

Biostimulation of mandibular condyle growth

Ridvan Okşayan, Mehmet Ertuğrul Çiftçi¹, Ali Murat Aktan², Oral Sökücü³

Department of Orthodontics, Faculty of Dentistry, University of Eskisehir Osmangazi, Eskisehir, ¹Department of Dentomaxillofacial Radiology, Faculty of Dentistry, University of Akdeniz, Antalya, Departments of ²Dentomaxillofacial Radiology and ³Orthodontics, Faculty of Dentistry, University of Gaziantep, Gaziantep, Turkey

ABSTRACT

Skeletal Class II malocclusion has been called the common orthodontic problem in orthodontic clinics. These malocclusions are often due to mandibular deficiency. Various fixed and removable functional appliances have been used for the treatment of skeletal Class II malocclusion in patients who are undergoing a pubertal growth spurt. The results obtained from human and experimental animal studies showed that functional treatment of skeletal Class II treatment enhances the backward and upward growth potential of the mandibular condyle, and this mechanism provides forward movement of the lower jaw. Many studies reported that the adaptive remodeling of condylar cartilage and glenoid fossa increases with the aid of mechanical forces sourced from a functional appliance. One of the most important factors in mandibular advancement is to provide the condylar cellular activity in a shorter treatment time. The duration of functional appliance therapy depends on several factors such as patient age, sex, severity of the skeletal problem, and appliance type. The functional treatment period varies between 6 and 24 months. The patients undergoing orthodontic treatment often complain about the length of treatment time. In many studies, different techniques such as low level laser, ultrasound stimulation, anabolic steroids, growth hormone, and cyclosporine have been used to reduce functional treatment time and stimulate the condylar cartilage and bone. The purpose of this review is to describe biostimulation of mandibular condyle growth and evaluate the various techniques for mandibular condyle biostimulation.

Key words: Biostimulation, mandibular condyle, skeletal Class II

Introduction

Functional appliance treatment has been used in patients who have skeletal Class II malocclusion. Adolescent patients also complain about the treatment time of this kind of treatment. Many methods were used to shorten the functional treatment time.

Skeletal Class II malocclusion has been called the common orthodontic problem in orthodontic clinics. These malocclusions are often due to mandibular

deficiency.^[1] Various fixed and removable functional appliances have been used for the treatment of skeletal Class II malocclusion in patients who are undergoing a pubertal growth spurt.^[2-4] The results obtained from human and experimental animal studies showed that functional treatment of skeletal Class II treatment enhances the backward and upward growth potential of the mandibular condyle, and this mechanism provides forward movement of the lower jaw.^[5] Mandibular condyle cartilage is called as a secondary cartilage and composed from periosteal originate cells. Prenatally 3/4 parts of condylar cartilage are ossified as endochondrally. Secondary cartilages persist postnatally in areas such as the mandibular condyle cartilage, intermaxillary suture,

Address for correspondence: Dr. Mehmet Ertuğrul Çiftçi, University of Akdeniz, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, Antalya 07058, Turkey. E-mail: mertugrulciftci@hotmail.com

Access this article online

Quick Response Code:



Website:
www.jorthod.org

DOI:
10.4103/2321-3825.165071

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Okşayan R, Çiftçi ME, Aktan AM, Sökücü O. Biostimulation of mandibular condyle growth. J Orthod Res 2015;3:147-50.

and angular part of the mandible.^[6] Many studies reported that the adaptive remodeling of condylar cartilage and glenoid fossa increases with the aid of mechanical forces sourced from a functional appliance.^[5,7,8] One of the most important factors in mandibular advancement is to provide the condylar cellular activity in a shorter treatment time. The duration of functional appliance therapy depends on several factors such as patient age, sex, severity of the skeletal problem, and appliance type. The functional treatment period varies between 6 and 24 months.^[2,3,9] The patients undergoing orthodontic treatment often complain about the length of treatment time.^[10]

In many studies, different techniques such as low level laser, ultrasound stimulation, anabolic steroids, growth hormone, and cyclosporine have been used to reduce functional treatment time and stimulate the condylar cartilage and bone.^[11-15]

The purpose of this review is to describe biostimulation of mandibular condyle growth and evaluate the various techniques for mandibular condyle biostimulation.

Low-Level Laser Applications

Low-level laser application has gained popularity in medical and dental fields in recent years. Many *in vitro* and *in vivo* experimental studies were performed before clinical use.^[16] Enhancement of chondroblastic and osteoblastic activation provides the organic matrix increase. The stimulation of these cells' activity causes mandibular condylar growth and forward lower jaw growth.^[11] Jia and Guo examined the biostimulatory effect of He-Ne laser on chondrocytic cultures, and their study showed that 4-6 J/cm² laser irradiation increased the cell numbers and revealed higher cell proliferation activity compared to the control group.^[17] Seifi *et al.* studied the effect of 904 nm low-level laser on condylar growth in rats, and reported that laser irradiation can stimulate condylar growth and cause mandibular advancement.^[11] Abtahi *et al.* studied the effect of low-level laser on condylar growth in rabbits, and they concluded that irradiation of 630 nm KIO₃ low-level laser during mandibular advancement in rabbits enhances bone formation in the condylar area.^[12] El-Bialy *et al.* evaluated the effect of a light-emitting diode (LED) and laser on mandibular growth in rats, and they reported that the laser irradiated groups showed less mandibular growth than LED-treated groups.^[18]

