Available online at http://www.journalijdr.com

IJDR

International Journal of
DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 07, Issue, 02, pp.11566-11570, February, 2017

Full Length Research Article

AGE FACTOR EFFECT ON MAXIMUM MOLAR BITE FORCE OF INDIVIDUALS WITH DOWN SYNDROME

***[1]Flávia Cássia Cabral Rodrigues, [1]Marcelo Palinkas, [2]Myriam Estela Paiva Novaes, [1]Cristiane Aparecida Nogueira Bataglion, [1]Simone Cecilio Hallak Regalo and [1]César Bataglion**

[1]School of Dentistry of Ribeirão Preto, University of São Paulo, Brazil
[2]School of Dentistry of Uberlândia, Federal University of Uberlândia, Brazil

ARTICLE INFO

Article History:
Received 19th November, 2016
Received in revised form
11th December, 2016
Accepted 26th January, 2017
Published online 28th February, 2017

Key Words:
Down syndrome;
Bite force;
Stomatognathic system;
Aging.

ABSTRACT

To determine reference patterns of right (RMBF) and left (LMBF) maximum molar bite force of individuals with Down syndrome over the years and to compare them with individuals without Down syndrome. 100 individuals with Down syndrome were divided into age groups: 8-12 years (DSGI, n = 28), 13-20 years (DSGII, n = 30), 21-40 years (DSGIII, n = 29) and 41-60 years (DSGIV, n = 13). The Down syndrome age groups were matched subject to subject with their respective controls without Down syndrome (CGI, CGII, CGIII and CGIV). The RMBF and LMBF records were captured by digital dynamometer. There was statistically significant difference for LMBF in DSG over the years (P = 0.00), with higher bite force for DSGII. In the comparison of age range between Down syndrome group and control group, was observed statistically significant difference in RMBF: DSGII vs CGII (P = 0.00), DSGIII vs CGIII (P = 0.00), DSGIV vs CGIV (P = 0.00) and LMBF: DSGI vs CGI (P = 0.00), DSGII vs CGII (P = 0.00), DSGIII vs CGIII (P = 0.00) and DSGIV vs CGIV (P = 0.00). The RMBF and LMBF of the age groups with Down syndrome were smaller when compared to the control groups. The results demonstrated reference patterns of molar bite force over the years for individuals with Down syndrome, with prevailing higher molar bite force for adolescents, gradual decrease of molar bite force over the years and lower force of individuals with Down syndrome when compared with control group.

INTRODUCTION

Down syndrome; bite force; stomatognathic system; aging Down syndrome was first described by the British physician John Longden Hayden Down in 1866 (Kazemi *et al*., 2016), and only 100 years after its discovery, it has been demonstrated that 95% of the cases were due to the trisomy of chromosome 21, whereas the other 5% were due to chromosome translocation (Kageleiry *et al*., 2016; Arumugam *et al*., 2016). The worldwide incidence of Down syndrome is, approximately, 8.3 to 14.3 cases per 10.000 live births (Ferrés *et al*., 2016) and the mortality rate is higher than the general population (Uppal, 2015). In the United States, the population prevalence of Down syndrome in 2010 was estimated at 6.7 for 10.000 individuals (De Graaf*et al*., 2016). In Brazil, there is no specific statistic about the number of individuals with Down syndrome, but a study stated that between 2005 and 2013, the incidence was 1 case for every 700 individuals born alive (Bermudez *et al*., 2015), with an average of 8 thousand new cases per year. It is estimated that few dental surgeons are qualified to give care to this group of individuals with special needs, whose treatment is hampered by deficient knowledge about behavior and clinical orofacial aspects (Williams *et al*., 2015). However, it is necessary to investigate the stomatognathic system of individuals with Down syndrome to see if there are morpho-functional changes resulting from the syndrome. An important, internationally recognized method that evaluates the functional capacity of healthy individuals with morpho-functional changes is the maximum bite force that provides essential information regarding masticatory function (Orchardson, 1998; La Hoz-Aizpurua, 2013; Palinkas *et al*., 2016). Therefore, the objective of this unprecedented study was to determine reference parameters of maximum molar bite force in individuals with Down syndrome and to demonstrate if the age factor changes the bite force. The results will provide important subsidies for odontological science, so that health professionals, who perform treatments

****Corresponding author: Flávia Cássia Cabral Rodrigues,***
School of Dentistry of Ribeirão Preto, University of São Paulo, Brazil

with this public, can become more attentive, for example, in oral rehabilitation treatments, due to the possible functional alterations that the stomatognathic system of these individuals can present.

