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VITAMIN D_3 VERSUS PROSTAGLANDIN E1: A COMPARATIVE CLINICAL STUDY ON THE RATE OF ORTHODONTIC TOOTH MOVEMENT .

Dental Science

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KEYWORDS:

Introduction:

Application of mechanical forces to teeth causes tooth movement as a result of the biological responses of the periodontal tissues.[1]

Although most of the appliances differ in mode of action, they must ultimately achieve the similar cellular effect like; the resorption and apposition of alveolar bone to produce desired orthodontic tooth movement in the desired direction.[2]

Local regeneration of tissues involves resorption of alveolar bone adjacent to the periodontal ligament in the pressure zone and apposition in the tension zone. There are also degenerative and formative changes seen in the periodontal ligament.[3]

It is a generally accepted hypothesis that teeth move in response to applied mechanical forces, characterized by remodeling changes indental and paradental tissues, including dental pulp, periodontal ligament (PDL), alveolar bone, and gingiva. When these tissues, exhibited to varying degrees of magnitude, duration, and frequency of mechanical loading, explicitbroad macroscopic and microscopic variations.[1]

There are many theories as to the exact cellular mechanism by which orthodontic tooth movement occurs. The pressure-tension hypothesis[4-5], the theory of vascular occlusion[6-7], the concept of the periodontal ligament as a hydrostatic mechanism8and the piezo- electric or bone bending theory[9].

The adaptive response to applied orthodontic force primarily lies in the DNA of periodontal ligament and alveolar bone cells. Cell vitality and population determine the molecular genetic responses effectingfe asible tooth movement.[10]

Recently, several reviews have been published about the biologic operations related to OTM. These reviews describe similar reactions of periodontal cells and extracellular matrices to orthodontic force application. Briefly, the principal trigger for OTM is mainly due to pressure on the periodontal ligament cells, bone-related cells, and the extracellular matrix.This pressure prompts changes in quality statement in the cells by cooperations between the cells and the extracellular matrix, whereby integrins assume an essential part.Different cell-signaling pathways are enacted, which at last prompt incitement of periodontal ligament turnover, and limited bone resorption and bone deposition.[11]

Systemic or local application of medications and the intake of dietary supplements, such as vitamins and minerals, intentionally or unintentionally may have an impact on orthodontic tooth movement and orthodontic treatment.[12-13]

Recently, several researchers have shown that a simultaneous application of mechanical and chemical or electrical stimuli acting in combination might enhance bone turnover and facilitate faster orthodontic tooth movement than with mechanical alone.[14-17]

Previous studies on experimental tooth movement have shown that the simultaneous administration of Vitamin D_3 or Prostaglandin E1 with the application of mechanical force induce the formation of many osteoclasts and enhance bone resorption, resulting in significantly faster rates of tooth movement.[1-2,18-20]

Most reviews, be that as it may, did not report trial information on the impacts of medicines or dietary supplements on the rate of OTM.In any case, such data is critical for clinicians in correspondences with patients, in light of the fact that numerous patients utilize prescription and over-the-counter meds, and also dietary supplements every day. Consequently, these substances can affect both the rate of OTM and the expected duration of treatment.

Therefore, a clinical study was performed to check the effect of local application of Vitamin D_3 and Prostaglandin E1 on rate of canine retraction.

Materials and Methods:

Fifteen patients undergoing fixed orthodontic treatment using MBT appliance in the Department of Orthodontic and Dentofacial Orthopaedics, VS Dental College & Hospital, Bangalore were selected for this study.

Orthodontic armamentarium like pin and ligature cutter, ligature tucker was used to deliver the gel, elastic o rings, 0.010 inch ligature wire, Vitamin D_3 and Prostaglandin E1(PGE1) gels for local drug delivery and digital vernier caliper was used for this study apart from routine orthodontic instruments.

Method of Data Collection:

The study was conducted from the beginning of 2nd Phase (space closure phase) of fixed orthodontic treatment, for duration of 6 weeks.

It is a split-mouth type of study design, in which the maxillary arch of each subject is divided into right (Vitamin D_3)and left (PGE1).

All subjects included in this study were with Angle's class I or class II malocclusion indicated for bilateral maxillary first premolar extraction and belonged to age group of 12 to 27 years old. Prior consent from the patients or parents/guardian was taken. The subjects where there was a minimum of 3mm of extraction space available on both sides before maxillary permanent canine distalization and undergoing treatment with Pre-adjusted Edgewise Appliance (PEA) with 0.022 MBT prescription and who have finished with levelling and alignment were selected for the study.

The subjects with previous history of orthodontic or presence of any craniofacial anomalies, signs and symptoms of periodontal diseases were excluded from the study. Subjects with significant medical history (including drug allergy) and pregnant and lactating women were also excluded. Ethical clearance was obtained before the start of study.

Methodology :
Fifteen patients entering the 2nd phase of fixed orthodontic treatment were selected for the clinical trial. All participants were given a brief description about the purpose of the study.

All the subjects were bonded with 0.022 x 0.028 inch slot brackets using Pre-adjusted Egdewise Appliance (MBT prescriptions). Enmass retraction was used to retract the anterior segments.

After reaching to 0.019 x 0.025 inch stainless steel arch wire upper arch impressions were made using alginate at the end of leveling and aligning before canine retraction. Impressions were then poured using Type III orthodontic dental stone.

The maxillary enmass retraction (2nd phase) was started using Active tiebacks attached to the maxillary first molar tube and canine hook.

At each appointment, oral hygiene measures were reinforced and the appliances were assessed for any damage.

