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Class II/2 malocclusion: Early treatment with removable appliances and stability after 20 years

Key words: Class II/2 – early treatment – long-term stability

Summary The Class II/2 malocclusion is a challenge in orthodontics, because of its resistance to therapy and its tendency to relapse. The aim of this study is to test effectiveness and long-term stability (at least 20 years out of retention) of early treatment with removable appliances. In the author's practice, 44 Cl.II/2 patients were treated from 1978 to 1985 using an upper plate with an anterior bite plane and a protruding screw. Later a guide plane was added as well as an inferior splint acting as an activator. Thirty-seven patients were invited for a check-up visit in

2005 and 18 responded positively. The treatment was able to correct the malocclusion within 31–36 months, correcting the Cl.II intercuspation into a Cl.I, aligning and normalizing the inclination of upper and lower incisors and normalizing the deep bite. Little or no change was detected to ANB-angle, Wits appraisal and hypodivergency of the palatal plane-mandibular plane angle. These results were remarkably stable after 20 years, with the only exception of a minimal relapse of upper and lower anterior crowding.

Introduction

The Cl. II/2 malocclusion has been defined by ANGLE (1899) as having “the lower teeth occluding distal to normal, lingual inclination of the upper incisors and more or less bunching of the same” (Fig. 1). As early as the first decades of the last century, a particular resistance to therapy and a tendency to relapse of this type of malocclusion was observed, due to hereditary factors and muscle imbalance, upon which orthodontic treatment was thought to have little or no influence (SCHWARZ 1961a; HOTZ 1974a). VAN DER LINDEN (1983) showed the influence of the labial muscles as an important cause of this anomaly. Therefore, numerous authors have recommended early interceptive therapy, which allows for adequate dento-alveolar compensation with the help of the remaining available facial growth and the adaptation potential of the musculature (LITT & NIELSEN 1984; ARVYSTAS 1979).

Little has been written on the stability of this type of interceptive treatment, perhaps due to the fact that Cl.II/2 cases represent only 5–10% of all malocclusions (SASSOUNI 1971). The primary aim of this study was to examine long-term stability (at least 20 years out of retention) of early therapy with removable appliances.

Materials and methods

Subjects

In the author's private practice, 1461 patients concluded orthodontic treatment from 1978 to 1985 with complete initial and final documentation (at least study models, panoramic



Fig. 1 Typical Class II/2

radiographs and lateral headfilms). Of these, 75 (or 5.13%) were Cl.II/2 cases and 44 were treated with the method presented in this paper, while the other cases necessitated more complex therapy (e.g. severe lack of space and crowding of the lower anteriors, impacted canines, agenesis of permanent teeth, etc.). Seven patients were impossible to find. All 37 remaining patients were invited to contact the author in 2005 in order to verify the present status and to update their documentation. Eighteen agreed to participate in the study (almost 50%). This drop-out rate is in accordance with the literature (45% drop-outs after only 10 years reported by AL YAMI ET AL. – 1999). Therefore, a group of 18 patients (Group I) was available with initial documentation (before treatment, T_0), final treatment documentation (removal of all ortho appliances – T_1) and documentation taken at least 20 years later (T_{20}) regarding the long-term stability of the final result. The remaining 26 treated patients (= 44–18; Group II), for whom we only had initial and final documentation (at T_0 and T_1), were evaluated for the immediate effectiveness of the treatment only.

Treatment method

The method of treatment was described many decades ago by European authors (SCHWARZ 1961b, HOTZ 1974b) and is still in use (DEMISCH ET AL. 1992, FIELDS & PROFFITT 2000). The method consists of three essential steps: 1) the protrusion of the upper incisors in order to make space for the advancement of the lower arch, 2) the opening of the bite in a vertical direction, and 3) the advancement of the lower dental arch and the protrusion of lower incisors. These changes can be obtained by using just one removable appliance, modified appropriately throughout the course of treatment.

