# The Effect of Thyroid Hormone on the Eruption Rate of Incisor Teeth in Rats

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# The Effect of Thyroid Hormone on the Eruption Rate of Incisor Teeth in Rats

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Doctor of Philosophy

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**December 2001**

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*December 2001*

## Acknowledgements

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**ABSTRACT**

# The Effect of Thyroid Hormone on the Eruption Rate of Incisor Teeth in Rats

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*(Directed by Professor Choi, Byung Jai, D.D.S., M.S., Ph.D.)*

The purpose of this study was to verify the effect of thyroid hormone(3,3',5-triiodo-L-thyronine) on the rate of tooth eruption in rats. Each adult male albino rat was immobilized under anesthesia(n=14). Small notch was formed on the labial surface of tooth structure near the cervical gingival margin of lower left incisor. Through the specific linear measurement method with the interval of 7 days and the serum analysis of T3, T4, TSH, the information of normal eruption rate of lower incisor and average serum hormonal levels of laboratory animal was obtained. After one week of resting period, the rats were prepared and analyzed on the eruption rate and the hormonal levels with the same manner under the intraperitoneal injection of thyronine(T3) every morning for 7 days. Microscopic examination and statistical test was done.

During the T3 injection period, average body weight decreased, and tooth eruption rate increased with the statistical significance ($p<.01$). Microscopic view revealed congested blood vessels and enhanced cellular life-cycle, showing various forms of fibroblasts in periodontal tissues. From this results and comprehensive review, thyroid hormone could be considered as one of the important factors for controlling biologic ages like; skeletal age and dental age. Further study is needed about the effect of tooth movement on the level of thyroid hormone.

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Key words: thyroid hormone, cellular metabolism, life-cycle, rat, incisor, eruption rate

# INTRODUCTION

*Seong Oh Kim, D.D.S., M.S.*

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The function of thyroid hormone is known as to increase the basal metabolic rate of body. It controls the metabolism in cellular level, which influences on the cellular turnover rate. It has the effect on the metabolism not only of the soft tissue but also of the hard tissue.[19,33]

From this point of view, it is logical that thyroid hormone may control the rate of tooth movement and can reduce the amount of root resorption during the orthodontic treatment. The effect of thyroid hormone on tooth movement and root resorption with laboratory animals and several clinical trials of thyroxine has been reported.[6,15,20,22,24,25,28]

## A Clinical Case, Which Motivated This Study[31]

In 1990, an 11-year-old girl visited the department of pediatric dentistry, Yonsei University Dental Hospital, complaining her unerupted upper left canine. The active orthodontic treatment was done for 21 months successfully by forced eruption procedure

with some period of remarkably rapid tooth movement. During the finishing procedure with a rectangular heavy wire, the occurrence of progressive generalized spacing between lower anterior teeth has been notified. The information of patient's hyperthyroidism during the forced eruption period was obtained from her medical history interview.

As the tooth erupted remarkably fast speed, the eruption rate and the hormonal levels of thyroid are analyzed and compared.

Eruption rate is measured and calculated from the periapical film and it's exposure date. Each distance is calibrated to the last film through anatomical landmarks such as cusp tip, cervical margin, and root apex of adjacent teeth*(Table 1)*.

*Table 1. Data obtained from periapical radiographic film with calibration procedure.*

| Date | Depth of Canine Tip from Occlusal Plane (mm) | Period (days) | Movement (mm) | Average Eruption Rate (㎛/ day) |
|---|---|---|---|---|
| *90-03-28* | *18.00* | *285* | *0.9* | *3.16* |
| *91-01-07* | *17.10* | *80* | *0.7* | *8.75* |
| *91-03-28* | *16.40* | *55* | *0.9* | *16.36* |
| *91-05-22* | *15.50* | *19* | *1.0* | *52.63* |
| *91-06-10* | *14.50* | *58* | *1.5* | *25.86* |
| *91-08-07* | *13.00* | *146* | *4.5* | *30.48* |
| *91-12-31* | *8.55* | *69* | *1.9* | *27.68* |
| *92-03-09* | *6.64* | *235* | *4.6* | *19.74* |
| *92-10-30* | *2.00* | *42* | *2.0* | *47.62* |
| *92-12-11* | *0.00* | | | |

In 1991-8-28, she was diagnosed as the hyperthyroidism due to high level of thyroid hormone especially in serum T3 *(Table 2)*. Some event in her body, suspicious therapeutic forced eruption procedure, might have triggered to increase the serum thyroid level on that day. After the thyroid treatment, serum hormonal level showed relatively high but in normal range.

*Table 2. Data obtained from medical records.*

| Date | Serum T4 Level (μg/ dℓ) | Serum T3 Level (*ng*/ dℓ) | Serum TSH Level (μ*IU*/ mℓ) |
|---|---|---|---|
| *91-08-28* | *17.47* | *429.21* | *0.01* |
| *91-11-13* | *9.24* | *188.12* | *8.25* |
| *92-02-10* | *8.50* | *109.00* | *2.31* |
| *92-07-22* | *7.90* | *154.21* | *2.02* |
| *93-08-10* | *9.12* | *125.80* | *1.75* |
| Reference in Human | 5~13 | 80~220 | 0.34~3.5 |

Serum thyroid level was controlled with PTU(propylthiourasil), which is known as antithyroid. She also received beta-blocking anti-hypertensive drug(Inderal®) to control the hypertension caused by hyperthyroidism. Due to this prescriptions, serum thyroid level decreased markedly, but TSH level increased for a while*(Table 2 and 3)*.

