Acceleration Effect of Orthodontic Movement by Application of Low-intensity Laser

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Purpose: In vitro studies, animal models, and human case reports all suggest that the application of low-intensity laser accelerates orthodontic dental movement. This first prospective parallel cohort study was designed to study the effect of therapeutic laser on the time required to complete a corrective non-extraction orthodontic treatment in patients with crowding.

Materials and Methods: Sixty consecutive patients with crowding 5 mm or less, ages between 20 and 30 years old, comprised the initial sample. The first group of 30 made up the experimental group C-NE-LA (crowding–non-extraction–laser) and the next 30 patients formed the control group C-NE-NL (crowding – non-extraction – no laser). The final sample was reduced to 23 in the experimental group and 22 in the control group. The experimental group was irradiated with Photon Lase III at a wavelength of 830 nm, energy 80 J, for 22 s along the dental vestibular surface, and 22 s along the palatal surface of the teeth, 24 h after the first control, and then at every appointment. The control group received identical treatment appliances but was not laser irradiated. The outcome variable was: days to complete the treatment.

Results: The average duration of the treatment in the laser group was 398.4 ± 87.8 days while for the control group it was 565.5 ± 130.3. The difference is statistically significant ($p < 0.00001$). The average reduction in the treatment duration achieved by laser application was 167 days (30% less).

Conclusion: Low-intensity laser applied during orthodontic treatment to correct dental crowding, under the protocol described here, accelerated the dental movement, reducing the average time of treatment by 30%.

Keywords: orthodontic dental movement, laser, crowding.

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Pain and treatment duration are the main obstacles to making corrective orthodontics acceptable in adults. Coadjutants intending to reduce the time of treatment include local application of PGE1 or PGE2 (E1 or E2 prostaglandin) in animal models[1-3] and humans,[4] corticotomies,[5-11] osteogenic distraction,[12] osteocalcin administration,[13] local application of RANKL (Receptor Activator for Nuclear Factor κ B Ligand) gene transfer,[14] and irradiation with low-intensity therapeutic laser in human patients[15, 16] and animal models.[17-21] The therapeutic laser is also applied for pain control after archwire activation.[22,23]

The laser effects in cell cultures[24-26] support the biological applications. For instance, there was a significant increase in human normal osteoblast proliferation in cell cultures that could increase local osteoclast ac-

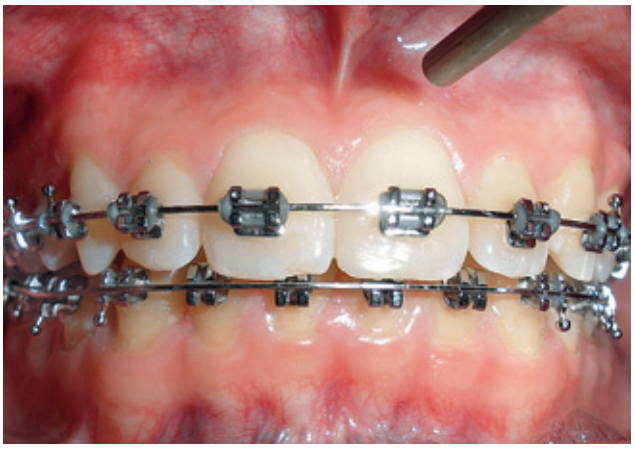

Fig 1 Applying irradiation 1 mm from the mucosa.

tivity via RANK-RANKL, as suggested by Nishijima.[27] Other in vitro studies presented evidence that therapeutic laser applications are safe, promoting cell proliferation without showing cytotoxic effects.[28-35]

Because these results are not easily extrapolated to the in vivo situation, it is necessary to perform longitudinal clinical studies to provide evidence of the acceleration of orthodontic corrective treatment by using low-intensity laser. Hence, the purpose of this clinical study was to compare the time in days required to complete crowding treatment, without extractions, in two parallel cohorts of patients: one cohort treated with laser and the other being the control group, treated without the application of laser.

MATERIALS AND METHODS

The initial group of 60 patients exhibited skeletal and dental Class I, presenting crowding, and they began orthodontic treatment in January 2008 at a private practice, all treated by the same orthodontist. The first 30 patients recruited comprised the experimental cohort C-NE-LA (crowding – non-extraction – laser), and the next 30 consecutive patients made up the control group C-NE-NL (crowding – non-extraction – no laser).

All the patients and two witnesses signed the informed consent form, following the ethics procedures established by the University (Universidad Del Valle, Cali, Colombia).

Inclusion Criteria

- Twenty to thirty years old at the beginning of the treatment.
- Crowding 5 mm or less.
- Treatment planned without premolar extractions.
- Patients without periodontal disease.
- No systemic disease.
- Sign the informed consent before any intervention.

Exclusion Criteria

- Failure to attend control visits for more than 5 weeks.
- Need for medical treatment during the study.
- Periodontal disease developed during the study.
- Pregnancy.

Four patients of the experimental cohort and 3 in the control cohort had to be excluded due to nonattendance at control visits. One patient in the control cohort passed away. Therefore, the final groups were 23 patients in the laser group (12 women, 10 men) and 22 in the control group (14 women, 8 men).