Treatment initiates with an upper removable plate provided with a protruding screw for the incisors (Fig. 2). The thickness of the acrylic in the retroincisal area causes a rise of the occlusion (Fig. 3), often followed by spontaneous anterior repositioning of the mandible, since it is no longer distally forced by the upper incisors, as some authors assert (e.g. THOMPSON 1986). The screw is activated by the patient, $\frac{1}{4}$ of a turn (= 0.2 mm)

every five days, until the alignment of the upper incisors and the necessary overjet are reached (Fig. 4). At this point, a guide plane (HOTZ 1974b) is added using self-curing acrylic (Fig. 5), which forces the mandible into a more forward position. At the same time retention of the upper incisors begins. The pressure of the guide plane on the lingual surface of the lower incisors causes them to protrude. If this step is not required, one can proceed directly to the “activator phase”. The guide plane is an excellent way to open the bite, as long as the appliance is worn full time, even during meals. It is important to obtain an overcorrection of the deep bite, almost to the point of achieving an open bite in order to reduce the amount of the expected vertical relapse (Fig. 6).

When the lower incisors are sufficiently protruded and when the bite is opened, the superior plate is complemented by an additional custom-made lower plate. This is trimmed bilaterally in order to obtain the correct thickness (approx. 1–2 mm above rest position) after which a layer of self-curing acrylic is applied. The two plates are placed in the mouth and the patient closes in an end-to-end position (Fig. 7). By doing so, the two united appliances become an activator (Fig. 8). The advantage of this procedure as opposed to making a new activator, in addition to reduce laboratory costs, is that the patient gets used to more easily, since the upper half of the appliance remains the same.

From this moment on, the appliance is worn only at night, in order to complete the correction of the Class II, or for retention. When a Class I occlusion is reached, the appliance is progressively reduced until complete eruption of all permanent teeth (every other night for several months, then two nights a week) and eventually discarded. Therefore there is no distinct separation between the active and the retention phase, but all periods flow into each other. In some cases the appliance was actually removed months before the final documentation, having been withheld until the eruption of the last permanent teeth. For this reason there is a difference between the duration of the treatment with appliances and the T_0 – T_1 interval in the table. In all these cases (Groups I and II), the



Fig. 2 Removable upper plate with protruding screw



Fig. 3 Bite opening after insertion of the plate



Fig. 4 End of incisor protrusion phase



Fig. 5 Application of anterior guide plane



Fig. 6 End of guide plane phase



Fig. 7 Upper plate and lower splint assembled with self-curing acrylic



Fig. 8 Upper plate and lower splint assembled with self-curing acrylic



Fig. 9 Final result



Fig. 10-11 Result after 23 years

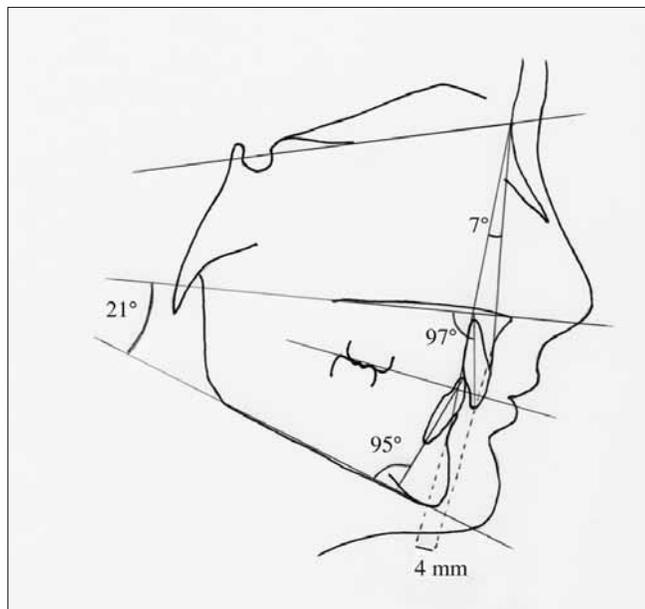


Fig. 12 Typical Class II/2 before treatment (June 1982)

