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Effects of Wearing a Custom-Made Mouth Guard during Static Exercise on Masticatory Muscle Activity in Athletes with Cerebral Palsy

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Abstract

Aim: Oral health is closely related to the general condition of athletes. Oral diseases can decrease their performance by affecting their concentration during games and practice sessions. Appropriate education is therefore required regarding the importance of dental support. We introduced periodic dental examinations and fabricated custom-made mouth guards (CMGs) for athletes with cerebral palsy (CP). This study aimed to determine the effects of wearing a CMG on masticatory muscle activities in CP athletes while measuring center of gravity (COG) sway.

Materials and Methods: Thirteen athletes with CP (male, n=12; mean age, 27.3 ± 8.96 y) and 10 healthy male controls (mean age, 28.5 ± 1.35 y) participated in the present study. The CMG comprised 2-mm-thick polyolefin sheeting. All participants underwent dental checks and occlusal contact areas were measured with and without a CMG. We simultaneously measured gravitational sway at the COG with the eyes open, as well as masticatory (masseter and digastric) muscle activities with or without a CMG. Data were statistically analyzed using two-way mixed analyses of variance.

Results: Indices for decayed, missing and filled teeth did not significantly differ between athletes and controls. However, the occlusal contact area significantly increased in athletes when wearing a CMG. Although COG sway slightly differed between having eyes open and closed in athletes, masticatory muscle activity increased and COG sway decreased.

Conclusions: The findings suggest that wearing a CMG might change the modality of masticatory muscle activity in athletes with CP and might help to improve balance during static exercise.

Keywords

Disabled sports; Cerebral palsy; Football athlete; Custom-made mouth guard; Masticatory muscle; Center of gravity sway

Introduction

Sport positively affects the mind and body by promoting mental stability and physical health. In addition to these health aspects, sport fosters a relationship with society that promotes vitality and improves the quality of life among persons with disabilities. This in turn imparts self-confidence to persons with disabilities [1,2]. Many events are now available for persons with and without disabilities to enjoy and practice sports without barriers in the same way regardless of a disability. Opportunities for disabled persons to practice, and a cooperative infrastructure of athletes and supporters should be established to promote sports for the disabled. Dentists should become involved in sport by delivering proactive support.

To date, the authors have provided dental support at the Special Olympics and to athletes with cerebral palsy (CP) who play CP football as part of a strategy to support disabled sports [3-6]. Support was provided to floor hockey athletes in the Special Olympics in the form of dental checks in the Special Smile program and the provision of custom-made mouth guards (CMG) [3]. In addition, the use of CMGs as opposed to pre-formed mouth guards has been advocated [3]. As team dentists for CP football athletes, we have provided dental examinations, oral hygiene guidance, dental treatment, and CMGs; thus, our activities have ranged from oral care guidance to the prevention of oral injury [4-6]. Dental support in the form of examinations and the provision of CMGs is still available to CP football teams.

Reports to date have described that CMGs exert many beneficial effects, including a reduction in the frequency or prevention of maxillofacial trauma such as tooth injury, soft tissue laceration, temporomandibular joint injury, concussion or mandibular fracture, as well as maintaining the position of the temporomandibular joint [7-11]. Several recent studies have investigated improving competitive ability as a new role for the CMG [8-10,12-20].

However, almost all of these studies assessed healthy persons [7-20], and few studies have focused on persons with disabilities. Suzuki et al. [4,5]. Manufactured CMGs for CP football teams and surveyed of the usability of CMGs worn during training. They reported that wearing CMGs improved posture and balance stability. Suzuki et al. explored the underlying mechanism by investigating the relationship between masticatory muscle activity due to wearing a CMG and center of gravity (COG) sway [5,6]. Their results suggested that athletes with CP who wear a CMG have a different modality of masticatory muscle activity from that of healthy persons, and that COG sway was improved. However, these studies had very few participants, and body sway was measured only with the eyes open. Therefore, the effects of wearing a CMG on COG sway and masticatory muscle activity in athletes with CP should be investigated in greater detail.