*Table 3. Prescribed date and drugs for hyperthyroidism.*

| Date | PTU(*mg*) | Inderal(*mg*) |
|---|---|---|
| *91-09-11* | *300* | *60* |
| *91-12-11* | *150* | *40* |
| *92-02-10* | *100* | *40* |
| *92-12-21* | *0* | *0* |
| *93-08-10* | *100* | *40* |
| *93-09-10* | *0* | *0* |
| *94-05-24* | *300* | *60* |
| *94-07-19* | *150* | *40* |
| *94-09-23* | *0* | *0* |

From these tables, the eruption rate and the levels of serum hormones and prescribed drugs are visualized in *Figure 1*. In

comparing the rate of eruption and thyroid hormonal levels with double Y-axis, it could be assumed that there be close relationship between them.

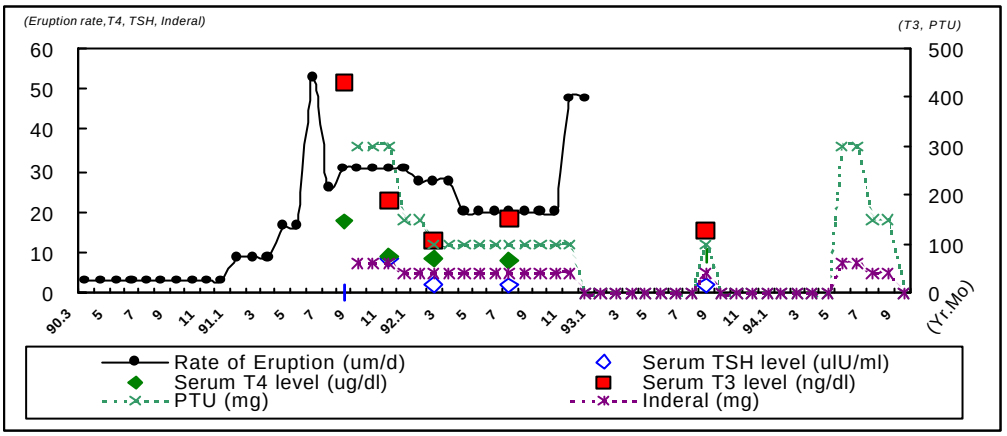


*Figure 1. Comparison of eruption rate and serum hormonal level related to thyroid in this case.*

## Negative Feedback System of Thyroid Hormones and Other Related Hormones *(Figure 2)*

As this hormone is considered in the complex feedback system, small amount of exogenous thyroxine did not increase circulating thyroxine levels.[25]

This hormone also has some interactions with growth hormones and sex hormones *etc.* It has been reported that GH and T4 stimulate bone formation. Estrogen result in diminished bone formation. Testosterone stimulate bone growth in humans, but it does not have any effect on bone formation in the rat.[33]

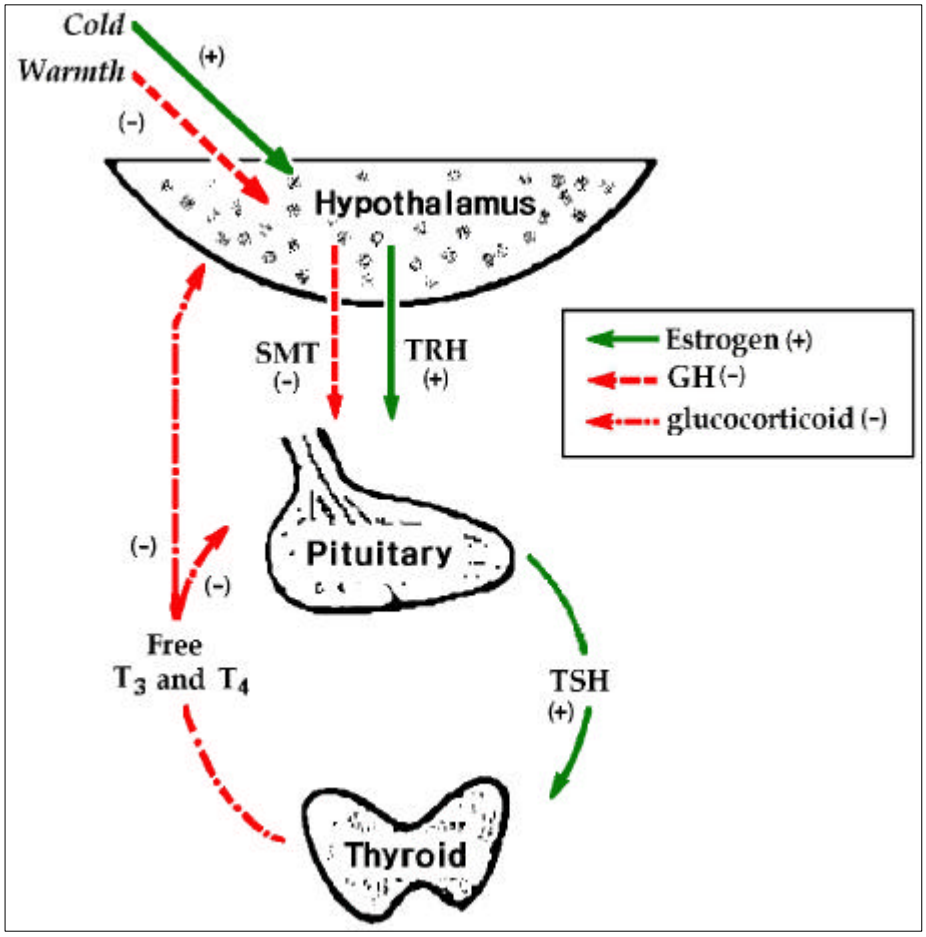


*Figure 2. Negative feedback system and related hormones*
*SMT(somatostatin), TRH(thyroid releasing hormone),*
*TSH(thyroid stimulating hormone),*
*T3(triiodothyronine), T4(thyroxine)*

## The Purpose of study

The aim of this study is to identify the effect of thyroid hormone(3,3',5-triiodo-L-thyronine) on the rate of tooth eruption in rats excluding other hormonal effects.

