lesions on deciduous molar, premolar and canine teeth, carious lesions with pulp exposure and presence of severe gingival disorders. Antibiotic therapy during trial would exclude the subject from the trial.

Each subject presented two initial deciduous teeth lesions. One has been treated double blind with Healozone for 40 seconds, and one lesion has been left untreated as control.

All lesions have been monitored over time. Treated lesions have been monitored after 1, 2 and 3 months. Control (untreated) lesions have been monitored only at 1 and 2 months.

After the 2 months reading, increased QLF values (83% n=20) in almost all the control lesions minus four of them, compelled to perform ozone treatment. The remaining 4 control lesions have been monitored at 3 months.

## *Results*

In the study group (lesions treated with ozone), at 1 month QLF values decreased in 67% of lesions (n=16), increased in 25% of lesions (n=6), and remained unchanged in 8% of lesions (n=2). At month 2 QLF values decreased in 83% of lesions (n=20), increased in 13% of lesions (n=3), remained unchanged in 4% of lesions (n=1). At month 3 QLF values decreased in 88% of lesions (n=21), increased in 4% of lesions (n=1), remained unchanged in 8% of lesions (n=2).

In the control group (lesions untreated), at 1 month, QLF values decreased in 25% of lesions (n=6), increased in 58% of lesions (n=14), and remained unchanged in 17% of lesions (n=4). At month 2, QLF values decreased in 17% of lesions (n=4), and increased in 83% of lesions (n=20). As the control lesions were rapidly worsening, all 20 lesions, which showed increased QLF readings were treated with ozone. The remaining four lesions in the control group showing decreased QLF reading have been monitored at month 3. Three of them showed increased QLF readings compared to the initial value, and one had increased reading compared to the initial value.

**Table 3: Deciduous Teeth Trial - Sample Group at 1 Month**

**Table 4: Deciduous Teeth Trial - Sample Group at 2 Months**

**Table 5: Deciduous Teeth Trial - Sample Group at 3 Months**

**Table 6: Deciduous Teeth Trial - Control Group at 1 Month**

**Table 7: Deciduous Teeth Trial - Control Group at 2 Months**

**Table 8: Deciduous Teeth Trial - Mean Diagnodent Readings**

### *Discussion*

The data published at present on the effect of ozone on deciduous teeth do match with our clinical experience. Ozone has become the treatment of choice for early deciduous teeth carious lesions, avoiding the use of filling materials.

### **Ozone instead of Sealants in erupted molars in kids.**

Sealing occlusal grooves in recently erupted first and second molars is a diffused preventive practice. Sealing resins prevent bacterial attack on maturing enamel. Ozone seems to give protection to the newly erupted teeth, creating an ecologic niche on grooves for aerobial micro flora, and thus allowing the maturation of erupted enamel to take place.

### *Material and Methods*

A Sample of 20 lesions in 5 young patients aging 6 to 13 years were selected. Participation criteria to the study were the following. Males and females took part in the

study. It was necessary that grooves with clinically suspected demineralization were present in at least four first and second molars accessible to diagnostic procedures in each patient. Clinical assessment was performed to detect caries.

Teeth needed to show Diagnodent readings greater than 10. It was necessary that the subjects were reliable concerning the attendance to recall appointments.

Exclusion criteria were presence of cavitated carious lesions on molars, and presence of severe gingival disorders.

Each subject presented with four teeth whose fissures were clinically selected for sealing. Three of them were treated with the Healozone for 40 seconds, and one lesion was left as control.

All lesions were monitored over time. Treated lesions were monitored after 1, 2 and 3 months. At the end of the study control lesions were treated with ozone and monitored.

### *Results*

In the study group, at 1 month QLF values decreased in 73% of lesions (n=11), increased in 20% of lesions (n=3), and remained unchanged in 7% of lesions (n=1). At month 2 QLF values decreased in 80% of lesions (n=12), increased in 13% of lesions (n=2), and remained unchanged in 7% of lesions (n=1). At month 3 QLF values decreased in 87% of lesions (n=13), increased in 0% of lesions (n=0), and remained unchanged in 13% of lesions (n=2).

In the control group, at 1 month, QLF values decreased in 20% of lesions (n=1), increased in 20% of lesions (n=1), and remained unchanged in 60% of lesions (n=3). At month 2, QLF values decreased in 0% of lesions (n=0), remained unchanged in 40% (n=2), and increased in 60% of lesions (n=3). At month 3, QLF values decreased in 0% of lesions (n=0), remained unchanged in 40% (n=2), and increased in 60% of lesions (n=3).