Therefore, the present study investigated the effects of wearing a CMG on masticatory muscle activity during static exercise in athletes who play CP football while measuring COG sway considered as static exercise.

Materials and Methods

Participants

The present study included 13 athletes with CP from a CP soccer club team, who had received dental support from our personnel (12 men, 1 woman; mean age, 27.3 ± 8.96 y; athletes) and innate

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or acquired physical movement disability due to CP, as well as cerebrovascular disease and head injury, and 10 healthy men (mean age, 28.5 ± 1.35 y; controls) without subjective or objective disorders of the stomatognathic system, cervicofacial area, etc. The study was implemented in accordance with the Declaration of Helsinki (2013 revision), and all those enrolled received an explanation of the purpose of the study before providing written, informed consent to participate (Ethics Review Committee, Nihon University School of Dentistry at Matsudo; Approval No: EC16-013).

CP football

The team sport of CP football (also known as seven-a-side football) became an official Paralympic event in 1984. It is played by athletes with movement disorders because of CP, traumatic brain injury, or stroke, and those who have difficulty in maintaining posture or walking [21]. Athletes must be able to walk independently without the use of protective equipment. In principle, teams comprise athletes with class C5-C8 disabilities [22]. The game is played according to the rules of the Fédération Internationale de Football Association, with the following changes: no offside, single-handed underarm throwing is allowed, and a smaller pitch and goal than those of regular 11-a-side football. The first and second halves of international matches are both 30 min, halftime is 15 min, and up to three substitutions are permitted [22].

Dental checks

Annual dental checks were held at the time of pre-season meetings. Considering the burden on athletes, these meetings provide good opportunities for almost all athletes to meet and interact. The checkups were all conducted visually by the same dentist using a dental mirror, and decayed, missing, and filled teeth (DMFT) indices were calculated according to the standards of the Fédération Dentaire Internationale (FDI) [23].

The DMFT indices of the athletes with CP were compared with 86 healthy persons of the same generation in the nationwide FY2016 Survey of Dental Diseases, which the Ministry of Health, Labour and Welfare in Japan implements every five years.

Manufacture of custom-made mouth guards

CMGs were manufactured by pressure-forming polyolefin-based 2 mm MG21 sheets (CGK Corp., Hiroshima, Japan) according to a standard protocol. The CMG was shaped approximately 2 mm above the cervical line on the labial side to completely avoid the frenum, and it follows the cervical line on the palatal aspect. The basic CMG also extends in the posterior direction to the distal side of the maxillary first molar (Figure 1). The occlusal surface of the CMG can be adjusted as needed by softening it on a dental model with gentle heat delivered using a hot air burner (Erkodent, Pfalzgrafenweiler, Germany) and then fitting it inside the mouth and directing the recipient to carefully close the mouth, ensuring the absence of lateral deviation.

Occlusal contact records

Occlusal contact was recorded to determine changes in occlusal relationships in the athletes and controls when wearing and not wearing a CMG. Contact was recorded using conformity test Blue Silicone® (GC Co. Ltd., Tokyo, Japan), which is an addition-type silicone. Impressions were taken by loading Blue Silicone® onto the mandibular arch and then having the participants close their mouths in the maximal intercuspal position with minimal force. The participants were seated in a chair so that the occlusal plane remained parallel to the floor during recording, and they were required not to move the mandible or change posture for 90 s until the silicone had completely hardened. The surface area of occlusal contact was evaluated using a dedicated Biteye BE-1 analytical device (GC Co. Ltd., Tokyo, Japan). A silicone thickness of ≤ 50 μm was judged to indicate occlusal contact [24].

