



## PRE-SURGICAL ORTHOPEDIC TREATMENT USING HOTZ PLATE: AN UPDATE

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### ABSTRACT

Throughout infancy, several difficulties like feeding, deglutition, articulation with aesthetic appearance are faced by cleft lip and palate (CLP) patients. Hotz plate is a passive pre surgical neonatal maxillary orthopedic appliance used in CLP patient after birth which facilitates not only in sucking and feeding but also exploit for treatment purpose. The prime purpose of this study was to evaluate the benefit of Hotz plate in patients with CLP and also to assess the effect of Hotz plate on enhancement of treatment outcome. A literature survey was executed on a Hotz plate in CLP patients by following terms: 'passive pre surgical orthopedic appliances and/or 'Hotz plate' and 'cleft lip and palate'. The electronic database including Medline-PUBMED, Science Direct, and ISI Web of Knowledge were searched from 1990 to 2014, and 10,311 relevant articles were found. Of these, we identified 41 articles including original articles and literature reviews. Even though the results differ from case to case because of anatomic and functional variability, this orthopedic appliance produced some changes in CLP patients. This update can generate better knowledge regarding the uses, advantages, and treatment effectiveness of Hotz plate. It can facilitate assessment and provide the momentum needed for a sustained upgrade in the standards of care for CLP in daily orthodontics.

**KEYWORDS:** Hotz plate, cleft lip and palate, treatment outcome.



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## INTRODUCTION

Hotz plate is a passive pre-surgical neonatal maxillary orthopedic appliance used in cleft lip and palate patients, made of soft and hard acrylic compound. Neonatal maxillary orthopedics started in Zurich in the mid-1950s based on the treatment principles of Mcneil<sup>1</sup>. After the first long-term evaluation, it became clear that forced approximation of the maxillary segments was not advisable. Consequently, the procedure was greatly modified to what is known now as the "Zurich approach"<sup>2</sup>. According to Hotz and Gnoinski<sup>3</sup> the primary aim of neonatal orthopedics is not to facilitate surgery or to stimulate growth as postulated by Mcneil, but to take advantage of intrinsic developmental potentials. Since 1969/70, early maxillary orthopedic treatment was essential in Zurich, while surgical intervention was postponed in order to minimize subsequent growth disturbance, created optimal conditions for the maxillary segment to develop their entire growth potential, maintain or improve arch form, and control effect of surgical lip closure<sup>3</sup>. It is a passive plate of compound soft and hard acrylic resins which worn 24 hours a day for about 16 to 18 months, when the soft palate closed surgically. The hard palate is closed after 5 years of age. During the course of treatment, the lip is closed at about 6 months of age. The posterior extension of the plate that extends to the uvula must be carefully adapted to the specific anatomy of the patient. Arch alignment

is achieved by grinding away the acrylic in specific area<sup>1, 3, 4</sup>. The aim of this manuscript is to provide an update to identify and assess the scientific evidence on the efficiency of Hotz plate. From which clinicians can acquire benefits for the better treatment outcome and also can aid to ensure better patient care.

## METHODS AND MATERIALS

The purpose of this article was to assess the importance of Hotz plate in CLP in orthodontics; a 2-examiner-based literature search was performed. The electronic databases from 1990 to 2014 included Medline-PUBMED, Science Direct and ISI Web of Knowledge search engines, from which 10,311 articles were included in the study initially. Articles were also searched manually and 41 articles were finally decided to be included according to the selection criteria. There was no language preference. Both original research articles as well as review articles were searched. The selection criteria included following: suitable quantity of subjects, quality of data assessed, functional benefits of Hotz plate, treatment outcome of Hotz plate, statistical analysis used and the conclusions reached. The following free-text terms were used for searches: Hotz plate, cleft lip and palate, pre surgical orthopedic appliances.