Ultrasound Applications

Ultrasound is a type of mechanical stimulus and energy

that occurs when acoustic pressure waves are transmitted through living tissues. Ultrasound frequencies are above the limit of ear hearing mechanisms.^[13] Oyonarte *et al.* used low-intensity pulsed ultrasound stimulation of condylar growth in rats. They concluded that ultrasound treatment may change mandibular growth patterns. More response was achieved when the rats were stimulated for 20 min rather than 10 min daily.^[1] El-Bialy *et al.* applied ultrasound on the condylar area of growing rabbits. They revealed that ultrasound enhances mandibular growth by endochondral condylar growth and ramus growth.^[13] Similar findings have been reported by Khan *et al.* who studied the effects of growth hormone and ultrasound on mandibular growth in rats. They showed that mandibular growth may be enhanced by ultrasound application.^[14] El-Bialy *et al.* studied the growth modification of the mandible with ultrasound in baboons and found ultrasound increased the mandibular growth over a 4 months period.^[19]

Hormone Applications

Growth hormone is a kind of pituitary hormone that enhances bone growth and has an anabolic impact on other organs and tissues. Khan *et al.* studied the effects of growth hormone and ultrasound on mandibular growth in rats and showed that there were synergetic effects of the growth hormone and ultrasound application in increasing mandibular condylar head length.^[14] Another study about the human growth hormone is presented by Yamamoto who revealed that the growth hormone group had larger condylar heads. In addition to this, cartilage cells were large in size and number.^[20] Ramirez-Yañez *et al.* reported that growth hormone stimulates mitotic activity and postpones the maturation of cartilage cells in the mandibular condyle.^[21] In rabbit mandibular condyle, growth hormone enhances chondrocyte proliferation, synthesis of DNA, and secretion of Type II collagens.^[22] Feizbakhsh *et al.* showed that localized injection of growth hormone accelerates the condylar cartilage growth activity in rabbits.^[23]

An *in vitro* study showed the effect of parathyroid hormone (PTH) in chondroprogenitor cell proliferation. PTH has a great effect on chondroprogenitor cells and might block the differentiation pattern into mature cartilage.^[24] Rabie *et al.* researched the effects of PTH on the cellular activities of chondrocytes in condylar cartilage during natural growth and mandibular advancement. According to the results, mandibular advancement supported mesenchymal differentiation and caused PTH expression, which delayed their further maturation to allow for more mandibular condyle growth.^[25]

Estrogen restricts the mandibular condyle growth and ovariectomy causes a proliferation of cartilage thickness.^[26] Márquez Hernández et al. studied the effect of sex hormone-specific receptor antagonist in growing mice, and they showed that growth is enhanced by the stimulation of sex hormone-specific receptor antagonist.^[27] Kamiya et al. found sex hormone-specific receptor antagonist increases condylar growth by inhibiting the fibrocartilage turnover.^[28]

Anabolic Steroid Applications

Anabolic steroids can be used to improve muscle dimension and performance. It may be possible to accelerate craniofacial growth and change muscle activity by using anabolic steroids.^[29] Barrett and Harris found that anabolic steroids produced both size and shape changes in the craniofacial region.^[15] da Silva and Cecanho found that local injection of anabolic steroids into rat masseter muscle was able to modify the growth direction and craniofacial morphology, but did not show any changes in mandibular length.^[30] Gebhardt and Pancherz revealed that anabolic steroids had a remarkable impact on mandibular growth in both juvenile and adult rats.^[31]

Conclusion

Biostimulation of mandibular condyle cartilage may affect the mandibular growth pattern in many ways with or without intraoral appliances. According to the results of many studies, development of new biostimulatory technologies may shorten functional orthodontic therapies. However, further *in vivo* studies are needed with histomorphometric, radiographic and micro-computed tomography analysis to explore different effects of various mandibular condyle cartilage biostimulatory techniques.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