**Table 9: Ozone au lieu of Sealant Trial - Sample Group at 1 Month**

**Table 10: Ozone au lieu of Sealant Trial - Sample Group at 2 Months**

**Table 11: Ozone au lieu of Sealant Trial - Sample Group at 3 Months**

**Table 12: Ozone au lieu of Sealant Trial - Control Group at 1 Month**

**Table 13: Ozone au lieu of Sealant Trial - Control Group at 2 Months**

**Table 14: Ozone au lieu of Sealant Trial - Control Group at 3 Months**

#### *Discussion*

The use of ozone in primary preventive dentistry is certainly a very exciting opportunity. The experiences collected in the last two years justify the previous hopes that acting on the metabolic processes of demineralisation of dentine might prove a successful and non invasive approach to treat caries without drilling and filling. The very limited sample of this test nonetheless demonstrates the efficacy of ozone as have many other published studies.

### **Ozone in the treatment of Primary Pit and Fissure Carious Lesions (PFCLs) in the Permanent dentition**

#### *Material and Methods*

A Sample of 352 lesions in 98 subjects aged 22 to 57 years have been selected. Young and adult subjects have been selected for this study presenting with occlusal primary carious lesions in the permanent dentition, and conforming to the criteria of participation to the study.

Males and females, aged over 12 participated to the study.

It was necessary that primary fissure carious lesions PFCLs were present in any tooth of permanent dentition, with the exclusion of the third molars, in at least two teeth accessible to diagnostic procedures. Teeth were classified in the Clinical severity Index Group 1-3, or they needed to show Diagnodent readings greater than 10. It was necessary that the subjects were reliable concerning the attendance to recall appointments.

Exclusion criteria were absence of primary fissure carious lesions PFCLs as defined in participation criteria, or the presence of advanced periodontal disease.

A clinical classification index, (Ekstrand, 1998, modified by Holmes and Lynch 2001)<sup>15</sup> has been utilized to classify lesions prior to treatment, as well as Diagnodent readings. A video camera at 40 X was used on both sample and control lesions.

After the clinical classification, and the cleaning of the surfaces with air abrasion using alumina oxide with 27,5 micron diameter, standard readings using qualitative laser fluorescence QLF with the DIAGNOdent® (KaVo, Germany) were performed. Half of the lesions were treated with ozone (HealOzone unit; KaVo, Germany), the remaining half was left as control. The amount of ozone exposure used was related to the CSI and Diagnodent values as in Table 2. All lesions were monitored over time. Ozonized lesions were monitored after 1, 2 and 3 months. As the control lesions were rapidly worsening, all 176 lesions which showed increased QLF readings were treated with ozone before 90 days.

### *Results*

In the study group, at 1 month QLF values decreased in 83% of lesions (n=146), increased in 11% of lesions (n=19), and remained unchanged in 6% of lesions (n=11). At month 2 QLF values decreased in 90% of lesions (n=160), increased in 5% of lesions (n=8), and remained unchanged in 5% of lesions (n=8). At month 3 QLF values decreased in 92% of lesions (n=163), increased in 5% of lesions (n=8), and remained unchanged in 3% of lesions (n=5).

In the control group, at 1 month, QLF values decreased in 16% of lesions (n=28), increased in 68% of lesions (n=116), and remained unchanged in 16% of lesions (n=29). At month 2, QLF values decreased in 6% of lesions (n=10), remained unchanged in 13% (n=22), and increased in 81% of lesions (n=144). At 1 month the mean QLF readings in the study population decreased from 13.5 to 10.1. In the control group the mean QLF readings increased from 16.8 to 18.5. At 2 months the mean QLF readings in the study population decreased from 10.2 to 6.5. In the control group the mean QLF readings increased from 18.5 to 20.8. At 3 months the mean QLF readings in the study population decreased from 6.5 to 6.2.

**Table 15: PFCLs Trial - Sample Group at 1 Month**

**Table 16: PFCLs Trial - Sample Group at 2 Months**

**Table 17: PFCLs Trial - Sample Group at 3 Months****Table 18: PFCLs Trial - Control Group at 1 Month****Table 19: PFCLs Trial - Control Group at 2 Months****Table 20: PFCLs Trial - Mean Diagnodent Readings**

Table 21 shows sample lesions classification according to the Clinical Severity Index.