MATERIALS AND METHODS

Study population

This research was performed after submission and approval of the Research Ethics Committee of the School of Dentistry of Ribeirão Preto, University of São Paulo (FORP/USP), São Paulo, Brazil (case number 39511714.6.1001.5419) and the Faculty of Dentistry of Federal University of Uberlândia (FOUFU), Minas Gerais, Brazil (case number 39511714.6.3001.5152). All individuals were informed about the research objectives, procedures, benefits, risks, discomforts, confidential nature of the data obtained and subsequently invited to participate. The caregivers responsible for the participant individuals signed the consent form. Individuals with Down syndrome diagnosis were selected at the Special Patient Dental Care Center of FORP/USP and FOUFU. From a total of 144 individuals with Down syndrome, 28 individuals did not meet the inclusion criteria and 16 individuals failed to perform the maximum molar bite force test. Were excluded from the study, individuals with a diagnosis of Down syndrome who were not accompanied by the direct caregiver and who had absences of one or more first permanent molars, both superior and inferior. The sample consisted of 100 complete dentate individuals (except the group of children with mixed dentition, but with the presence of the first permanent molars) with confirmed diagnosis of Down syndrome and belonging to the age group from 08 to 60 years old.

The individuals with Down syndrome selected were divided into four age groups: children between 08 and 12 years old (DSGI, n = 28); adolescents between 13 and 20 years old (DSGII, n = 30); young adults between 21 and 40 years old (DSGIII, n = 29) and adults between the ages of 41 and 60 (DSGIV, n = 13). The DSG (I, II, III and IV) was matched subject to subject with their respective controls that did not have Down syndrome (CGI, CGII, CGIII and CGIV) by age, gender and body mass index, totaling 200 participants in the study.

Analysis of the maximum molar bite force

The maximum molar bite force record (right and left) was collected using a digital dynamometer (Kratos Industrial Equipment Ltda., Cotia, Brazil) with a capacity of 980.665N, adapted to the oral cavity (Figure 1). The device has a "set-zero" key that provides exact control of the peak register, making it easier to read the analyzed variable. It has two stems with the extremities coated with teflon discs, where it can be measured the bite force applied by the individual. It is obtained in the digital display of the instrument, different measures of easy reading, due to the presence of high precision load and the connection of electrical elements to indicate the force. The individuals were trained by the same trained operator to perform the bite test of the dynamometer stems, to ensure the reliability of the proposed procedure. The maximum molar bite force data were collected with the individuals sitting comfortably in a chair with arms extended along the body and hands resting on the thighs. The dynamometer was cleaned with alcohol and the stems were protected with disposable latex finger cots (Wariper, São Paulo, Brazil) as necessary and important biosafety measures. To measure the maximum molar bite force, the device was positioned in the first and second molar regions of the dental arch (Figure 2). The parallelism of the horizontal plane of Frankfurt with the ground was observed (Sun *et al*., 2016). Three measurements were obtained from each side, alternating the sides, with maximum effort and intervals of rest, lasting two minutes between each bite. Among the three records made on each side, the maximum molar bite value was considered.

Table 1. Average, standard error (±) and statistical significance ($P \leq 0.05$) of maximum bite force (N) in the right side (RMBF) and left side (LMBF) for the four age groups with DS: children (DSGI), adolescents (DSGII), young adults (DSGIII) e adults (DSGIV)

	Age groups with DS				
Molar Force	DSGI	DSGII	DSGIII	DSGIV	P Value
RMBF	152.88±8.23	187.50±14.31	159.84±11.66	156.51±8.04	0.13
LMBF	136.80±6.86	182.99±15.20	140.13±7.74	139.54±8.53	0.00

Table 2. Average, standard error (±) and statistical significance ($P \leq 0,05$) of maximum bite force (N) in the right side (RMBF) and left side (LMBF) of the molar region, between the groups DSGI (children), DSGII (adolescents), DSGIII (young adults) and DSGIV (adults) versus respective controls without DS (CGI, CGII, CGIII e CGIV)