## RESULTS

The update of Hotz plate are shown in table 1

**Table 1**  
**Update of Hotz plate according to literature survey**

Author	population	Group	Sample size	Method	Outcome
1. Sasaguri et al. (2014) <sup>3</sup>	• Indonesia	• HP+ • LA-HP+ • HP- • NCG	• 22 • 14 • 14 • 10	• Cast analysis	HP+ prevents the collapse of maxillary arch.
2. Kajii et al. (2013) <sup>6</sup>	• Japan	• HP+ • HP- • Active plate	• 41 • 67 • 27	• Cast analysis	Favorable group Unfavorable group
3. Sulaiman et al. (2013) <sup>7</sup>	• Indonesia	• HP+	• 17	• Serial colour photograph	Significant improvement was found on nostril height & width ratio and height of alar groove.
4. Alam et al. (2013) <sup>8</sup>	• Japan	• HP+ • Active plate • HP-	• 41 • 27 • 72	• Cephalometric analysis	Hotz plate had less adverse effect than others.
5. Karube et al. (2012) <sup>9</sup>	• Japan	• HP+ • HP-	• 15 • 15	• Digitize nasal morphology	Significant correlation with visual evaluation was found for Hausdroff distance.
6. Hak et al. (2012) <sup>10</sup>	• Indonesia	• HP+ • LA-HP+ • HP- • NCG	• 24 • 18 • 11 • 10	• Cast analysis	HP+ prevents the collapse of pre maxilla.
7. Alam et al. (2008) <sup>11</sup>	• Japan	• HP+ • HP- • Active plate	• 41 • 72 • 27	• Cast analysis	Favorable group Unfavorable group
8. Suzuki et al. (2006) <sup>12</sup>	• Indonesia	• IO+ • IO-	• 3 • 3	• Ultrasonography	IO+ can prevent irregular movement of tongue during sucking and also can obtain normal articulation.
9. Bongaarts et al. (2006) <sup>13</sup>	• Netherlands	• IO+ • IO-	• 27 • 27	• Cast analysis	No clinically significant difference was found.
10. Prahj et al. (2005) <sup>14</sup>	• Netherlands	• IO+ • IO-	• 27 • 27	• Computerized balanced allocation method	No significant difference was found.
11. Bongaarts et al. (2004) <sup>15</sup>	• Netherlands	• IO+ • IO-	• 27 • 27	• Cast analysis	No significant difference was found.
12. Yamada et al. (2003) <sup>16</sup>	• Japan	• HP+	• 15	• Cast analysis	Presurgical orthopedics can reduce cleft width and make subsequent surgery easier.
13. Knost et al. (2003) <sup>17</sup>	• Netherlands	• IO+ • IO-	• 9/4 • 7/2	• Phonological skill analysis	IO+ subjects showed normal phonological development.
14. Silvera et al. (2003) <sup>18</sup>	• Japan	• HP+ • HP- • NCG	• 10 • 11 • 11	• Cephalometric analysis	HP+ had good effects on maxillary growth until 12 years.
15. Knost et al. (2003) <sup>19</sup>	• Netherlands	• IO+ • IO-	• 6 • 6	• Language skill analysis	Diminutive difference was found.
16. Brauman et al. (2003) <sup>20</sup>	• Germany	• cUCLP • iUCLP	• 15 • 13	• Cast analysis	Diminutive difference was found.
17. Mishima et al. (2000) <sup>21</sup>	• Japan	• HP+ • HP-	• 12 • 8	• Cast analysis	The width of palate was larger in the group with HP+
18. Severens et al. (1998) <sup>22</sup>	• Netherlands	• HP+ • HP-	• 26 • 26	• Short term cost effectiveness analysis	Significantly difference was found.
19. Kogo et al. (1997) <sup>23</sup>	• Japan	• mHP	• 10	• Lateral cine radiograph analysis	Wearing mHP, babies could suck.
20. Mishima et al. (1996) <sup>24</sup>	• Japan	• HP+ • HP-	• 12 • 8	• 3D palatal form analysis	Appliance could guide the growth of the maxillary segments to narrow the cleft width until 18 months of age.
21. Ross & MacNamera (1994) <sup>25</sup>	• Canada	• IO+ • IO-	• 20 • 20	• Profile slide	No significant difference was found.