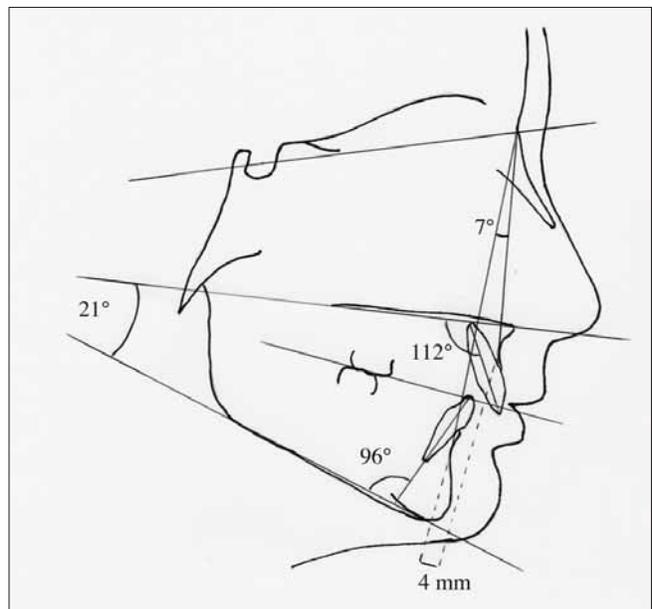


Fig. 13 After protrusion of the upper incisors. Some bite opening due to the acrylic thickness (January 1983)

results were satisfactory with no need for a second phase of treatment.

Fig. 9 demonstrates the final result. Figs. 10 and 11 depict a typical case after 23 years out of retention. Cephalometric tracings of the different treatment phases are shown in Figs. 12 to 15.

Cephalometric radiographs were all taken with the same machine and with a focus-film distance of 2 meters. The cephalometric norm values and standard deviations used were those of the "Analysis of Zürich" (WICK 1970). The ANB angle and the "Wits appraisal" (JACOBSON 1975) were measured to determine the antero-posterior relationship of maxilla and man-

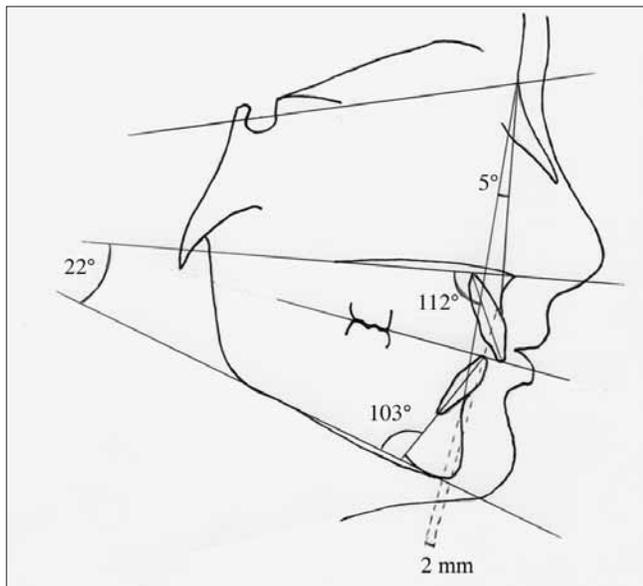


Fig. 14 After correction of the Class II intercuspatation into a Class I with the guide plane. Overcorrection of the deep bite (September 1983)

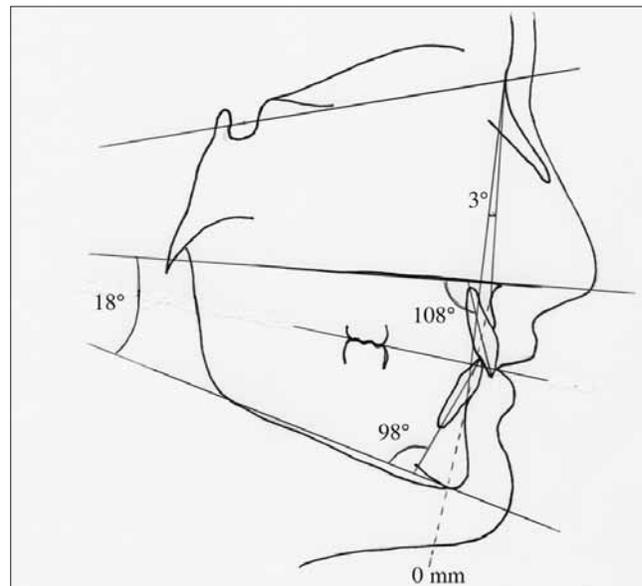


Fig. 15 End result after the activator phase (October 1985)

dible; the basal angle between palatal plane and mandibular plane expressed their vertical relationship. Upper and lower incisor inclination was related to palatal and mandibular plane. The PAR-index (RICHMOND ET AL. 1992) was used to quantify the irregularity of the dentition measured on plaster models. Since it doesn't differentiate between the classes, but attributes 0 points in cases with excellent intercuspatation in cl.I, II or III, in order to verify the effect on the Class II intercuspatation, we added another measurement, called "Cl.II-mm", which expresses the distance in mm between the mesio buccal cusp of the first maxillary molar and the buccal groove of the first mandibular molar, parallel to the occlusal plane. In a perfect Class I this measurement is 0. It becomes positive in a Class II and negative in a Class III. The mean value of the right and left side was used.