Initial values refer to the CSI prior to ozone exposure.

INDEX	Initial	1 Month	2 Months	3 Months
1	0	0	0	0
2	12	7	2	2
3	7	11	3	1
4	157	168	171	173

**Table 21 : Clinical Severity Index in the Sample population**

### *Discussion*

Early diagnosis of primary pits and fissure caries is of great importance in children and adults because of the rise of a new model of carious lesion<sup>16</sup> which is difficult to diagnose with standard traditional detection methods such as oral radiographs and probe.<sup>17 18</sup> Low sensitivity to visual, probing and bitewing examination leads to a significant number of teeth with dentinal caries being undetected.<sup>19</sup> Lesions have a natural history of deepening into dentine leaving a macroscopically undamaged enamel surface. Minimal mineral loss prevents X rays to show evidence of decay<sup>20</sup>, and no macroscopic cavitation shows no probe stickiness. Systems using indirect light fluorescence have been demonstrated to be effective in the clinical diagnosis of decays in the permanent<sup>21 22</sup> and in the deciduous dentitions<sup>23</sup>.

Clinical reproducibility has been confirmed *in vitro*<sup>24</sup>. It has been observed that such methods are superior to oral radiography in the detection of occlusal lesions<sup>25</sup>. Our experience is that Laser fluorescence is technique sensitive, and the values do correspond to the clinical classification only if a thorough cleaning of the tooth surface from stains and salivary proteins has been properly done. If the reading of Diagnodent has no distortions given by the presence of stains or extrinsic protein deposits, then the values can be scored according the Severity Index Classification. Clinical classification is preferable when performed using an intra-oral video camera.

The relevant aspect of such a diagnostic methodology relies in the possibility to identify metabolic processes' dynamics taking place in dental tissues. What is made evident and available in every day dental practice is that dental decay is not a process of destruction of dental tissues, but the destruction is the consequence of an early detectable dynamic metabolic process whose development can be indirectly monitored (using the Diagnodent), and then confronted with a clinical framework.

The use of ozone in the remineralisation therapy of primary occlusal lesions gives much greater advantages in comparison with demolitive and also minimally demolitive methodologies .

I would stress three major advantages: no pain at all, rapidity and effectiveness. It is a non invasive treatment, which means that micro burs or air abrasion are no longer needed. Since we know that a preparation greater than 1/4 the inter-cuspal width reduces the inter-cuspal strength by up to 50%<sup>26</sup>, early diagnosis and non invasive treatment stops the progression of caries and therefore any need for future remaking of fillings. And costs are significantly reduced.

### **Primary Root Carious Lesions (PRCLs) treatment with ozone.**

Treatment of PRCLs with ozone has been the pioneering studies which validated the effectiveness of such a technique<sup>27 28 29</sup>. In everyday clinical practice we monitor the results. Many of these lesions have difficult access, and those easily accessible are in many cases not aesthetic for patients. We have been extensively using ozone to remineralise root lesions prior to reconstruction with flowable composites or veneers, or simply leaving the lesion to remineralise in the oral environment and our subjective clinical results are excellent., We could perform only limited clinical trials and controls are not available.

### *Material and Methods*

A Sample of 30 primary root carious lesions in 18 patients aging 55 to 82 years, males and females, have been selected. It was necessary that primary root carious lesions on molar, premolar and canine teeth were present in at least two teeth accessible to diagnostic procedures. The lesions should be classified as hard, leathery and soft according to Lynch. Clinical assessment was performed using a probe. Teeth needed to show Diagnodent readings greater than 10. It was necessary that the subjects were reliable concerning the attendance to recall appointments.

Exclusion criteria were absence of primary root carious lesions on molar, premolar and canine teeth, carious lesions with pulp exposure and presence of severe gingival disorders.

Each subject presented at least two primary root lesions. All were treated with the Healozone for 40 seconds. No lesions could be left as control.

All lesions were monitored over time, and Diagnodent readings were registered after 1 and 3 months.

### *Results*

At 1 month QLF values decreased in 77% of lesions (n=23), increased in 13% of lesions (n=4), and remained unchanged in 10% of lesions (n=3). At 3 months QLF values decreased in 90% of lesions (n=26), increased in 7% of lesions (n=2), and remained unchanged in 3% of lesions (n=1).