HP+: with Hotz plate  
HP- : without Hotz plate  
NCG: non cleft group  
IO+ : with infant orthopedic (Hotz plate)  
IO- : without infant orthopedic  
LA-HP+ : Hotz plate with lip adhesion.  
cUCLP : complete unilateral cleft lip and palate.  
iUCLP : incomplete unilateral cleft lip and palate.

## DISCUSSION

Cleft lip and palate (CLP) is one of the most common oro-facial congenital defects with an incidence of one per seven hundred live births<sup>26, 27</sup>. CLP patients face a multitude of problems including feeding, dental, aesthetic, speech, hearing and psychological problems<sup>28</sup>. Therefore, the treatment of CLP should be considered through multidisciplinary approaches including multiple surgeries, speech therapy, dental and orthodontic treatment with several specialists<sup>29</sup>. Pre surgical orthopedic appliances are mainly used to mold the maxillary alveolar and nasal tissues of CLP patients. The use of this appliance is

prevalent; in United Kingdom, 47-51% neonates are treated with this appliance<sup>30</sup>. Two types of appliances are used; active and passive. Active appliances are preset intraorally and apply traction through mechanical means like elastic chains, screws and plates<sup>31, 32</sup>. Passive appliance (Hotz plate) already has been described in introduction part. In contemporary era, the importance of using Hotz plates is amplifying day by day since the preface of the early maxillary orthopedic intervention. However, Hotz plate is not only used for feeding but also for treatment purpose. Hotz plate serves as<sup>33, 34, 35, 36, 37</sup>.

1. Monitoring function- a. feeding, b. tongue posture.
2. Guidance of growth and position of maxillary segments, especially with a view to intermaxillary relationship; delay of surgery in order to allow intrinsic growth potentialities to become manifest.
3. Normalizing function and arch form.
4. Improvement in the nursing obstruction.
5. Prevention of the tongue insertion into the cleft.
6. Normalization of tongue position.
7. Cleft alveolar narrowing.
8. Growth acceleration of maxilla.
9. Reduction of parent's anxiety.
10. Reconstructing anatomical feature.
11. Recovering oral function.
12. Preventing growth difficulty.
13. Preventing speech impediment.
14. Improve suckling pressure.

The controversy for or against the Hotz plate still continues. Some recent publications advocating early orthopedics state that it has definite advantages as it concerns both growth and development and primary surgery. Evaluation of orthopedic measures is not possible unless based on detailed knowledge of concomitant surgical interventions and their possible effects. It is well known that, even under the same heading, procedures vary considerably from surgeon to surgeon and, even if performed by the same operator, their effects may differ from case to case because of anatomic and functional variability<sup>38</sup>. Sasaguri et al.<sup>5</sup> scanned maxillary dental cast between the three groups and found treatment by Hotz plate had anti collapsing effect on maxillary

arch after cheiloplasty and palatoplasty. In a study, subjects who did not use pre surgical orthopedic appliance showed unfavorable condition respectively<sup>6, 11</sup>. However, in another study the nasal form and growth was analyzed using consecutively taken color photos an exemplified considerable improvement between nostril height and width ratio and height of the alar groove<sup>7</sup>. The naris evaluation after cheiloplasty among 30 unilateral CLP patients (15 with Hotz plate and 15 without any plate) was carried out by Karube et al.<sup>9</sup> Remarkable association was observed for Hausdroff distance as the visual evaluation was found higher and Hausdroff distance was found notably lower with Hotz plate group. Alam et al.<sup>8</sup> compared the subjects who were treated with