# MATERIALS AND METHODS

## Experimental Design

16 adult male albino rats of Sprague-Dawley strain which weighed 400 500gm were obtained. During the experimental period, they had the access to pelleted food and water *ad libitum* and were kept under controlled temperature(19 21℃) and lightening(lights on from 07:00 to 19:00). During the experimental period, they were weighed once a week.

Before the experiment, they had the adaptation period to a new laboratory environment, which was more then 7 days. Two of them were killed for the histological study of control group.

At the first day of experiment, each rat was anesthetized with sodium barbiturate(*4mg/100gm intraperitoneal injection*). The extremities of subject were immobilized with tape and pins, and mouth was widely opened using a large pincette. The labial side of the lower incisor was fully exposed and immobilized with the retraction of lower lip using tied dental floss and pins. And then, small notch was formed on the labial surface of tooth structure near the cervical gingival margin of lower left incisor with the thin metal disk. The identical metallic ruler was positioned in parallel with the long axis of lower incisor in a labial view, which is then photographed twice per each rat for the further

linear analysis. Photograph was taken in rectangular angle with the labial surface of lower incisor*(Figure 3)*. The injection of normal saline was done every morning for 7 days.

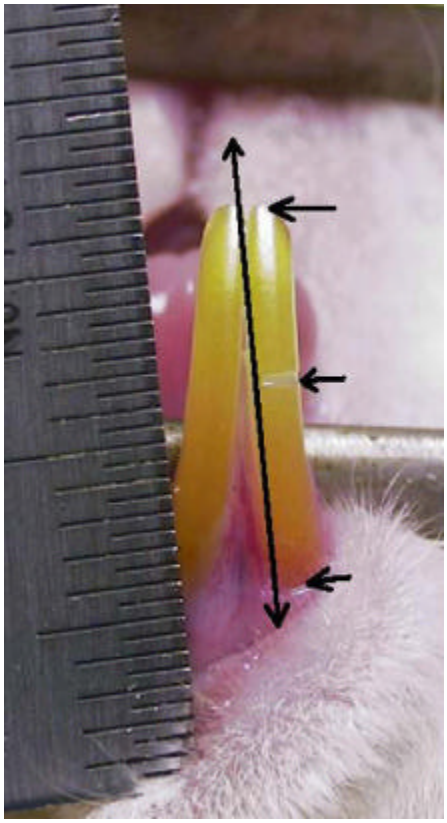

*Figure 3. Photograph with a metallic ruler in parallel with the long axis of incisor. Photograph is taken in perpendicular angle with labial surface of incisor and viewing direction.*

After one week(day 7), each notched incisor was photographed with the same manner previously mentioned. Then blood sample(2*ml*) was taken for the serum analysis of T3, T4, and TSH. The analysis was done with the kit of RIA-gnost T3®, RIA-gnost T4®, and RIA-gnost TSH® at the Radioimmunoassay Laboratory of Soonchunhyang University Hospital, Seoul, Korea. Two of them were killed for the microscopic histological study. The data is considered as control.

After one week of resting period(day 14), another notch is formed and photographed with the same manner previously mentioned. Then they received the intraperitoneal injection of 3,3',5-triiodo-L-thyronine(T3, T6397™, Sigma-Aldrich Korea LTD)

with the amount of 100㎍/㎏ *body weight*. The injection was done every morning for 7 days. On the last day of experiment(day 21), blood was drawn by intracardiac puncture(4㎖) under the anesthesia and killed by cervical dislocation. Then each notch was photographed twice.

The obtained serum was analyzed for the levels of T3, T4, and TSH with the same kit at the RIA Laboratory and then sent to Ewon Reference Laboratory(Seoul, Korea) for the analysis of PTH. The mandibles of rats were sectioned for the microscopic study.

**Linear Measurements**

Each notched incisor with the metallic ruler was photographed twice. Linear measurement was done with the pictures according to *Figure 4*.

Measuring points and linear measurements are defined as follows:

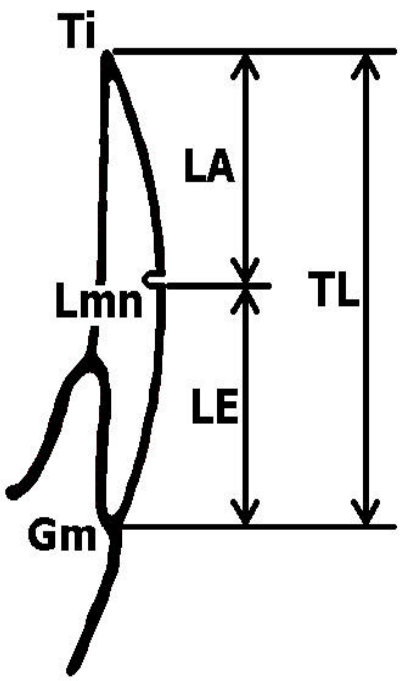


*Figure 4. Selected points and linear measurements on the lateral view of lower incisor in rat. For definitions of the points refer to the text.*

**Gm**: The lowest point of clinical gingival margin

**Lmn**:Lower margin of notch

**Ti**: Tip of incisor

**LE**: The linear length related to eruption

**LA**: The linear length related to attrition

**TL**: Total length of incisor

The measurements from pictures were converted to a real length according to the calibration of ruler in picture. *Pure eruptive length* is calculated as follows:

$$\textit{Length of Pure Eruption}_{(\text{Control period})} = \textbf{LE(day 7) - LE(day 1)}$$

$$\textit{Length of Pure Eruption}_{(\text{T3 injection period})} = \textbf{LE(day 21) - LE(day 14)}$$

*Pure attrition length*, and the *changes of total incisal length* are also analyzed.

## Statistical analysis

After the descriptive analysis of eruption rate, body weight, and serum levels of T3, T4, TSH and PTH, changes between two periods were tested.