	Age Groups		
Bite Force	DSGI	CGI	*P* Value
RMBF	152.88±8.23	184.26±19.02	0.13
LMBF	136.80±6.86	186.13±15.88	0.00
	DSGII	CGII	
RMBF	187.50±14.31	367.74±32.85	0.00
LMBF	182.99±15.20	374.41±31.18	0.00
	DSGIII	CGIII	
RMBF	159.84±11.66	284.98±29.02	0.00
LMBF	140.13±7.74	399.10±30.98	0.00
	DSGIV	CGIV	
RMBF	156.51±8.04	249.38±28.34	0.00
LMBF	139.54±8.53	256.54±42.16	0.00

Statistical Analysis

After obtaining the data related to the maximum molar bite force, the Kolmogov-Smirnov normality test was applied. Normal data distribution for Down syndrome group and control group was observed. The maximum molar bite force data were submitted to statistical analysis using SPSS software

version 22.0 for Windows (SPSS Inc., Chicago, IL, USA). The results were obtained through the descriptive analysis (average and standard error) for each variable. The values were compared by the student t test for independent samples (between the Down syndrome group vs respective control group) and ANOVA (Down syndrome groups over the years), with a significance level of 5% and a 95% confidence interval.

RESULTS

Table 1 shows the values of the maximum bite force in the right side region (RMBF) and left side (LMBF) for the four age groups with Down syndrome groups over the years over the years. There was a statistically significant difference ($P \leq 0.05$) for LMBF ($P = 0.00$). In the DSGI, lower values of RMBF and LMBF were observed. In the DSGII it was noticed higher values of RMBF and LMBF.

Figure 1. Dynamometer (Kratos)

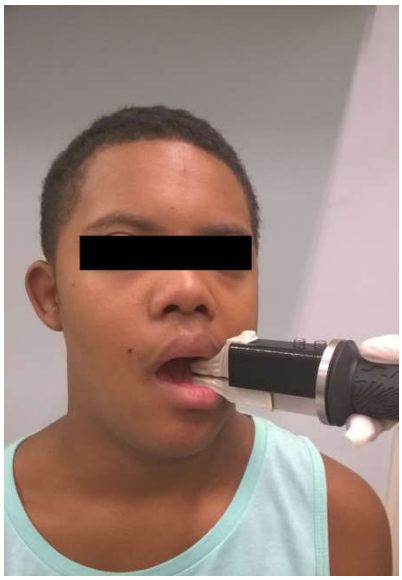

Figure 2. Dynamometer positioned in the region of the first molars on the left side

The DSGIV presented lower RMBF and LMBF in relation to DSGIII. The RMBF and LMBF data between Down syndrome group and the corresponding control group by age are shown in Table 2. There was a statistically significant difference ($P \leq 0.05$) for RMBF and LMBF in all comparisons ($P = 0.00$), except between DSGII and CGII in RMBF. The maximum molar bite force within the Down syndrome groups was smaller when compared to the respective control groups without Down syndrome.

DISCUSSION

Considering the importance of the development of the stomatognathic system over the years, this research had as objective to determine reference values for maximum molar bite force in individuals with Down syndrome, observing the age factor and comparing results with individuals without Down syndrome. Through the participation of individuals with DS, assisted by their direct caregivers, it was possible to perform gnathodynamometry, in order to provide relevant information to the scientific community. Working with this sample was challenging because although the cognitive characteristics of the individuals were modified due to the lack of attention and memory, the communicative performance is always present (Hoeffer *et al*., 2007; Belichenko *et al*., 2015). Our communication with the individuals with Down syndrome was didactic, easy to understand, showing step by step each procedure to be performed, being essential for the correct performance of the maximum dental clamping condition on the dynamometer stems, making the result of scientific research reliable, safe and reproducible. Bite force evaluates masticatory function, but recent studies have focused on factors such as: age, gender, clinical status of teeth, temporomandibular dysfunction and orofacial pain (Rane, 2017). The age factor influences the resistance of jaw lifts muscles in relation to the bite force exercised by individuals without functional alterations (Shiau *et al*., 2003; Palinkas *et al*., 2010).