pre-surgical orthopedic appliances with who were not treated with appliances by using cephalogram. The result showed Hotz plate had significantly larger upper incisor/sellasion (U1-SN) measurements than who had no preoperative orthopaedic treatment or an active plate. Therefore, their study declaimed that Hotz plate had fewer adverse effects on craniofacial morphology. Serial dental casts were evaluated between 53 Indonesian subjects with bilateral CLP and 10 subjects with non cleft. Among 53 subjects, 11 subjects treated without Hotz's plate, 24 subjects treated with Hotz's plate and 18 subjects treated with lip adhesion and Hotz plate. Dental casts were scanned at the first visit, labioplasty, palatoplasty, and 5 years of age. Temporary negative effect was showed by lip adhesion group. The completion of the study showed that Hotz plate group could prevent the collapse of the premaxilla<sup>10</sup>. Changes in lip morphology are found to be different in different type of malocclusion<sup>39</sup>. Genetics also plays role in dental arch and craniofacial morphology in patients with unilateral CLP<sup>40</sup>. Although

different techniques of cheiloplasty and palatoplasty show different results<sup>41,42</sup> but using of pre surgical orthopedic appliance can help in alleviate maxillary growth. Dental arch relationship is imperative factor for maxillary growth and Hotz plate plays an important role for favorable dental arch relationship<sup>43,44</sup>. For the purpose of feeding, Hotz plate is quite popular right after birth. Wearing of orthopedic plate, tongue movements during sucking were analyzed in a study. The analyses were carried out by ultrasonography. Orthopedic treatment helped in regular tongue movement during sucking and also could support in normal articulation<sup>12</sup>. Similarly Knostet al.<sup>17,19</sup> analyzed both phonological and language skills between with and without orthopedic group and found some differences. Silveraet al.<sup>17</sup> reviewed cephalometric records of three groups (with Hotz plate, without Hotz plate and non cleft group). The study showed Hotz plate group had good effects on maxillary growth until 12 years. A parallel study by Bongaartset al.<sup>13, 15</sup>, using dental cast found no significant difference.

**Table 2**  
**Prospective changes evaluation from different studies using Hotz plate**

Author	Year	Group	Sample size	Variables	Pre treatment Mean (SD)	Post treatment Mean (SD)
Silvera et al. <sup>17</sup> .	2003	Two stage palatoplasty with Hotz plate.	10	SNA	84.17 (5.17)	80.75 (3.72)
				SNB	74.72 (4.01)	75.40 (3.54)
				ANB	9.44 (3.32)	5.35 ( 3.15)
				Total maxillary arch length	50.56 (2.49)	54.15 (1.70)
		One stage palatoplasty without Hotz plate	11	SNA	81.54 (3.89)	78.45 (4.00)
				SNB	74.77 (4.04)	76.64 (4.39)
				ANB	6.77 (2.54)	1.81 3.36)
				Total maxillary arch length	49.64 (2.78)	52.36 (3.57)
		Non cleft group	11	SNA	-	80.82 (3.70)
SNB	-			77.68 (2.77)		
ANB	-			3.14 (1.50)		
Total maxillary arch length	-			51.09 (1.70)		
Bongaarts et al. <sup>15</sup> .	2004	IO +	27	Overjet	1.35 (1.25)	1.30(1.15)
				Overbite (%)	32.45(41.94)	23.97(34.90)
		IO -	27	Overjet	2.08 (2.44)	1.30(1.68)
				Overbite (%)	23.50(35.99)	15.17(39.87)
Bongaarts et al. <sup>13</sup> .	2006	IO +	27	CC'	33.9 (1.9)	26.76 (2.73)
				TT'	33.3 (1.9)	40.27 (4.52)