As the measurements were obtained from the same rat with

the different period, analysis was done by the *Wilcoxon Matched-Pairs Signed-Ranks Test*. Main focus was on the changes of eruption rate between two different periods.

## Histological Preparations and Microscopic Examination

Obtained mandibles were fixed in formaldehyde solution as soon as possible, and decalcified in 0.6 M solution of EDTA buffered at pH 7.3 for 2 to 3 weeks. After serial sectioning in the sagittal plane, the tissue sections were stained with hematoxylin-eosin. Slide samples were photographed and compared.

# RESULTS

## The Eruption Rate of Incisor

Descriptive analysis has shown that eruption rate, attrition rate and incisor length have increased in T3 injection period*(Table 4, 5, 6)*.

But only the eruption rate has revealed the statistical significance between two periods($p<0.01$). There were no statistical significances of attrition rate and incisor length change between two periods.($P>0.1$)

*Table 4. Changes of **eruption rate** between control period and T3 injection period.* *(n=14)*

| Period | Mean (mm/week) | Standard deviation | Minimum (mm/week) | Maximum (mm/week) |
|---|---|---|---|---|
| *Control* | *4.07* | *0.572* | *3.48* | *5.37* |
| *T3 Injection* | *4.76* | *0.493* | *4.13* | *5.78* |
| *Changes* | *0.69* | *0.550* | *0.01* | *2.00* |

*p=0.001 by Matched-Pairs Signed-Ranks Test*

*Table 5. Changes of **attrition rate** between control period and T3 injection period.* *(n=14)*

| Period | Mean (mm/week) | Standard deviation | Minimum (mm/week) | Maximum (mm/week) |
|---|---|---|---|---|
| *Control* | *3.55* | *0.901* | *2.76* | *5.70* |
| *T3 Injection* | *3.88* | *0.566* | *2.66* | *5.00* |
| *Changes* | *0.33* | *0.908* | *-1.30* | *1.48* |

*p=0.177 by Matched-Pairs Signed-Ranks Test*

*Table 6. Changes of incisor length between control period and T3 injection period.* *(n=14)*

| Period | Mean (mm/week) | Standard deviation | Minimum (mm/week) | Maximum (mm/week) |
|---|---|---|---|---|
| *Control* | *7.62* | *1.392* | *6.39* | *11.07* |
| *T3 Injection* | *8.65* | *0.911* | *6.79* | *10.18* |
| *Changes* | *1.03* | *1.247* | *0.88* | *-1.71* |

*p=0.011 by Matched-Pairs Signed-Ranks Test*

## Serum Analyses and Body Weight Change

In *Table 7.*, serum T3 level of T3 injection period was three times greater than that of control period ($p<0.01$). T4 level has decreased with statistical significance ($p<0.01$). There seemed no change in the level of TSH.

*Table 7. Assays of serum hormones between control period and T3 injection period.* *(n=14)*

| Hormones | *Reference in Human* | Period | Mean (mm/week) | Standard deviation |
|---|---|---|---|---|
| T3 | ( 70 190*ng*/dℓ ) | *Control* | *73.14* | *16.75* |
| | | *T3 Injection* | *268.36* | *124.40* |
| | | *Changes* | *195.07*** | *112.44* |
| T4 | ( 5 12㎍/dℓ ) | *Control* | *4.76* | *0.980* |
| | | *T3 Injection* | *0.32* | *0.059* |
| | | *Changes* | *-4.44*** | *0.948* |
| TSH | ( 0 50 μU/㎖ ) | *Control* | *0.0119* | *0.0056* |
| | | *T3 Injection* | *0.0124* | *0.0065* |
| | | *Changes* | *0.0004* | *0.0070* |
| PTH | ( 12-72 *pg*/㎖ ) | *After* | *13.41* | *11.03* |

** *p <0.01 by Wilcoxon Matched-Pairs Signed-Ranks Test*

In *Table 8.*, average body weight was 473.8±40.1gm during control period, and there was no statistically significant change. But during the T3 injection period, body weight has decreased about 63.2±21.3gm with statistical significance ($p<0.01$).

*Table 8. Changes of body weight between control period and T3 injection period.* *(n=14)*

| Experimental Day | Mean (gm) | Standard deviation |
|---|---|---|
| *1* | *473.8* | *40.1* |
| *7* | *475.5* | *36.7* |
| *Changes* | *-1.7* | *19.9* |
| *14* | *496.9* | *37.3* |
| *21* | *433.6* | *29.5* |
| *Changes* | *63.2*** | *21.3* |

*Wilcoxon Matched-Pairs Signed-Ranks Test*

*** p <0.01*

## Histological Findings *(Figure 5 9)*

In contrast to the control group, microscopic view of T3 group shows the typical congested blood vessels in the periodontal ligamental tissue. Odontoblast shows more hyperchromatic and elongated nucleus*(Figure 5,6)*.

In viewing with the magnification of x400, dentinal tissue of T3 group shows more hyperchromatic than that of control group. The cells of periodontal tissue show more hyperchromatic nucleus and various cellular forms, indicating the enhanced cell cycles.