There are no reports in the world literature about the behavior of the stomatognathic system of individuals with Down syndrome, observed by the bite force, justifying our interest of this study. We identified differences in maximum molar bite force over the years for individuals with Down syndrome. The DSGI presented lower values of RMBF and LMBF when compared to other age groups. This data are consistent with Palinkas *et al*. (2010), where it was showed that children, aged between 7 and 12 years old, without systemic and genetic problems, had lower average values of molar bite force in relation to adolescents, adults and the elderly. Functional performance within a given age group results from different levels of maturity, rather than differences in ability to perform a given task (Ganya, 2016). Children present occlusal morphological characteristics, functional aspects and masticatory maturity that influence the muscular strength (Kotsiomiti *et al*., 2000; Hirao *et al*., 2015). The increased of muscle strength occurs from childhood to adolescence (Hébert *et al*., 2015). Similar data were also observed in our study where DSGII presented higher value of maximum molar bite force. The phase of adolescence is the time of life between childhood and the adult period, characterized by various physical, metabolic and physiological changes (Fuss, *et al*., 2015). In this period the hormonal levels are altered, increasing the muscular strength (Karakis, 2014). The DSGIV showed a maximum molar bite force lower in relation to the young adults. During aging process, the individual with Down syndrome faces several challenges inherent to this phase of life, such as muscular, cardiac, auditory, ophthalmological and otorhinolaryngological problems (Weiss *et al*., 2016; Morales-Angulo *et al*., 2016). The early aging of muscle fibers, due to

the trisomy of chromosome 21, causes structural alterations of the remaining mitochondria and myonuclei, reducing all the functional patterns of the human organism (Hefti, 2017). With advancing age, there is an increase in the incidence of malocclusion (Dontas *et al*., 2010) and in individuals with special needs, who already have this disharmony installed, can aggravate the functional clinical picture (Shukla *et al*., 2014).

The combination with other problems such as oromotor dysfunction and reduction of oral and facial muscle tone, can lead to changes in strength, phonation, chewing and swallowing (Abanto *et al*., 2011). Our study demonstrated that maximal molar bite force was lower in all comparisons between the Down syndrome groups with their respective controls without Down syndrome, with significant difference except for the right molar region in the DSGI. Bite force, efficiency and masticatory ability demonstrate the functional state of the stomatognathic system and when the importance of occlusion is observed, always evaluating the bite force variable, individuals with occlusal disharmony present lower efficiency than individuals who denote normal occlusion (Toro *et al*., 2006). The malocclusion that is often found in individuals with Down syndrome (Hennequin *et al*., 2015) may be one of the explanations for the reduction of bite force when compared to individuals without Down syndrome with Angle Class I occlusion. The present study did not evaluate the severity of malocclusion of individuals with Down syndrome.
The individuals with Down syndrome present occlusal alterations and macroglossia (Chin, 2014) and when associated with the reduced development of the maxilla (Lee *et al*., 2016), result in the decrease of the mandibular function, due to hypotonia of the orofacial muscles and subsequently reduction in masticatory muscle strength (Macho *et al*., 2014). Muscle hypotonia promotes imbalance of forces between the oral and facial muscles, modifying the dental arch, giving an aspect of mandibular projection that contributes to the inadequate positioning of the tongue (Hill *et al*., 2016). With the presence of low muscle tone, individuals with Down syndrome present ligament laxity throughout the body, causing hyperflexibility in the joints (Peterlein *et al*., 2013), including the periodontal ligament, which causes discomfort during mastication and excursion of the mandible, reducing occlusal forces (Macho *et al*., 2014). The considerations described above point to the growing need to seek knowledge about Down syndrome, especially on the behavior of the stomatognathic system. This research aimed to determine reference patterns of molar bite force in individuals with Down syndrome and to observe the influence of age. Expanding and revealing knowledge on this subject that is much studied in the world literature and has its social and scientific importance, because it provides subsidies that will aid in the diagnosis, prognosis and treatment of this public, being fundamental for medical and dental science.

Conclusion

With the evaluation of the reference patterns of maximum molar bite force in individuals with Down syndrome, it was possible to conclude that the maximum molar bite force was different over the years and lower in relation to the control group without Down syndrome.