On the right side/quadrant Vitamin D_3 gel and left side/quadrant PGE1 was delivered using local delivery system. These gels were applied on the mucous membrane on distal side of the maxillary canine using ligature tucker.(Fig1A-E)

The gel was applied once in 2 weeks of three applications. All the Patients were evaluated from the beginning, (T0)0 weeks, (T1) 2 weeks, (T2) 4 weeksof canine retraction. At these appointments, impressions of the maxillary arch were taken with alginate to obtain the study models.

The study period extended from the beginning of canine retraction through a period of 6 weeks. This ensures that the appliance remains active for the entire period of the study and that the rate of orthodontic tooth movement was measured over a defined period of time.

All Study measurements were performed on dental cast. The extraction space at each interval is measured from the distal surface of canine to the mesial surface of 2nd premolar.

Measurements are made bilaterally with digital vernier caliper (Fig 2). After 14 days the measurements were repeated to check the reproducibility

The difference of Canine distance (C) between pretreatment (C1) and post treatment (C2) was measured on cast and in mouth.

RESULTS:
Group 1- Vitamin D , Group 2 –PGE2

Table no. 1 Comparison of tooth movement (baseline) between the Group 1 and Group 2

Group	Mean	SD	T value	P value
Group 1	4.5560	.74729	.015	.737
Group 2	4.5520	.67936		
Total	15			

Table no. 2 Comparison of tooth movement (15 days) between the groups

Group	Mean	SD	T value	P value
Group 1	.8847	.08643	.044	.677
Group 2	.8833	.08006		
Total	15			

Table no. 3 Comparison of tooth movement (30 days) between the groups

Group	Mean	SD	T value	P value
Group 1	.7333	.06914	.025	.963
Group 2	.7327	.07905		
Total	15			

Table no. 4 Comparison of tooth movement (45 days) between the groups

Group	Mean	SD	T value	P value
Group 1	.7973	.09362	0.8400	.030*
Group 2	.7973	.09809		
Total	15			

Discussion:
The data from the current study indicated that local application of Vitamin D_3 and PGE1 gels increases the tooth movement.

And we noticed that there were no apparent clinical side effects with the local application of the gel. Although similar findings have been reported with the use of pulsed electromagnetic fields, direct electrical currents, and by other means, these techniques represent completely different mechanisms of action which are biological.[1]

The pulsed electromagnetic field and direct electrical current increases the rate of orthodontic tooth movement by a significant increment in the amount of bone and matrix deposited in the area of strain and sound increase in a number of osteoclasts in the alveolar bone in the zone of pressure.[15-16] Researches have demonstrated that the Prostaglandins likewise acts by stimulating the osteoclast and Vitamin D_3 acts on osteoblast and osteoclasts thereby expanding the rate of orthodontic tooth movement.[18]

Previous studies have shown there was no significant difference between Vitamin D3 and prostaglandin PGE1 concerning their effects on the amount of tooth movement was found.[1]

However, Vitamin D_3 acts directly on the nucleus of the circulating monocytes and osteo-progenitor cells, which have specific receptors for it. This allows a cellular activation that is totally independent of the cyclic nucleotide cascade.[2]

Vitamin D_3 increases the numbers of Howship's lacunae. And this finding agrees with many other studies in which Vitamin D_3 were found to increase the number of active osteoclasts.[2]

PGs are inflammatory mediators and a paracrine hormone that acts on nearby cells; it stimulates bone resorption by directly increasing the number of osteoclasts.[3]

When 1,25(OH)2D3 and PGE1 was applied locally together with experimental tooth movement, the number of osteoclasts reached a peak on day 3 and subsequently decreased to the baseline level on day 15.19And hence in this study the gel was applied at an interval of 15 days according to the biology of tooth movement.

The current study showed that there was no significant difference in the rate of tooth movement with the application of Vitamin D3 and PGE1.

Conclusion:
After a 45 days experimental study we concluded that with 3 local application of Vitamin D_3 gel, produced a significantly increased rate of orthodontic tooth movement.

The study achieved 33.60% of increase in the rate orthodontic tooth movement with application of Vitamin D_3 gel.

There was no obvious clinical, microscopic, or biochemical side effects noted, with gel application. And also this method proved to be non invasive and yet effective.

FIGURES AND TABLES :

Fig 1(A to E) – DEMONSTRATION OF GEL APPLICATION.



FIG 2 – SHOWING MEASUREMENTS RECORDED USING DIGITAL VERNIER CALIPER ON DENTAL CAST.



TABLES : Table 1: Results showing mean tooth movement at T_1,

T_2&T_3 were n = 15.

Mean n=15	T_1 at 15 days Amount of tooth movement			T_2 at 30 days Amount of tooth movement			T_3 at 45 days Amount of tooth movement			Over all increase in the rate of OTM * 33.60 %
	In Ex *	In C*	Diff in T_1	In Ex*	In C*	Diff in T_2	In Ex*	In C*	Diff in T_3	
	0.92	**0.66**	**0.26 (39.39%)**	**0.73**	**0.57**	**0.16 (28.07%)**	**0.80**	**0.60**	**0.20 (33.33%)**	

Ex* – Experimental Group, C* - Control Group, OTM* - Orthodontic Tooth Movement

Table 2: Statistical analysis obtained with Anova test.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	*Interpretation*
Days (every 15 days)	61.61	43.00	1.43	5.65	0.0000	1.66	Highly Significant
Treatment (Ex vs C)	1.08	1.00	1.08	4.25	0.0454	4.07	Significant
Error	10.91	43.00	0.25				
Total	73.60	87.00					

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