				Total maxillary arch length	64.5 (3.4)	95.88 (7.83)
		IO –	27	CC'	32.7 (2.3)	27.16 (2.70)
				TT'	33.4 (2.0)	42.63 (2.99)
				Total maxillary arch length	64.5 (3.4)	95.88 (7.83)
Hak et al <sup>10</sup> .	2012	Hotz plate	24	CC'	30.6 (2.8)	26.4 (3.3)
				TT'	33.7 (2.4)	40.8 (3.7)
				Total maxillary arch length	29.4 (3.3)	34.9 (3.7)
		Without hotz plate	11	CC'	-	28.7 (4.5)
				TT'	-	44.7 (4.1)
				Total maxillary arch length	-	32.1 (3.8)
		Hotz plate with lip adhesion	18	CC'	32.4 (3.3)	28.6 (4.6)
				TT'	35.7 (1.8)	44.3 (5.4)
				Total maxillary arch length	32.6 (2.0)	35.6 (3.5)
		Non cleft group	10	CC'	-	35.2 (2.1)
				TT'	-	42.7 (2.1)
				Total maxillary arch length	-	34.5 (2.1)
Sasaguri et al <sup>5</sup> .	2014	Hotz plate	22	CC'	33.8 (1.8)	32.8 (1.8)
				TT'	33.6 (2.2)	41.8 (3.1)
				Total maxillary arch length	22.8 (1.8)	31.0 (1.9)
		Without hotz plate	14	CC'	33.9 (1.4)	30.1 (2.1)
				TT'	34.1 (0.8)	41.4 (2.1)
				Total maxillary arch length	22.5 (2.5)	28.0 (1.9)
		Hotz plate with lip adhesion	14	CC'	34.3 (1.7)	29.9 (2.1)
				TT'	33.9 (2.4)	41.3 (1.9)
				Total maxillary arch length	23.6 (1.2)	27.1 (1.4)
		Non cleft group	10	CC'	-	35.2 (2.1)
				TT'	-	42.7 (2.1)
				Total maxillary arch length	-	34.5 (2.1)

IO + : with infant orthopedics (Hotz plate).

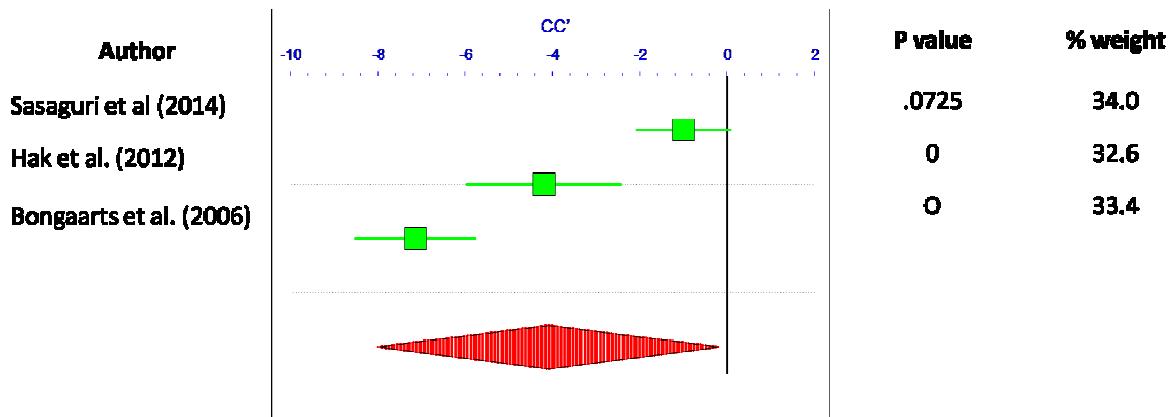
IO - : without infant orthopedics.

CC': Anterior arch width.