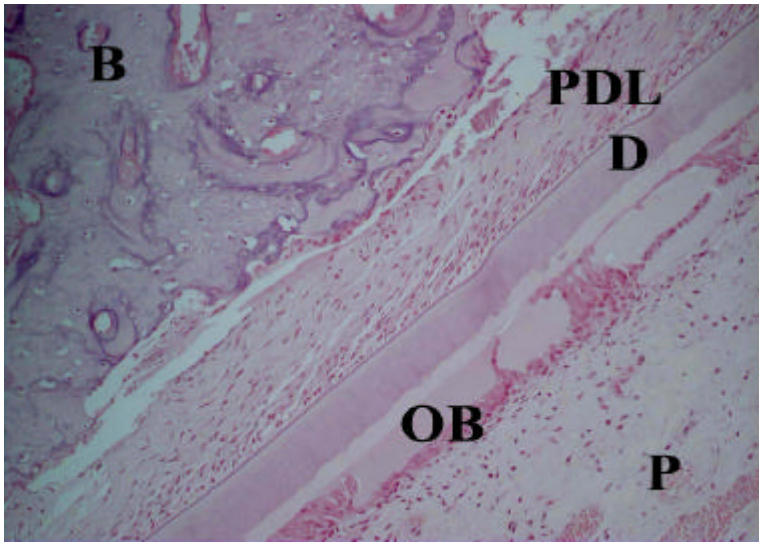


*Figure 5. Microscopic view of periodontal tissues in the control group of a rat. Large intercellular matrix can be seen in the odontoblastic layer, which is absent in human. Most of the periodontal fibroblasts are matured in well-aligned direction. PDL(periodontal ligament), B(alveolar bone), D(dentin and predentin), OB(odontoblast), P(pulp) /magnification X200, H-E stain.*

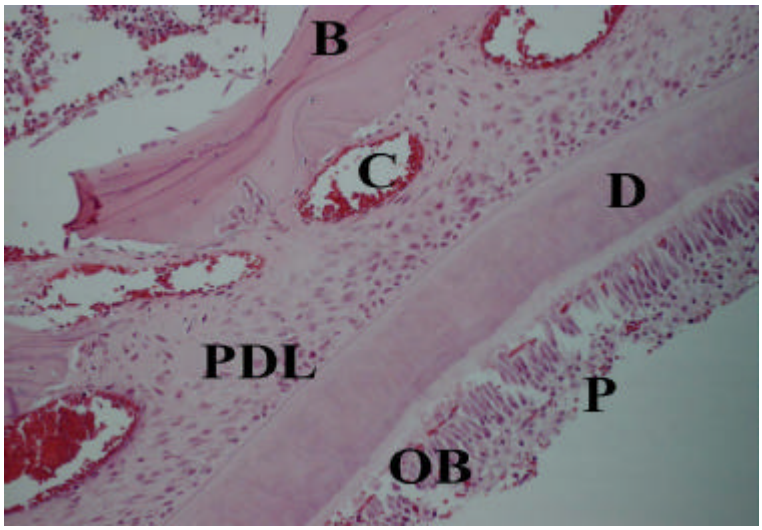


*Figure 6. Microscopic view of periodontal tissues in T3 injection group. Multiple congested blood vessels can be seen in the periodontal membrane. Periodontal fibroblasts lost its directional alignments. Nucleus of odontoblast looks elongated and hyperchromatic. PDL (periodontal ligament), B(alveolar bone), D(dentin), OB(odontoblast), P(pulp), C(congested blood vessel) /magnification X200, H-E stain.*

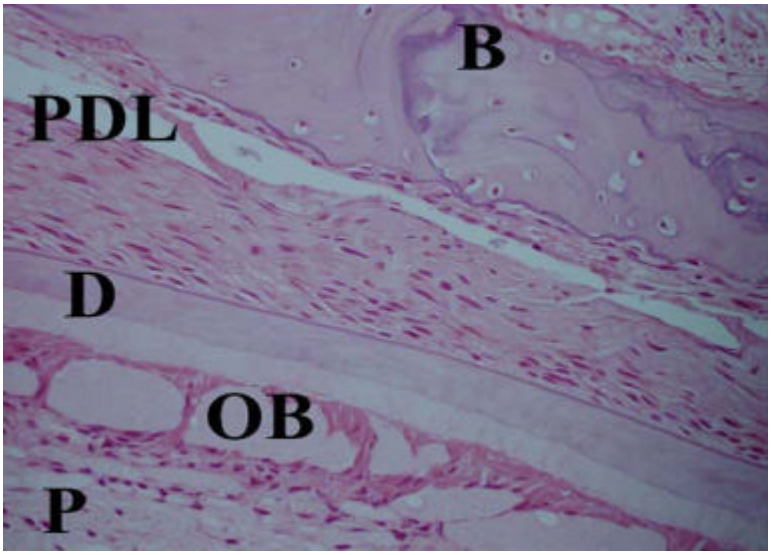


*Figure 7. Magnified view of periodontal tissues in the control group. Alveolar bone looks basophilic. Periodontal fibroblasts shows well-aligned elongated nucleus. Large intercellular matrix can be seen in the odontoblastic layer, which is absent in human. PDL(periodontal ligament), B(alveolar bone), D(dentin), OB(odontoblast), P(pulp) /magnification X400, H-E stain.*

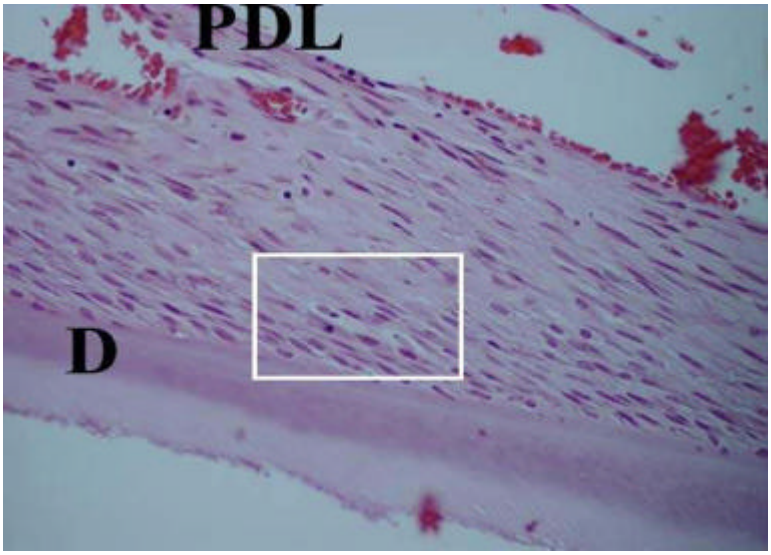


*Figure 8 Magnified view of periodontal tissues in T3 injection group. Multiple hyperchromatic round form nuclei can be seen. Layer of dentin looks more basophilic than that of control group. Inside the white rectangular line is magnified in the next figure. PDL (periodontal ligament), B(alveolar bone), D(dentin), OB(odontoblast), P(pulp), C(congested blood vessel) /magnification X400, H-E stain.*