Myoelectric measurements

The volume of masticatory muscle activity was measured using a Polymate Mini AP108 (Miyuki Giken, Tokyo, Japan) (Figure 2). Among the various masticatory muscles, we assessed the superficial layer of the left and right masseter muscles that close the mouth, and the belly of the left and right anterior digastric muscles that open the mouth. We used Ag-AgCl electrodes, and care was taken to ensure that the cords connecting the electrodes did not affect biomechanics. The electrodes were affixed such that the distance from the belly of the corresponding muscle was 10 mm.

Figure 1: Custom-made mouth guard for athletes with cerebral palsy.

Figure 2: Myoelectrical measurement and center of gravity sway.

The Maximum Voluntary Contraction (MVC) of each muscle was measured before starting the experiment. The MVC of the masseter muscle was determined by maximum clenching in the intercuspal position, and that of the digastric muscle was determined by placing the thumb of each hand on the submental region, without touching the electrodes, and maximally opening the mouth against resistance [19,20]. The MVC measurements were repeated three times, and the largest of the three values was taken as the MVC for that muscle. The relative ratio of activity for each muscle was determined as %MVC and %MVC root mean square was also determined as %MVC-RMS. The %MVC-RMS value shows the mean RMS value for muscle activity expressed as %MVC during COG sway measurement in 60 seconds. The %MVC-RMS values of the left and right masseter and digastric muscles were calculated, then the means of the left and right values were calculated and used as the respective %MVC-RMS values to determine muscle activity volume.

These measurements were taken under circumstances of wearing and not wearing a CMG, and with the eyes open and closed. Each measurement was repeated three times for 60 s, and the mean value was then calculated. The order of measurements when wearing and not wearing a CMG was random. The position of the jaw at the start of measurements was that with the mandible at rest and no instructions given regarding the position of the mandible after starting measurements.

Measurement of center of gravity sway

We used ECG-1500AK (Kyowa Co., Ltd., Fukuoka, Japan) to measure COG sway (Figure 2). Based on the standards of the Japan Society for Equilibrium Research, measurements proceeded with participants standing upright with their arms by their sides in a quiet room with uniform illumination to avoid postural deviation owing to aural or visual stimuli. Tests proceeded with eyes open and closed for 60 s each. Measurements were taken with the eyes open by having the participants steadily gaze at a point set at eye level two meters in front of them. Measurements were taken with the eyes closed and the head upright while mentally visualizing the same visual point. COG sway was evaluated based on the outer area (mm^2) and total trajectory length (mm).

Because COG sway and myoelectric values were simultaneously measured, the start times of both measurements were matched using a synchronization system.

Statistical analysis

The DMFT indices of CP athletes calculated from the results of dental checkups were compared with those for a Japanese population within the same generation in the FY2016 Survey of Dental Diseases using independent t-tests.

Changes in occlusal contact were compared between athletes and controls while wearing a CMG or not using paired t-tests.

The effects of wearing a CMG on masseter and digastric muscle activities and COG sway (total area and length) in the athletes and controls were analyzed using a two-way mixed analysis of variance (ANOVA).

Data were statistically analyzed using SPSS 24.0J for Windows Japan (IBM Co., Ltd. Tokyo, Japan) and the level of significance was set at 5% [25].

Results

Dental checks

Table 1 shows that the DMFT indices of the athletes and of Japanese individuals of the same generation from the (2016) Survey of Dental Diseases did not significantly differ (t (96)=0.16, p=0.314; independent t-tests).

Occlusal contact area

Table 2 shows that the occlusal contact area at the maximal intercuspal position significantly increased when athletes with CP wore a CMG, but did not significantly differ regardless of wearing a CMG in controls (p=0.022 vs. p=0.212)

Masticatory muscle activity during COG sway

The volume of masticatory muscle activity while measuring COG sway was compared using a two-way mixed ANOVA with group (CP athletes and controls) and condition (with and without a CMG) as the primary factors.