**Table 22: PRCLs Trial - 1 Month**

**Table 23: PRCLs Trial - 3 Months**

### *Discussion*

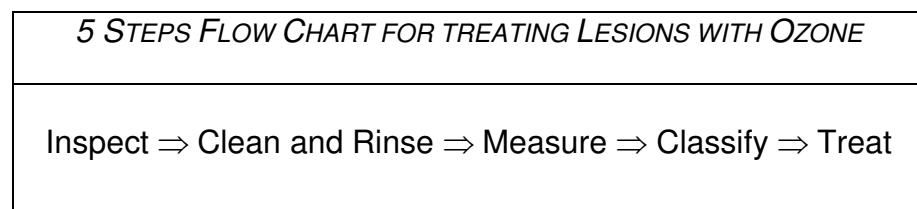
Treatment of primary root carious lesions has been the great challenge of geriatric dentistry<sup>30</sup>. Studies demonstrated that consistency of the lesion, discolouration and bacterial activity were not directly correlated<sup>31</sup>. Therefore, a diagnosis and the consequent course of action (treatment or not) has always been controversial<sup>32</sup>. The same studies demonstrated also that any root lesion is reversible and associated with remineralisation, if antibacterial methods are applied<sup>33</sup>. Studies on the effectiveness of ozone on PRCLs have

demonstrated its tremendous effects in removing organic debris enhancing remineralisation<sup>34</sup>.

## Techniques

### *Treating Primary Carious Lesions using Diagnodent and Healozone*

In our experience treating primary carious lesions with ozone is a five steps procedure. Step one is the clinical inspection with magnification (Picture 1). Step two is the cleaning of fissures using air abrasion or bicarbonate and then rinsing with an air-water syringe (Picture 2). Step three is the measurement with the Diagnodent (Picture 3). Step four is the classification according to the Clinical Severity Index and the QLF readings (see Table 2). Once the lesion has been classified, step five is exposure to ozone (Picture 4). The steps are summarized in the following flow chart.



**Picture 1: Inspection of the lesion**

**Picture 2: Cleaning of the lesion**

**Picture 3: Measurement with Diagnodent**

**Picture 4: Apply ozone**

*Apply ozone on natural crowns and roots*

Ozone produced by HEALOZONE acts when in contact of the tooth. Sometimes this is not always feasible, due to the anatomy of teeth, which defies the diameter range of silicone cups provided by the manufacturer. We suggest two tips: using your own finger to obtain a seal, and reconstruct or create a seal for the cup using flowable composite without etching and applying adhesive. In picture 2, some help from a finger is illustrated. Rubber in gloves are damaged by ozone. In pictures 3 and 4, the use of flowable composite is suggested to overcome some anatomical obstacle to seal the silicon cup.



### *Treating cavitated lesions with ozone and filling*

The study of Mertz-Fairhurst's group provides some evidence that some infected dentine left underneath some sealed restorations might not progress<sup>35</sup>. There is evidence that infected dentine should be removed prior to sealing. Destruction of bacterial agents in carious lesions using ozone stops the progression of the demineralisation process. With adequate dosage of ozone, the infected layer of dentine becomes disinfected, and the affected dentine (demineralised dentine with fewer pathogenic micro-organisms<sup>36</sup>) is subject to remineralisation. These observations provide the rationale for a non invasive technique consisting in an ozone exposure of infected dentine as long as the estimated depth of the lesion is radiographically or clinically determined. The exposure time we use are a ratio of 30 seconds of ozone for every one millimetre of infected dentine's depth. In doubt, I remind readers that *melius est abundare quam deficere* (it is better to have plenty than to have little). Once the lesion is sterile, a filling can be placed provided that it can be sealed.. I am confident that more studies will be performed to validate the technique.

## **Conclusions**

Ozone has demonstrated effectiveness in treating carious lesions at a very early stage. It is my belief that its main field of action is the maintenance of primary oral health. To achieve this goal two things are necessary. The first is to teach the new scientific paradigm at Dental Schools and in continuous education programs. The latter is to inform the public that a new strategy is available which can stop the progression of dental caries at a very early stage. And both parties, dentists and public, should develop a common ground where dentists act more as therapists and patients are more responsible for their well-being.

Companies in the dental sector also should understand that the change in the scientific paradigm makes dental therapists and patients equal in the decision process. Therefore, a greater attention to the needs and demands of the public should be considered in their marketing strategies.

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