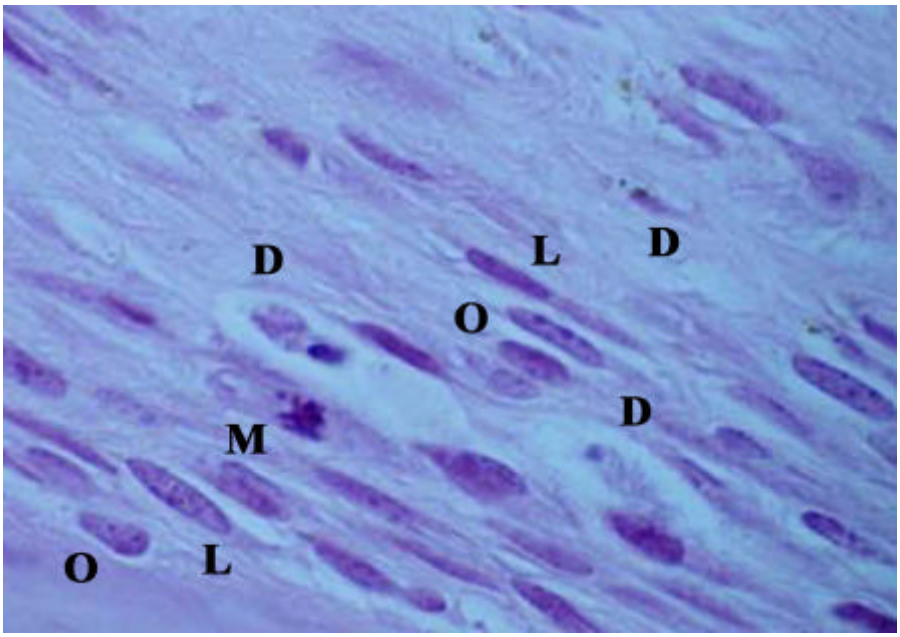


*Figure 9. Periodontal fibroblasts in T3 group. Multiple cellular forms could be seen in this picture implying enhanced cellular life-cycle. Oval(O) and elongated(L) forms of nuclei including multiple hyperchromatic spots indicate active young and matured fibroblasts. Mitosis(M), and suspicious degenerative change(D) of nuclei could also be observed. On the contrary, the most type of fibroblasts must be matured elongated form in normal periodontal tissue. /magnification X1000, H-E stain.*

In viewing with the higher magnification(x1000), hyperchromatic pleomorphic nuclei could be observed, indicating enhanced rate of cellular life-cycle. Oval and elongated forms of nuclei suggests young and matured fibroblasts. Mitosis and suspicious degenerative change of nuclei could also be seen*(Figure 9)*. From these views, the systemic injection of T3 caused histologically congested blood vessels and enhanced cellular metabolism of periodontal tissues.

# DISCUSSION

## Considering the Animal Study of Thyroid Hormone

Thyroid hormone not only interacts with several hormones such as estrogen, testosterone, growth hormone *etc.*, but also is a part of complex negative feedback system with hypothalamus and pituitary gland.[9,13,14,19,25,27,33,36]

In 1994, Povolny[25] reported that exogenous T4 did not increase circulating T4 levels. This phenomenon is the result of reduced production of endogenous thyroid hormone in healthy animals.

In 1966 Tapp[33] also suggested relatively high levels of estrogen, testosterone, cortisol, T4 and growth hormone to produce bone changes in the rat. These doses are not physiological, and this must be taken into consideration in interpreting the results. He also mentioned that thyroid hormone may have some interactions with sex hormones and growth hormones. In his article, testosterone stimulated bone growth in humans. But it did not have any effect on bone formation in the rat.

On the basis of this concept, adult male rats(400 500gm) are selected for this study. And large dose of T3(about 3 times higher than the average level) is injected every morning.

The effect of T3(3,3',5-triiodo-L-thyronine) is 4 5 times more

potent than that of T4(L-thyroxine). Half-life of T3 in blood is about 8 hours, which is much shorter than that of T4 (7 days). So T3 has to be administered every day.

In order to control the serum level of T3, intraperitoneal injection is preferred to oral route, because rats may not constantly take the food mixed with the hormone.

## Thyroid Hormone and Bone Metabolism

In 1990, Mosekilde *et al.*(1990)[19] comprehensively reviewed this title. Hormones that regulate serum calcium level usually include PTH, calcitonin, vitamin D, and thyroid hormones. Thyroid hormones exert profound effects on skeletal growth, maturation, and turnover. He compared the difference between high turnover and low turnover of bone caused by thyroid hormones*(Figure 10)*.

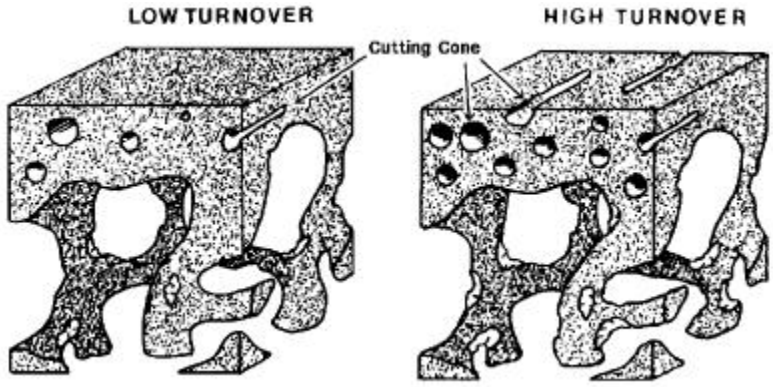


*Figure 10. Comparison of the turnover rate of bone metabolism. In high turnover rate, increased bone marrow space and increased number of cutting cone can be seen. (Adapted from Mosekilde L et al.: Effect of thyroid hormones on bone and mineral metabolism. Endocrin Metab Clin North Am 19(1):35-63, 1990)*

This hormone increases the exchangeable calcium pool in serum, which is absorbed from intestine and subtracted from bone. As the renal excretion rate of calcium also increases, hyperthyroid results in negative calcium balance in body. So high skeletal turnover due to thyroid hormones causes increased bone marrow space and increased number of cutting cone. Prolonged hyperthyroidism may induce osteoporosis.