Table 3 shows that masseter and digastric muscle activities significantly interacted when the eyes were open (F[1, 21]=5.32, p=0.03 vs. F[1, 21]=5.23, p=0.03). Simple main effect analysis showed significantly higher mean values for the masseter and digastric muscles in the athletes when wearing the CMG (F[1, 21]=13.70, p=0.001 and F[1, 21]=12.42, p=0.002, respectively), but not in the controls (F[1, 21]=0.03, p=0.860 and F[1, 21]=0.00, p=0.962, respectively). Interaction was significant only with the masseter muscles with the eyes closed (F[1, 21]=6.3, p=0.020). Simple main effect analysis showed significantly higher mean values for the athletes, but not the controls when wearing the CMG (F[1, 21]=14.32, p=0.001 and (F[1, 21]=0.00, p=0.99, respectively). Interaction was not significant for the digastric muscles, but the mean value was greater when wearing the CMG only in the athletes (eyes open: F[1, 21]=12.42, p=0.002); eyes closed: F[1, 21]=5.10, p=0.035). Mean values in the controls did not significantly differ between having their eyes open and closed (F[1, 21]=0.00, p=0.962 vs. F[1, 21]=0.01, p=0.912; Table 3).

Center of gravity sway

We assessed COG sway using a two-way mixed ANOVA with the primary factors of athletes and controls wearing a CMG or not.

Table 4 shows that significant interaction was identified in the total length of sway with the eyes open and closed (F[1, 21]=4.85, p=0.039 vs. F[1, 21]=6.14, p=0.02). Simple main effect analysis showed significantly lower mean total length when the athletes wore the CMG (eyes open vs. closed: F[1, 21]=10.91, p=0.003 vs. F[1, 21]=13.40, p=0.001), but not the controls (eyes open vs. closed: F[1, 21]=0.00, p=0.974 vs. F[1, 21]=0.01, p=0.933).

No significant interaction was found for total area with the eyes open or closed, but the mean was lower when wearing the CMG in the athletes (eyes open vs. closed: F[1, 21]=4.60, p=0.044 vs. F[1, 21]=7.75, p=0.011). Mean values did not significantly differ in the controls (eyes open vs. closed: F[1, 21]=0.00, p=0.966 vs. F[1, 21]=0.00, p=0.992; Table 4).

Table 1: DMFT indices of CP athletes and healthy controls.

Group	N	DMFT index			
		M	SD	t	p
CP	13	5.67	5.02	0.16	0.314
Healthy	86	5.9	4.29		

Table 2: Occlusal contact area of CP athletes and healthy controls wearing and not wearing a CMG.

Group	N	With CMG		Without CMG		
		M	SD	M	SD	p
CP	13	39.4	21.56	17.28	11.17	0.02
Healthy	10	22.28	22.81	12.23	11.2	0.21

Table 3: Masticatory muscle activity of CP athletes and healthy controls wearing and not wearing a CMG.

Eyes	Variable	Group	N	With CMG		Without CMG		CMG	
				M	SD	M	SD	F	p
Open	Masseter	CP	13	3.1	1.88	1.71	0.8	6.63	0.02
	muscle	Healthy	10	0.47	0.31	0.4	0.21		
	Digastric	CP	13	4.7	2.86	0.4	2.73	5.57	0.03
	muscle	Healthy	10	1.18	0.83	1.16	1		
Closed	Masseter	CP	13	3.34	2.05	1.62	0.8	6.16	0.02
	muscle	Healthy	10	0.4	0.23	0.41	0.23		
	Digastric	CP	13	4.84	2.86	3.88	3.51	2.47	0.13
	muscle	Healthy	10	1.23	0.86	1.17	0.98		
Eyes	Variable	Group	N	Group		CMG×Group		Simple main effect	
				F	p	F	p	F	p
Open	Masseter	CP	13	28.73	<.001	5.32	0.03	13.7	0
	muscle	Healthy	10					0.03	0.86
	Digastric	CP	13	11.29	<.001	5.23	0.03	12.42	0
	muscle	Healthy	10					0	0.96
Closed	Masseter	CP	13	33.35	<.001	6.3	0.02	14.32	0
	muscle	Healthy	10					0	0.99
	Digastric	CP	13	10.04	<.001	1.97	0.18	5.1	0.04
	muscle	Healthy	10					0.01	0.91

N: Number; M: Mean; SD: Standard Deviation

Table 4: COG values of CP athletes and healthy controls wearing and not wearing a CMG.