The statistical significance (*P*) of the difference between T_1-T_0 and $T_{20}-T_1$ values was assessed with a paired *t* test.

The patient's subjective perception of any given treatment is very important in orthodontics. Therefore the 18 patients in Group I were asked to answer a questionnaire with simple questions regarding the inconvenience caused by the treatment and the achieved result.

Results

The results are presented in Tables I-IV and Figs. 9 to 11. In both groups the treatment corrected typical features of Cl. II/2, normalizing the ANB angle, the Wits, the inclination of the upper incisors and the intercuspidation. The PAR-index, which includes also deep bite and crowding, was reduced to a nearly ideal value. Only the palatal-mandibular plane angle worsened slightly, whereas the inclination of the lower incisors was practically unchanged. 20 years later only minor changes had

occurred, except for a nearly 5° relapse of the upper incisor inclination.

Discussion

The first interesting observation which can be derived from data is that a morphological Class II/2 is not necessarily a skeletal Class II. The average initial ANB angle for both groups was 4.08°, respectively 5.0°, showing a tendency to Class II. However, the values vary for both groups from 0.5° to 7°, ranging from cases tending towards Class III to cases of very pronounced Class II. This is confirmed by the initial Wits value, which in both groups is 0.56 resp. 1.10, with a range from -3 to +4. All cases, by definition, had a dental Class II to start with, and the measurements on the models (Cl.II-mm) varied from 3 to 10.5 mm, that is from half to one and a half premolar widths.

From the values shown in Table II and Table III it can be concluded that the treatment corrected the dental Class II by more than 7 mm, whereas the ANB angle and Wits appraisal were only slightly modified, since they were already less deviated to start with. 20 years later, only minor changes had taken place.

In both groups, the maxillary incisors were protruded by 6°, resp. 5°, until reaching normal values, and relapsed by nearly 5° after 20 years, maintaining a gain of only 1.5°. In contrast, DE VREESE ET AL. (2007) found a relapse of only 2.2° in 61 patients, but 3.4 years out of retention. The difference from our results could be due to our longer follow-up. The mandibular incisors, even with the action of the guide plane, migrated labially less than 1° and after the 20 year period went back to their original position.

The therapy did not have any positive influence on the hypodivergence: the palatal-mandibular plane angle worsened

Tab. I Age and treatment duration

	T_0	Mean age [y-m] T_1	T_{20}	Duration [m]	No. of appointments
Group I	10-8	14-5	36-1	31.2	24.0
Group II	10-10	14-2		36.8	26.5

Tab. II Group I (n=18): measurements, standard deviations and comparison of differences (t test) of cephalometric and dental variables at T₀, T₁ and T₂₀

		Normal		T ₀		T ₁		T ₂₀		T ₁ -T ₀		P	T ₂₀ -T ₁		P
		mean	SD	mean	SD	mean	SD	mean	SD	mean	SD		mean	SD	
ANB	[°]	4	3.6	4.8	1.9	2.67	2.00	3.11	2.25	-1.41	1.51	**	0.44	1.19	NS
Wits	[mm]	0/+1		0.56	2.06	-0.83	1.79	0.94	2.65	-1.39	1.61	**	1.77	1.76	**
Cl. II-mm	[mm]	0		7.31	2.58	-0.50	1.68	1.00	1.95	-7.81	2.70	**	1.50	2.09	*
Mx 1	[°]	109	5.64	103.44	7.69	109.72	6.95	105.00	8.51	6.28	6.94	**	-4.72	8.14	*
Md 1	[°]	92	5.08	94.17	6.16	95.44	5.67	94.00	5.52	1.05	4.67	NS	-1.44	3.80	NS
Bases	[°]	28	4.03	20.39	4.84	19.50	5.80	16.78	6.21	-0.88	2.44	NS	-2.72	2.88	**
PAR	[-]	0/5		11.94	5.03	3.44	1.92	6.72	3.58	-8.50	4.57	**	3.33	4.67	**