Acknowledgment

We gratefully acknowledge the support of *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).*

REFERENCES

Abanto, J., Ciamponi, A.L., Francischini, E., Murakami, C., de Rezende, N.P., Gallottini, M. 2011. Medical problems and oral care of patients with Down syndrome: a literature review. *Spec Care Dentist*. 31: 197-203.

Arumugam, A., Raja, K., Venugopalan, M., Chandrasekaran, B., Kovanur Sampath K., Muthusamy, H., *et al*. 2016. Down syndrome-A narrative review with a focus on anatomical features. *Clin Anat*. 29: 568-577.

Belichenko, P.V., Kleschevnikov, A.M., Becker, A., Wagner, G.E., Lysenko, L.V., Yu, Y.E., *et al*. 2015. Down Syndrome Cognitive Phenotypes Modeled in Mice Trisomic for All HSA 21 Homologues. *PLoS One*. 10: e0134861.

Bermudez, B.E., Medeiros, S.L., Bermudez, M.B., Novadzki, I.M., Magdalena, N.I. 2015. Down syndrome: Prevalence and distribution of congenital heart disease in Brazil. *Sao Paulo Med J.* 133: 521-524.

Chin, C.J., Khami, M.M., Husein, M. 2014. A general review of the otolaryngologic manifestations of Down Syndrome. *Int J Pediatr Otorhinolaryngol.* 78: 899-904.

de Graaf, G., Buckley, F., Skotko, B.G. 2016. Estimation of the number of people with Down syndrome in the United States. Genet Med.

De-La-Hoz, J.L. 2013. Sleep bruxism: review and update for the restorative dentist. Alpha Omegan. 106 (1-2): 23-28.

Dontas, I.A., Tsolakis, A.I., Khaldi, L., Patra, E., Lyritis, G.P. 2010. Malocclusion in aging Wistar rats. *J Am Assoc Lab Anim Sci.* 49: 22-26.

Ferrés, M.A., Bianchi, D.W., Siegel, A.E., Bronson, R.T., Huggins, G.S., Guedj, F. 2016. Perinatal Natural History of the Ts1Cje Mouse Model of Down Syndrome: Growth Restriction, Early Mortality, Heart Defects, and Delayed Development. *PLoS One*. 11: e0168009.

Fuss, J., Auer, M.K., Briken, P. 2015. Gender dysphoria in children and adolescents: a review of recent research. *Curr Opin Psychiatry*. 28: 430-434.

Ganya, W., Kling, S., Moodley, K. 2016. Autonomy of the child in the South African context: is a 12 year old of sufficient maturity to consent to medical treatment? BMC Med Ethics. 17(1): 66.

Hébert, L.J., Maltais, D.B., Lepage, C., Saulnier, J., Crête, M. 2015. Hand-Held Dynamometry Isometric Torque Reference Values for Children and Adolescents. Pediatr Phys Ther. 27: 414-423.

Hefti, E., Bard, J., Blanco, J.G. 2017. Analysis of Heteroplasmic Variants in the Cardiac Mitochondrial Genome of Individuals with Down Syndrome. Hum Mutat. 38(1): 48-54.

Hennequin, M., Mazille, M.N., Cousson, P.Y., Nicolas, E. 2015. Increasing the number of inter-arch contacts improves mastication in adults with Down syndrome: a prospective controlled trial. *Physiol Behav.* 145:14-21.

Hill, C.M., Evans, H.J., Elphick, H., Farquhar, M., Pickering, R.M., Kingshott, R., *et al*. 2016. Prevalence and predictors of obstructive sleep apnoea in young children with Down syndrome. *Sleep Med.* 27-28: 99-106.

Hirao, A., Murata, S., Kubo, A., Hachiya, M., Mitsumaru, N., Asami, T. 2015. Association between occlusal force and physical functions in preschool children: a comparison of males and females. *J Phys Ther Sci.* 27: 3729-3732.

Hoeffer, C.A., Dey, A., Sachan, N., Wong, H., Patterson, R.J., Shelton, J.M., *et al*. 2007. The Down syndrome critical region protein RCAN1 regulates long-term potentiation

and memory via inhibition of phosphatase signaling. *J Neurosci.* 2748: 13161-13172.