Eyes	Variable	Group	N	With CMG		Without CMG		CMG	
				M	SD	M	SD	F	p
Open	Masseter	CP	13	491.64	206.82	885.18	994.82	2.09	0.16
	muscle	Healthy	10	265.73	124.24	274.73	127.63		
	Digastric	CP	13	698.19	168.93	827.18	244.6	4.64	0.04
	muscle	Healthy	10	537.94	141.67	536.46	133.77		
Closed	Masseter	CP	13	735.57	621.37	1264.68	1461.37	3.4	0.08
	muscle	Healthy	10	337.2	187.31	339.47	195.7		
	Digastric	CP	13	815.85	264.53	1047.65	352.2	5.52	0.03
	muscle	Healthy	10	675.46	182.93	669.34	206.95		
Eyes	Variable	Group	N	Group		CMG×Group		Simple main effect	
				F	p	F	p	F	p
Open	Masseter	CP	13	5.14	0.03	1.91	0.18	4.6	0.04
	muscle	Healthy	10					0	0.97
	Digastric	CP	13	10.11	0.01	4.85	0.04	10.91	0
	muscle	Healthy	10					0	0.97
Closed	Masseter	CP	13	4	0.06	3.34	0.08	7.75	0.01
	muscle	Healthy	10					0	0.99
	Digastric	CP	13	6.47	0.02	6.14	0.02	13.4	0
	muscle	Healthy	10					0.01	0.93

N: Number; M: Mean; SD: Standard Deviation

Discussion

The present study investigated the effects of wearing a CMG on COG sway and masticatory muscle activities when the eyes were open and closed, considering COG sway during measurements as static exercise and the functions of the masseter and digastric muscles being to close and open the mouth respectively. The results showed that COG sway improved when the athletes with CP wore a CMG during static exercise and that their masticatory muscle activities differed from those of the controls, suggesting that jaw movements are different in the athletes.

We initially found during dental checks that oral status did not significantly differ between the athletes with CP and a Japanese population of the same generation. However, Suzuki et al. [5] found that the DMFT indices of the oral status of a CP football team in 2011 was 12.4 teeth, whereas that of the same team in the present study was 5.67 teeth. The oral milieu of athletes with CP has steadily improved over time and is now equivalent to that of healthy persons. While this might be largely a result of improved dental care for persons with disabilities in Japan, but as team dentists, we consider that this might also be partly associated with consistent dental checkups and oral hygiene guidance.

The occlusal contact area significantly increased in athletes with CP when wearing a CMG compared with the controls. The main factor for this might be that the CMG makes it easier to maintain the mandible in position between the teeth than when adopting the maximum intercuspal position, so the athletes could manage more stable occlusion. When occlusal contact area is determined using silicone materials, the contact surface area increases with increasing occlusal strength [26]. Suzuki et al. [4-6] reported that athletes with CP tend to try to stabilize their jaw position by routinely clenching their teeth, and that even if these athletes are instructed to hold the mandible in place only with the amount of force needed to maintain upper and lower occlusal contact, the unconscious habit of routinely clenching the teeth might have caused the increase in contact area.

Moreover, as athletes with CP have hypertonia and unpredictable involuntary muscle activities, they might have coped with this by unconsciously clenching their teeth to maintain the mandible in a fixed position during the 90-s test period when the CMG was in place. The phenomenon of a completely different result from healthy persons is therefore of interest.