* = P < 0.01 ** = P < 0.001 NS = non significant

Tab. III Group II (n=26): measurements, standard deviations and comparison of differences (t test) of cephalometric and dental variables at T₀ and T₁

		Normal		T ₀		T ₁		T ₁ -T ₀		P
		mean	SD	mean	SD	mean	SD	mean	SD	
ANB	[°]	4	3.6	5.50	1.29	3.33	1.71	-1.96	2.40	**
Wits	[mm]	0/+1		1.22	1.70	-0.58	2.23	-1.80	2.30	**
Cl. II-mm	[mm]	0		7.17	2.15	0.30	2.35	-6.88	7.34	**
Mx 1	[°]	109	5.64	104.76	5.92	109.68	6.16	4.92	8.63	**
Md 1	[°]	92	5.08	95.34	6.27	96.26	7.15	0.92	3.68	NS
Bases	[°]	28	4.03	19.69	4.57	17.89	4.72	-1.80	3.27	*
PAR	[-]	0/5		14.38	3.71	3.65	1.14	-10.30	12.50	**

* = P < 0.01 ** = P < 0.001 NS = non significant

Tab. IV Group I (n=18): number of answers to a questionnaire with subjective judgment of the received treatment

Treatment	Actual teeth position	After treatment my teeth had
Very annoying	1 Excellent	2 Not changed
Moderately annoying	7 Good	13 Slightly improved
Little annoying	9 Mediocre	3 Slightly worsened
Not annoying	1 Bad	0 Greatly improved
		0 Much worsened

Overall quoting of the treatment (from 1 = bad to 6 = excellent): mean value 5.44

slightly during the treatment time and after 20 years was further reduced by approximately 3°. Therefore, it can be argued that opening of the bite is not due to molar extrusion with mandibular rotation, but to tilting of the upper incisors and intrusion of the lower incisors (Figs. 13 and 14).

The PAR index, which exhibited a value of 11.94 resp. 14.3, was reduced by the treatment to 3.44 resp. 3.65, that is by about 71%–76%, indicating a good alignment of the arches. According to RICHMOND ET AL. (1992) a high treatment standard is characterized by a PAR score reduction of at least 70%, and a final score below 10 is an acceptable result; a score of less than 5 is close to perfect occlusion and alignment. Twenty years later this value moved to 6.72, which is equivalent to an improvement of 43.7%. Our data are in accordance with other studies. AL YAMI ET AL. (1999) achieved an immediate reduction of 67.1%, and 45.2% after 10 years; VON BREMEN & PANCHERZ (2002) reported a reduction of 73%.

A separate examination of the different components of the PAR index showed that 1/3 of the regression after 20 years was due to lower anterior crowding, which became even worse than at the beginning (T₀ = 1.33, T₁ = 0.88, T₂₀ = 2.05). These

data are also in accordance with the literature: LITTLE ET AL. (1988) found that lower anterior crowding continued to increase in an unpredictable manner even 10 to 20 years postretention, and SHAH (2003) stated that lower incisors crowding is almost inevitable, but might possibly be reduced with prolonged retention. On the other hand the upper anterior crowding showed a greater improvement and only a moderate relapse after the 20 year period (T₀ = 2.55, T₁ = 0.16, T₂₀ = 1.55) and the overbite remained surprisingly stable. In contrast, KIM & LITTLE (1999) reported a relapse of 1.4 mm 15 years postretention. Since their group had a mean age of 12.7 years at the onset of treatment, the difference could be explained by our earlier treatment.

The mean treatment time including the retention period was of 31 resp. 36 months, with 24 resp. 26 appointments. These data are in accordance with those reported in the literature for the most efficient treatments (VON BREMEN & PANCHERZ 2002). It should be noted that, according to these authors, "treatment efficiency was defined as a shorter treatment duration with a better outcome". This definition is incomplete. It does not take into consideration the type of appliance used. It is a com-

pletely different approach to use a removable appliance for only 9–10 hours/day, mainly at night, for most of the duration of treatment, with all the obvious advantages of facilitated oral hygiene and unaffected social life, as opposed to the use of fixed appliances, combined with a Herbst appliance, which is much more invasive, delicate and difficult to clean. This aspect is reflected by the results of our questionnaire (Table IV): most patients judged the treatment little or moderately annoying, and rated the result and the stability positively.