Cutting cone is considered as a basic unit of internal remodeling, which makes new Haversian system. Both front osteoclastic and rear osteoblastic activity can be seen in this unit*(Figure 11)*.

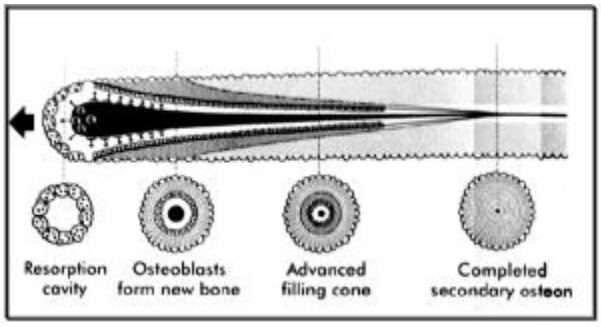


*Figure 11. Illustrations of cutting cone. (Adapted from Robers WE et al.: Am J Orthod 86:95~111, 1984)*

Mosekilde *et al.(*1990)[19] showed the decreased length of cutting-cone in hyperthyroid, and increased length of cutting-cone in hypothyroid *vice versa*. Which implicates that internal remodeling rate increases in hyperthyroid*(Figure 12)*. Thus, thyroid hormone stimulates both osteoclastic and osteoblastic activity in trabecular and cortical bone.

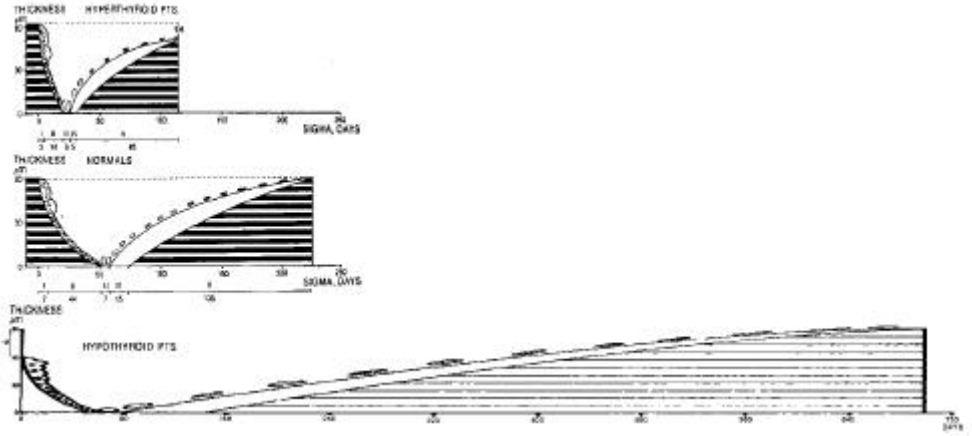

*Figure 12. Length of cutting cone by the levels of thyroid hormones. (Adapted from Mosekilde L et al.: Effect of thyroid hormones on bone and mineral metabolism. Endocrin Metab Clin North Am 19(1):35-63, 1990)*

## Thyroid Hormone as a Biologic Timer

Thyroid hormone is basically known as regulating the basal metabolic rate (BMR) of body. In the cellular level, the effect of thyroid hormones on metabolic rate is associated with the increase in mRNA synthesis in nucleus, ATP production in mitochondria. Net effect is an over-all increase in cellular metabolism and activity.[16] As a result, thyroid hormones enhance the cellular turnover rate.

Alexander *et al.*(1982)[2], and Loftus and Peterson(1979)[16] reported delayed healing in hypothyroid patients. Klaushofer and Peterlik(1994)[13] studied the effect of Vitamin D, PTH, GH, Sex hormones as the important factors on the healing of bony fractures.

Pangrazio-Kulbersh(1983)[22] reported a case with the markedly reduced orthodontic movement in a hypothyroid patient with

dwarfism. Treatment of that cretinism not only enhanced the biologic response of orthodontic movement but also restored the normal skeletal growth.

Persson *et al.*(1989)[23] found that T4 influences the growth of craniofacial morphology. Thyroxine regulates not only the maturation of the different cell populations involved in bone growth but also the remodeling pattern of craniofacial regions. Christiansen(1994)[6] also mentioned that thyroid hormones increase the osteoclastic activity of bone resorption in neonatal mouse.

In considering these articles, thyroid hormone could be regarded as a timer of biologic age during the whole life period, such as a determinant of skeletal age or dental age.

Growth hormone also could be considered as a biologic pacemaker, but its effect is mainly in the growing period. Fisher and Lakshmanan (1990)[9] mentioned the negative feedback effect between growth hormone and thyroid hormone in connection with the epidermal growth factor, maintaining relatively constant net biologic effect.

## Dental Eruption Rate and Orthodontic Tooth Movement

Thyroid hormone affects the orthodontic tooth movement as well as the dental eruption rate. Loberg and Engstrom(1994)[15] reported the 3 clinical cases that 0.5*mg* of T4 administered everyday during orthodontic treatment, and none of the patients exhibited any clinical

side effects. All appeared to benefit from the thyroid hormone supplement.