The occlusal contact surface did not significantly differ between athletes with CP and controls when not wearing a CMG. However, that occlusal contact status does not affect posture while standing still cannot be assumed. Further studies are needed to clarify this phenomenon. On the other hand, the occlusal contact area increased in athletes with CP while wearing a CMG, suggesting that wearing a CMG affects masticatory muscle activity.

Masticatory muscle activity during various sport-related movements has been documented, and many authors have suggested that COG sway should be measured under conditions of intentionally clenched teeth [13-16]. However, humans do not always clench their teeth during static or dynamic exercise. Therefore, the effects of wearing a CMG on masticatory muscle activity in a natural state without specific instructions to clench the teeth required investigation. Here, we deliberately measured COG sway under a natural state in which instructions regarding jaw position or occlusal status were not given.

Masseter and digastric muscle activities significantly increased among athletes with CP while wearing a CMG with their eyes open, but not in the controls. Masseter muscle activity also significantly increased in athletes with CP while wearing a CMG with their eyes closed. Digastric muscle activity tended to increase in the athletes, but the difference did not reach significance. Muscle activity did not significantly change in the controls with the eyes open or closed.

The above results suggest that when athletes with CP wear a CMG, they can maintain their jaw position because of an increase in the occlusal contact area. The results also suggest that athletes try to use the masticatory muscle groups to maintain jaw position via more powerful exertion of the muscles used to open and close the mouth. This phenomenon is not found in healthy persons, and it might help to explain the increase in occlusal surface area. If wearing a CMG affects masticatory muscle activity in athletes with CP, it could be a step toward improving their competitive ability.

On the other hand, all humans have some gait unsteadiness, and equilibrium in the body is controlled by moving the COG in response. Failure to compensate for unsteadiness in all directions by COG sway would result in unstable posture or falls [27]. Measuring COG sway is one way to objectively evaluate such instability; therefore, we measured COG sway as static exercise with the eyes open and closed.

The total length of sway significantly decreased in athletes with CP when wearing a CMG with their eyes open and with their eyes closed, and while this difference was not significant, the total area tended to decrease. Neither of these parameters significantly differed in the controls. These results suggest that wearing a CMG promotes a decrease in COG sway during static exercise in athletes with CP. Therefore, wearing a CMG during static exercise probably affects maintenance of a posture and withstanding unintentional postural instability, which are aspects of improved exercise performance.

Measuring COG sway in athletes with CP with their eyes open probably reflects essentially unconscious masticatory muscle activity and the COG sway that naturally occurs throughout life. The results suggest that when wearing a CMG with the eyes open, these athletes maintained the position of the mandible not by firmly clenching the teeth, but rather by coordinating the opposing movements of opening and closing the mouth, thereby stabilizing their COG sway. Several reports have described a fixed position of the mandibular jaw [14-16]. According to Hellman et al., a mandibular position stabilized using the mandibular condyle and temporomandibular fossa improves COG sway more than maximal intercuspal or eccentric occlusal positions. In this study, the masticatory muscle groups are used to maintain jaw position using CMG via more powerful exertion of the muscles used to open and close the mouth. The digastric muscle opens the mouth and pulls the jaw backwards. The increase in digastric muscle activity caused by wearing a CMG indicates that the athletes try to maintain the position of the mandible by pulling the mandibular condyle backwards and pushing against the posterior wall of the temporomandibular fossa. Masseter muscle activity would then increase together with this, suggesting that the athletes might have attempted to hold the mandible in place more firmly by coordinating the masseter muscles with the muscles that close the mouth.