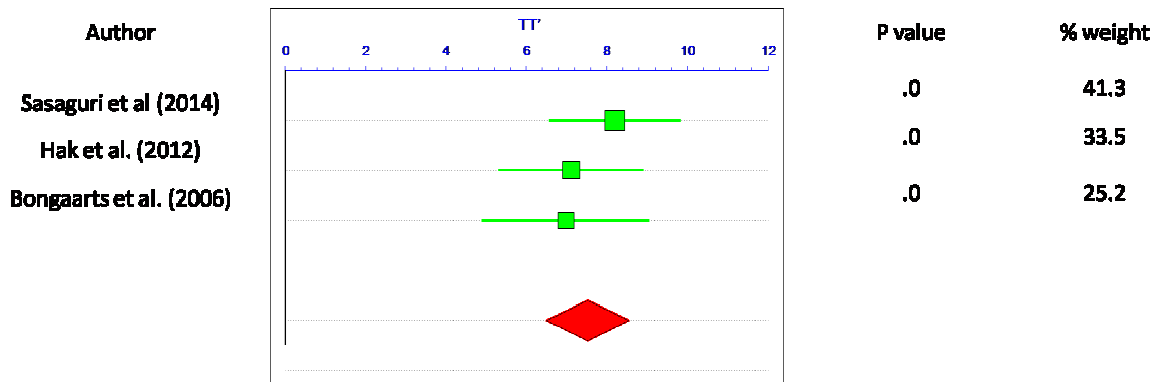
TT': Posterior arch width.

To obtain the precise estimation of outcome of previous research studies, a scientific evaluation can be done by forest plot meta-analysis which is a perceptible, formal, epidemiologic study<sup>45</sup>. In this study forest plot was performed by acquiring data that are listed in chronological order and refer to the studies summarized in Table 2. Shown for every study is the weighted mean difference (WMD) between the pre treatment and post treatment

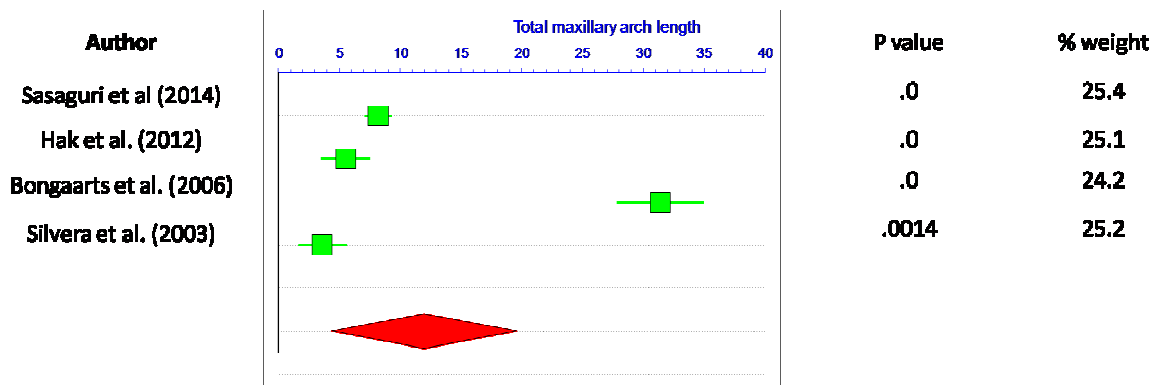
based on the random effects forest plot model, as well as the 95% confidence interval (95% CI) for each variable. The diamond represents the overall WMD. *P* values (for statistical significance) and % weight are shown beside the each forest plot. The forest plot is presented in figure 1- anterior arch width as CC' value, figure 2- posterior arch width as TT' value and figure 3- total maxillary arch length.



**Figure 1**  
Forest plots representing the effect of Hotz plate appliances on anterior arch width as CC'.



**Figure 2**  
Forest plots representing the effect of Hotz plate appliances on posterior arch width as TT'



**Figure 3**  
Forest plots representing the effect of Hotz plate appliances on total maxillary arch length.

## CONCLUSION

According to the scientific use at the time, conclusions regarding the effects of treatment were mainly based on observations: orthopedic guidance together with optimal timing of surgery has beneficial effects. Later evaluations claimed better result with two stage palatal closure on speech; whether or not the presurgical treatment had an influence could not be demonstrated. We can conclude that the treatment principles of Hotz and Gnoinski have

had a tremendous impact on cleft palate treatment, especially in Europe. Unfortunately in last two decades not much has been published about the results of the Zurich approach and the earlier paper have no strict research design that allows us to draw evidence-based conclusions about the neonatal orthopedics. It might be very well be possible that the surgical timing and sequencing are the decisive factors in the final treatment result.

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