Conclusion

The one-stage early treatment with removable appliances of the uncomplicated Cl. II/2 malocclusion analyzed in this study has been shown to be simple, efficient and less a burden to the patients, with good stability for over 20 years. The stability could certainly be further improved with a long-term fixed retention in the lower anterior arch.

Résumé

La classe II/2 représente un défi considérable pour l'orthodontiste, à cause de sa résistance à la thérapie et sa tendance à la récurrence. Le but de cette étude est d'évaluer l'efficacité et la stabilité à long terme (au moins 20 ans après contention) d'un traitement précoce avec des appareils amovibles. Dans le cabinet de l'auteur, 44 patients de Cl. II/2 ont été traités entre 1978 et 1985 par des appareils amovibles (une plaque supérieure avec une vis de protrusion, complétée par la suite par un plan de guidage antérieur et suivie par une phase d'activateur). 37 patients ont pu être contactés pour une visite de contrôle en 2005, et 18 ont accepté. Le traitement présenté a été en mesure de corriger la Cl. II/2 en 31–36 mois, en obtenant une Cl. I molaire, en alignant et corrigeant l'inclinaison des incisives, et en normalisant la supraclusion. Par contre, l'angle ANB, le «Wits» et l'hypodivergence de l'angle des bases n'ont presque pas été influencés. Les résultats étaient stables même après 20 ans, avec la seule exception d'un léger encombrement des incisives inférieures.

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Zusammenfassung

Die Klasse II/2 stellt aufgrund ihrer Therapieresistenz und Rezidivneigung grosse Anforderungen an den Kieferorthopäden. Ziel dieser Studie ist die Überprüfung der Wirksamkeit und Stabilität (mindestens 20 Jahre nach Retention) einer Frühbehandlung mit abnehmbaren Apparaturen. Zwischen 1978 und 1985 wurden in der Privatpraxis des Autors 44 Klasse-II/2-Patienten zuerst mit einer Oberkieferplatte mit Protrusionsschraube behandelt, die dann mit einem Vorbisswall ergänzt wurde. Später wurde die Platte mit einem UK-Splint verbunden und als Aktivator eingesetzt. Von 37 im Jahr 2005 zu einer Kontrollsituation eingeladenen Patienten sagten 18 zu. Die Behandlungsmethode korrigierte die Anomalie innerhalb von 31 bis 36 Monaten: Die Kl.-II-Verzahnung wurde zur Kl. I umgewandelt und der Tiefbiss behoben. Die oberen und unteren Schneidezähne wurden eingereicht und ihre Achsenneigung normalisiert. Dagegen wurden der ANB-Winkel, die Wits-Evaluierung und die Hypodivergenz des Kieferbasenwinkels kaum beeinflusst. Diese Resultate waren auch noch 20 Jahre nach der Retention stabil.

Riassunto

La classe II/2 pone all'ortodontista seri problemi per la sua resistenza alla terapia e per la tendenza alla recidiva. Scopo di questo studio è di verificare l'efficacia e la stabilità a lungo termine (almeno 20 anni dopo la contenzione) di una terapia precoce con apparecchi mobili. Nell'ambulatorio dell'autore, 44 pazienti di cl. II/2 sono stati curati fra il 1978 ed il 1985 con apparecchi mobili (una placca superiore con vite protrusiva, completata in seguito con un vallo protruso e poi con la parte inferiore di un attivatore). È stato possibile contattare 37 di essi ed invitarli ad una visita di controllo, e 18 si sono presentati. Questo tipo di cura è stato in grado di risolvere l'anomalia in 31–36 mesi, portando l'intercuspidazione dalla cl. II alla cl. I, allineando e correggendo l'inclinazione assiale degli incisivi ed eliminando il morso profondo. Per contro, l'angolo ANB, il «Wits» e l'ipodivergenza delle basi mascellari non sono quasi stati influenzati. Il risultato è rimasto stabile fin oltre i 20 anni dopo la contenzione, a parte un leggero aumento dell'affollamento anteriore.