The COG values obtained with the eyes closed probably reflect masticatory muscle activity and COG sway under conditions where the absence of visual information depletes the sense of balance and causes psychological anxiety. These results suggest that when wearing the CMG with their eyes closed, unlike having their eyes open, the athletes held the mandible in place by clenching their teeth via the muscles that close the mouth to a greater extent than those used to open the mouth to maintain COG sway. Jaw movements in which the teeth are clenched to retain posture seem unlikely in healthy persons [15,16] and it is probably a trait of athletes with CP. One report has indicated that clenching the teeth might stabilize posture by maintaining the position of the ankle [17]; thus, if the method of maintaining posture differs between athletes with CP and healthy persons, the athletes might instinctively firm up the ankle by clenching the teeth in an attempt to retain and stabilize posture. In situations where maintaining posture is difficult or when visual and/or other types of sensory information are unavailable, sensations from the temporomandibular joint receptors associated with occlusal status play an important role. The present findings that wearing a

CMG results in the mandible being held in position with increased stability support the results of these previous studies. Some athletes with CP use a CMG not only during matches and training, but also when commuting or working. Through necessity, they might have appreciated the effects of wearing a CMG, and thus wear it to cope with unpredictable postural instability.

Wearing a CMG during static exercise resulted in athletes with CP being able to increase their volume of masticatory muscle activity and improve their COG sway. Thus, the CMG might become essential not only for preventing physical trauma, but also for supporting improvements in balance. Therefore, the effects of wearing a CMG during dynamic exercise should be investigated. While the implications are that clenching the teeth holds the ankle in place and thereby contributes to greater postural stability, it might also impede the smoothness of movement during dynamic exercise [22]. If teeth clenching impedes smooth movement in dynamic exercise that requires smoothness, future studies should investigate whether athletes with CP clench their teeth during dynamic exercise to maintain posture, and whether wearing a CMG during dynamic exercise is effective for maintaining posture.

This study was limited by a small sample size. Considering this, we plan to conduct a randomized controlled clinical trial to determine the effects of CMG during static exercise on masticatory muscle activity in athletes with CP.

Conclusion

The DMFT indices of athletes with CP and healthy individuals did not significantly differ. However, occlusal contact increased in the athletes as a result of wearing a CMG. We found an increase in masticatory muscle activity and a decrease in COG sway. Wearing a CMG allows athletes with CP to easily maintain the position of the mandible and perhaps helps to maintain posture. These findings suggest that wearing a CMG confers protection against physical trauma and promotes improvements in balance among athletes with CP.