Christiansen(1994)[6] suggested that thyroxine administration increases the rate of alveolar bone resorption, thus, indirectly decreasing root resorption. T4 administration should be considered for some patients, especially those who begin to show root resorption or who have low thyroid function.

In 1982, King and Fischlschweiger concluded that orthodontic forces stimulate the production of extractable molecules, which can cause bone resorption. Light forces produce more rapid tooth movement than intermittent heavy forces. The tissue damage caused by orthodontic forces initiates the production of the bone resorptive activity.

Newman(1975)[20], and Poumpros *et al.(*1994*)*[24] studied the hormonal effect on root resorption. They concluded that bone resorptive activity is regulated by L-thyroxine, in addition to PTH. The administration of high doses of T4 in rats has been shown to increase bone resorption, in contrast to low dose administration, which was found to reduce periosteal resorption.

Shirazi *et al.*(1999)[28] reported that conduction of 20μg/ kg T4 could reduce bone density that, in turn, accelerates orthodontic tooth movement and decreases force-induced root resorption. It appears that T4 administration increases the rate of alveolar bone remodeling,

thus indirectly augments orthodontic tooth movement and decreases force-induced root resorption.

The turn over rate of fibroblast in periodontal ligament is considered about 4 7 days. It is logical that orthodontic screw in a removable appliance should be activated according to these intervals.

## Other Factors Which Could Affect Tooth Movement

In 1990, Fisher and Lakshmanan introduced the epidermal growth factor(EGF), which has the similar effect with thyroid hormone.[9] Several studies reported its effect on cellular metabolism.(1986 Chester *et al.*[4], 1995 Juhl *et al.*[10], 1995 Maraschin *et al.*[17], 1996 Breider *et al.*[3], 1996 Reindel *et al.*[26], 1999 Chevalier *et al.*[5]) Especially, Soory and Kasasa(1997)[30] reported the effect of EGF on fibroblast metabolism. And Uematsu *et al.*(1996)[35] reported that orthodontic tooth movement caused the increased level of EGF.

In 1996, Trippel *et al.*[34] introduced several factors which can stimulate the cellular growth, these are fibroblast growth factor(FGF), insulin-like growth factor(IGF), and bone morphogenetic protein(BMP).

# CONCLUSION

From this controlled animal study, the results are summarized as;

1. Additional T3 injection caused enhanced eruption rate of lower incisor in rats with statistical significance ($p<0.01$).
2. Histologically, exogenous systemic T3 caused congested blood vessels and enhanced cellular life-cycle in periodontal tissues.

Although we got the evidence in this study that the additional T3 injection has the effect on increasing the rate of tooth eruption in rat, several other factors have to be considered, such as; too much high dose of injected T3, negative stress effect of intraperitoneal injection on the eruption rate, and the effect of other factors related to this hormone. And further reverse study be needed such as the effect of tooth movement on the levels of thyroid hormones.

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국문요약

# 갑상선 호르몬이 흰쥐의 치아맹출에 미치는 영향

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갑상선 호르몬은 치아의 맹출속도와 밀접히 연관되어 있다고 임상적으로 보고되어 왔다. 본 연구의 목적은 흰쥐에 있어서 갑상선 호르몬의 농도가 절치의 맹출속도에 미치는 영향을 분석하기 위함이다. 성장호르몬 및 성호르몬의 영향을 배제하기 위하여 성장이 끝난 400~500gm의 수컷의 흰쥐(Sprague-Dawley)를 그 실험대상으로 하였다(n=14). 실험대상을 sodium barbiturate로 마취시킨후 하악 좌측 절치의 치경부에 디스크로 작은 홈을 형성하고 홈의 하연을 기준으로 치은경계부 까지의 길이와 절단연 까지의 길이를 금속자와 함께 사진촬영하여 계측후 실제 길이로 환산하였다. 그후 7일간 생리식염수를 매일 1회 1㎖/㎏로 주사하였으며, 7일째에 다시 마취하여 동일한 방법의 촬영 및 계측을 시행하였으며, 이 자료로 정상대조군의 1주간의 맹출량을 계산하였다. 또한 촬영직후 2㎖를 채혈하여 T3, T4, TSH의 호르몬 분석을 의뢰하였다. 그후 정상식이로 7일간의 휴식기간을 경과시킨 다음 같은 쥐의 치경부에 새로운 홈을 재형성하고 촬영하였으며, 7일간 매일 오전에 1회씩 3,3'5-triiodo-L-thyronine(T3)를 ㎏당 100㎍/㎖으로 복강투여 하였다. 마지막날 동일한 방법의 촬영후 4㎖채혈하고 희생시켰다. T3투여전후의 사진을 근거로 맹출량을 계측 및 환산하였으며, 채득한 혈청은 T3, T4, TSH 및 PTH 의 정량분석을 의뢰하였다. 또한 희생시킨 쥐의 절치 및 치주조직에 대한 조직검사를 시행하였다.

T3투여시기의 치아맹출량은 정상시기에 비하여 증가하였으며 통계학적 유의차가 있었다.($p<0.01$) T3의 추가 주사시 혈청농도는 약3배 증가하였고 1주간 체중은 63.2±21.4gm 감소하였다.

조직학적 소견상 T3투여군의 치주인대조직에서 상대적으로 울혈된 혈관들이 다수 관찰되었으며, 고배율 소견에서 치주인대의 섬유모세포 및 상아질 모세포가 정상군에 비하여 더 진한 핵과 다양한 외형으로 관찰되어 세포활성이 증가하였고 세포생활사가 빨라졌음을 확인할 수 있었다.

결론적으로 본 실험에서는 혈청내 갑상선 호르몬의 농도증가시 흰쥐에 있어서도 치아의 맹출속도가 증가하는 것으로 확인되었다.

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핵심되는 말 : 갑상선호르몬, 세포대사, 세포생활사,
흰쥐, 절치, 맹출속도