References

- Oyonarte R, Zárate M, Rodríguez F. Low-intensity pulsed ultrasound stimulation of condylar growth in rats. *Angle Orthod* 2009;79:964-70.
- Doshi UH, Bhad WA. A simple method for Twin Block activation. *J Clin Orthod* 2011;45:328-31.
- Rudzki-Janson I, Noachtar R. Functional appliance therapy with the Bionator. *Semin Orthod* 1998;4:33-45.
- Ruf S, Pancherz H. Temporomandibular joint growth adaptation in Herbst treatment: A prospective magnetic resonance imaging and cephalometric roentgenographic study. *Eur J Orthod* 1998;20:375-88.
- Owtad P, Potres Z, Shen G, Petocz P, Darendeliler MA. A histochemical study on condylar cartilage and glenoid fossa during mandibular advancement. *Angle Orthod* 2011;81:270-6.
- Hinton RJ, Carlson DS. Regulation of growth in mandibular condyle cartilage. *Semin Orthod* 2005;11:209-18.
- Rabie AB, She TT, Hägg U. Functional appliance therapy accelerates and enhances condylar growth. *Am J Orthod Dentofacial Orthop* 2003;123:40-8.
- Rabie AB, Xiong H, Hägg U. Forward mandibular positioning enhances condylar adaptation in adult rats. *Eur J Orthod* 2004;26:353-8.
- Bishara SE, Ziaja RR. Functional appliances: A review. *Am J Orthod Dentofacial Orthop* 1989;95:250-8.
- Lew KK. Attitudes and perceptions of adults towards orthodontic treatment in an Asian community. *Community Dent Oral Epidemiol* 1993;21:31-5.
- Seifi M, Maghzi A, Gutknecht N, Mir M, Asna-Ashari M. The effect of 904 nm low level laser on condylar growth in rats. *Lasers Med Sci* 2010;25:61-5.
- Abtahi M, Poosti M, Saghravani N, Sadeghi K, Shafaei H. The effect of low level laser on condylar growth during mandibular advancement in rabbits. *Head Face Med* 2012;8:4.
- El-Bialy T, El-Shamy I, Graber TM. Growth modification of the rabbit mandible using therapeutic ultrasound: Is it possible to enhance functional appliance results? *Angle Orthod* 2003;73:631-9.
- Khan I, El-Kadi AO, El-Bialy T. Effects of growth hormone and ultrasound on mandibular growth in rats: MicroCT and toxicity analyses. *Arch Oral Biol* 2013;58:1217-24.
- Barrett RL, Harris EF. Anabolic steroids and craniofacial growth in the rat. *Angle Orthod* 1993;63:289-98.
- Torricelli P, Giavaresi G, Fini M, Guzzardella GA, Morrone G, Carpi A, et al. Laser biostimulation of cartilage: *In vitro* evaluation. *Biomed Pharmacother* 2001;55:117-20.
- Jia YL, Guo ZY. Effect of low-power He-Ne laser irradiation on rabbit articular chondrocytes *in vitro*. *Lasers Surg Med* 2004;34:323-8.
- El-Bialy T, Alhadlaq A, Felemban N, Yeung J, Ebrahim A, Hassan AH. The effect of light-emitting diode and laser on mandibular growth in rats. *Angle Orthod* 2015;85:233-8.
- El-Bialy T, Hassan A, Albaghdadi T, Fouad HA, Maimani AR. Growth modification of the mandible with ultrasound in baboons: A preliminary report. *Am J Orthod Dentofacial Orthop* 2006;130:435.e7-14.
- Yamamoto M. Effect of human growth hormone on mandibular condyle growth of the rat. *Fukuoka Shika Daigaku Gakkai Zasshi* 1990;17:145-60.
- Ramirez-Yañez GO, Young WG, Daley TJ, Waters MJ. Influence of growth hormone on the mandibular condylar cartilage of rats. *Arch Oral Biol* 2004;49:585-90.
- Huang N, Luo SJ, Yang HM. The effects of growth hormone on rabbit's mandibular condylar chondrocytes proliferation and secretion *in vitro*. *Hua Xi Kou Qiang Yi Xue Za Zhi* 2004;22:370-2.

23. Feizbakhsh M, Razavi M, Minaian M, Teimoori F, Dadgar S, Maghsoodi S. The effect of local injection of the human growth hormone on the mandibular condyle growth in rabbit. *Dent Res J (Isfahan)* 2014;11:436-41.
24. Lewinson D, Silbermann M. Parathyroid hormone stimulates proliferation of chondroprogenitor cells *in vitro*. *Calcif Tissue Int* 1986;38:155-62.
25. Rabie AB, Tang GH, Xiong H, Hägg U. PTHrP regulates chondrocyte maturation in condylar cartilage. *J Dent Res* 2003;82:627-31.
26. Talwar RM, Wong BS, Svoboda K, Harper RP. Effects of estrogen on chondrocyte proliferation and collagen synthesis in skeletally mature articular cartilage. *J Oral Maxillofac Surg* 2006;64:600-9.
27. Márquez Hernández RA, Ohtani J, Fujita T, Sunagawa H, Ishikawa E, Tsubamoto N, *et al.* Mandibular and femoral growth alteration after sex hormone disruption in growing mice. *Orthod Craniofac Res* 2011;14:63-9.
28. Kamiya Y, Chen J, Xu M, Utreja A, Choi T, Drissi H, *et al.* Increased mandibular condylar growth in mice with estrogen receptor beta deficiency. *J Bone Miner Res* 2013;28:1127-34.
29. Noda K, Chang HP, Takahashi I, Kinoshita Z, Kawamoto T. Effects of the anabolic steroid nandrolone phenylpropionate on craniofacial growth in rats. *J Morphol* 1994;220:25-33.
30. da Silva HC, Cechanho R. Cephalometric changes produced by locally applied anabolic steroid in Wistar rats. *Arch Oral Biol* 2009;54:389-95.
31. Gebhardt A, Pancherz H. The effect of anabolic steroids on mandibular growth. *Am J Orthod Dentofacial Orthop* 2003;123:435-40.