Kageleiry, A., Samuelson, D., Duh, M.S., Lefebvre, P., Campbell, J., Skotko, B.G. 2016. Out-of-pocket medical costs and third-party healthcare costs for children with Down syndrome. *Am J Med Genet* A.

Karakis, D., Aktas-Yilmaz, B., Dogan, A., Yetkin, I., Bek, B. 2014. The bite force and craniofacial morphology in patients with acromegaly: a pilot study. *Med Oral Patol Oral Cir Bucal.* 19(1): e1-7.

Kazemi, M., Salehi, M., Kheirollahi, M. 2016. Down Syndrome: Current Status, Challenges and Future Perspectives. *Int J Mol Cell Med.* 5:125-133.

Kotsiomiti, E., Arapostathis, K., Kapari, D., Konstantinidis, A. 2000. Removable prosthodontic treatment for the primary and mixed dentition. *J Clin Pediatr Dent*. 24(2): 83-89.

Lee, H.C., Tan, K.L., Cheah, P.S., Ling, K.H. 2016 Potential Role of JAK-STAT Signaling Pathway in the Neurogenic-to-Gliogenic Shift in Down Syndrome Brain. Neural Plast. 2016:7434191.

Macho, V., Coelho, A., Areias, C., Macedo, P., Andrade, D. 2014. Craniofacial features and specific oral characteristics of Down syndrome children. Oral Health Dent Manag. 13: 408-411.

Morales-Ângulo, C., Gallo-Terán, J., Azuara, N., Rama Quintela, J. 2006. Otorhinolaryngo logical manifestations in patients with Down syndrome. *Acta Otorrinolaringol* Esp. 57: 262-265.

Orchadson, R., Cadden, S. 1998. W. Mastication, in scientific basis of eating. *Front Oral Biol.* 9: 79-121.

Palinkas, M., Bataglion, C., De Luca Canto, G., Machado Camolezi, N., Theodoro, G.T., Siéssere, S., *et al*. 2016. Impact of sleep bruxism on masseter and temporalis muscles and bite force. Cranio. 34:309-315.

Palinkas, M., Nassar, M.S., Cecílio, F.A., Siéssere, S., Semprini, M., Machado-de-Sousa, J.P., *et al*. 2010. Age and gender influence on maximal bite force and masticatory muscles thickness. *Arch Oral Biol. Arch Oral Biol.* 55: 797-802.

Peterlein, C.D., Schiel, M., Timmesfeld, N., Schofer, M.D., Eberhardt, O., Wirth, T., *et al*. 2013. Characteristics in treatment of the hip in patients with Down syndrome. Z Orthop Unfall. 151: 585-595.

Rane, V., Hamde, S., Agrawal, A. 2017. Development of computerized masticatory force measurement system. *J Med Eng Technol.* 41(1): 65-71.

Shiau, Y.Y., Wang, J.S. 1993. The effects of dental condition on hand strength and maximum bite force. *Cranio.* 11: 48-54.

Shukla, D., Bablani, D., Chowdhry, A., Thapar, R., Gupta, P., Mishra, S. 2014. Dentofacial and cranial changes in down syndrome. *Osong Public Health Res Perspect*. 5: 339-344.

Sun, K.T., Chen, S.C., Li, Y.F., Chiang, H.H., Tsai, H.H., Li, C.Y., *et al*. 2016. Bite-force difference among obese adolescents in central Taiwan. *J Formos Med Assoc*. 115: 404-410.

Toro, A., Buschang, P.H., Throckmorton, G., Roldán, S. 2006. Masticatory performance in children and adolescents with Class I and II malocclusions. *Eur J Orthod*. 28: 112-119.

Uppal, H., Chandran, S., Potluri, R. 2015. Risk factors for mortality in Down syndrome. *J Intellect Disabil Res*. 59: 873-881.

Weiss, A.H., Kelly, J.P., Phillips, J.O. 2016. Infantile Nystagmus and Abnormalities of Conjugate Eye Movements in Down Syndrome. *Invest Ophthalmol Vis Sci.* 57: 1301-1309.

Williams, J.J., Spangler, C.C., Yusaf, N.K. 2015. Barriers to dental care access for patients with special needs in an affluent metropolitan community. *Spec Care Dentist.* 35: 190-196.

****