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References

1. Barak S, Mendoza-Laiz N, Fuentes MTG, Rubiera M, Huyzler Y (2016) Psychosocial effects of competitive Boccia program in persons with severe chronic disability. J Rehabil Res Dev 53: 973-988.
2. Blauwet C, Willick SE (2012) The Paralympic movement: Using sports to promote health, disability rights, and social integration for athletes with disabilities. PM R 4: 851-856.
3. Suzuki H, Kawara M, Tanaka Y, Mega J, Takahashi H (2007) Custom-made mouth guards for Special Olympics athletes. Spec Care Dentist 27: 125-126.
4. Kato E, Suzuki H, Aono H, Watanabe A, Kuroki T, et al. (2011) Dental support for Cerebral Palsy International Sports and Recreation Association Football 7-a-side athletes: Dental check-up and consciousness survey concerning dentistry. J Jpn Sports Dent 14: 53-59.
5. Suzuki H, Kato E, Kawara M, Kuroki T, Komiyama O et al. (2010) Necessity of mouthguards for football 7-a-side athletes of the Cerebral Palsy International Sports and Recreation Association. Int J Sport Dentistry 3: 13-20.
6. Suzuki H, Aono H, Watanabe A, Kuroki T, Komiyama O, et al. (2012) Influence of custom-made mouthguard wearing on masticatory muscle activity during center of gravity fluctuation. Int J Sport Dentistry 5: 28-34.
7. Duarte-Pereira DM, Del Rey-Santamaria M, Javierre-Garcés C, Barbany-Cairó J, Paredes-Garcia J, et al. (2008) Wearability and physiological effects of custom-fitted vs. self-adapted mouthguards. Dent Traumatol 24: 439-442.
8. Keçeci AD, Cetin C, Eroglu E, Baydar ML (2005) Do custom-made mouth guards have negative effects on aerobic performance capacity of athletes? Dent Traumatol 21: 276-280.
9. Collares K, Correa MB, Mohnsam da Silva IC, Hallal PC, Demarco FF (2014) Effect of wearing mouthguards on the physical performance of soccer and futsal players: A randomized cross-over study. Dent Traumatol 30: 55-59.
10. Narimatsu K, Takeda T, Nakajima K, Konno M, Ozawa T, et al. (2015) Effect of clenching with a mouthguard on head acceleration during heading of a soccer ball. Gen Dent 63: 41-46.
11. Cetin C, Keçeci AD, Erdoğan A, Baydar ML (2009) Influence of custom-made mouth guards on strength, speed and anaerobic performance of taekwondo athletes. Dent Traumatol 25: 272-276.
12. Wang K, Ueno T, Taniguchi H, Ohyama T (1966) Influence on isometric muscle contraction during shoulder abduction by changing occlusal situation. Bull Tokyo Med Dent Univ 43: 1-12.
13. Sakaguchi K, Mehta NR, Abdallah EF (2007) Examination of the relationship between mandibular position and body posture. Cranio 25: 237-249.
14. Gangloff P, Louis JP, Perrin PP (2000) Dental occlusion modifies gaze and posture stabilization. Neurosci Lett 293: 203-206.
15. Hellmann D, Giannakopoulos NN, Blaser R, Eberhard L, Schindler HJ (2011) The effect of various jaw motor tasks on body sway. J Oral Rehabil 38: 729-736.
16. Takada Y, Miyahara T, Tanaka T, Ohyama T, Nakamura Y (2000) Modulation of H reflex of pretibial muscles and reciprocal Ia inhibition of soleus muscle during voluntary teeth clenching in humans. J Neurophysiol 83: 2063-2070.
17. Sasaki Y, Ueno T, Taniguchi H, Ohyama T (1988) Effect of teeth clenching on isometric and isokinetic strength of ankle plantar flexion. J Med Dent 45: 29-37.
18. Asano T, Kawara M, Suzuki H, Komiyama O, Iida T, et al. (2009) Masticatory muscle activities during snatch weightlifting. Int J Sport Dentistry 2: 33-40.
19. Kawara M, Asano T, Suzuki H, Watanabe A, Obara R, et al. (2012) Influence of mouthguard on masticatory muscles activities and physical performance during exercise. Int J Sport Dentistry 5: 28-34.
20. Reina R, Sarabia JM, Yanci J, García-Vaquero MP, Campayo-Piernas M (2015) Change of direction ability performance in cerebral palsy football players according to functional profiles. Front Physiol 6: 409.
21. CP-ISRA Classification and Sports Rules Manual 9th Edition.
22. Namal N, Vehid S, Sheiham A (2005) Ranking countries by dental status using the DMFT and FS-T indices. Int Dent J 55: 373-376.
23. Horie T, Kanazawa M, Komagamine Y, Hama Y, Minakuchi S (2014) Association between near occlusal contact areas and mixing ability. J Oral Rehabil 41: 829-835.
24. IBM SPSS Statistics 24 Documentation.
25. Obara R, Komiyama O, Iida T, Asano T, De Laat A, et al. (2014) Influence of different narrative instructions to record the occlusal contact with silicone registration materials. J Oral Rehabil 41: 218-225.
26. Alexander KM, LaPier TL (1998) Differences in static balance and weight distribution between normal subjects and subjects with chronic unilateral low back pain. J Orthop Sports Phys Ther 28: 378-383.
27. Tardieu C, Dumitrescu M, Giraudeau A, Blanc JL, Cheynet F, et al. (2009) Dental occlusion and postural control in adults. Neurosci Lett 450: 221-224.

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