Treatment

The patients were all treated with brackets and tubes, Orthos slot 0.022 (Ormco, S.A. de C.V. México). The arch sequence was: Orthos: Thermic Cu-Ni-Ti 35°C 0.016 (maxillary 219-4203, 219-4403, mandibular 219-4103, 219-4303), Thermic Cu-Ni-Ti 35°C 0.016 X 0.022 (maxillary 219-4208, 219-4408 mandibular 2194108, 219-4308), Thermic Cu-Ni-Ti 35°C 0.019 X 0.025 (maxillary 219-4212, 219-4412, mandibular 219-4112, 219-4312) and stainless steel 0.019 X 0.025 (maxillary 219-1212, 219-1412, mandibular 219-1112, 219-1213).

The brackets were bonded with Transbond XT (3M Unitek; Monrovia, CA, USA) resin.

The laser group patients were irradiated with Photon Lase III (DMC equipamentos; Sao Carlos, Brazil) at a wavelength of 830 nm, energy 80 J, for 22 s along the vestibular surface and 22 s along the palatal surface of all the teeth (Fig 1).

In every case, the irradiation was accomplished 24 h after the first control and thereafter at every appointment. The protocol follow-up and time elapsed (counted as days of treatment) were recorded using the database software Orthonet version 0.8 (Cali, Colombia).

Table 1 Experimental group C-NE-LA

Days	Age										Total
	20	21	23	24	25	26	27	28	29	30	
264									1		1
280				1							1
292								1			1
313				1							1
315					1						1
316										1	1
320									1		1
331		1	1								2
408								1	1		2
409	1										1
415						1					1
421				1							1
428							1				1
435				1							1
437				1							1
439					1						1
443							1				1
459		1									1
537				1							1
551								1			1
555			1								1
Total	1	2	2	6	2	1	2	3	3	1	23

The treatment was considered as completed when all the parameters described in the form FO-OR-05-v1 (checklist to remove brackets) were verified, including the following points: alignment, coincidence of marginal ridges, buccolingual inclination, interocclusal relationships, occlusal contacts, horizontal and vertical overbite, interocclusal contacts, root parallelism (verified in panoramic radiography), patient satisfaction with the final outcome, signature of the patient and the orthodontist.

Statistical Analysis

The data in the Orthonet version 0.8 clinical form were tabulated as concluded, excluded, suspended, age, gender and days of treatment. The statistical analysis included ANOVA and Student's t-test.

RESULTS

Table 1 shows the number of days of treatment and the age of the patients in the laser group. The treatment was finished in the range of 264 to 555 days. Ten out of 23 patients (43.5%) completed the treatment in the interval of 408 to 459 days.

Table 2 shows the same data for the control group. The treatment was finished in the range of 311 to 956 days. Eight out of 22 patients (36.6%) completed the treatment in the interval of 604 to 670 days.

Table 2 Control group C-NE-NL

Days	Age										Total
	21	22	23	24	25	26	27	28	29	30	
311						1					1
416										1	1
431						1					1
444						1					1
464								1			1
496									1		1
501			1								1
503							1				1
524		1									1
584									1		1
590			1								1
598							1				1
604							1				1
611				1			1				2
612		1									1
620								1			1
624							1				1
657					1						1
660	1										1
670			1								1
956				1							1
Total	1	2	3	2	1	3	5	2	2	1	22

Table 3 Age and gender distribution

	C-NE-LA	C-NE-NL
n	23	22
Age (years)	25.34 ± 2.84	25.63 ± 2.55
Men	11	8
Women	12	14
Total days	398.476 ± 87.8	565.524 ± 130.33
Men days	390.5 ± 89	597.71 ± 184.29
Women Days	406.1 ± 89.3	547.58 ± 103.44

The average difference between groups is statistically significant ($p < 0.00001$). The reduction of time due to the application of laser is 167 days (30% less than the control).

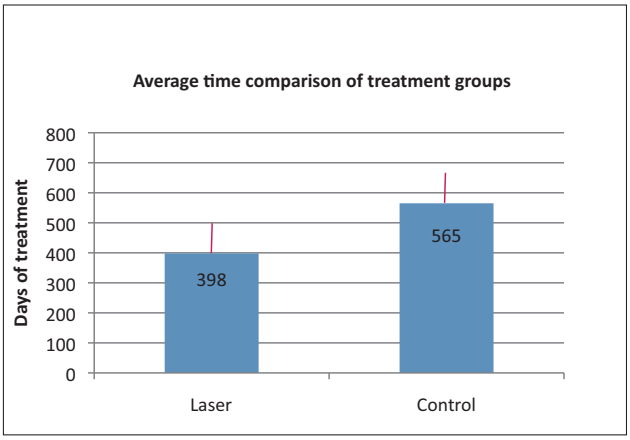

Fig 2 Average treatment time by group.

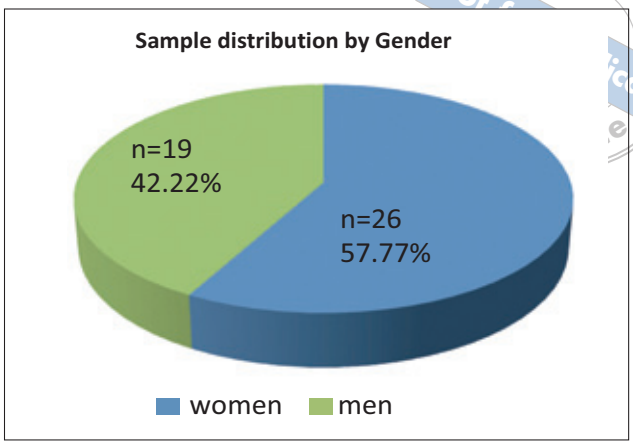

Fig 3 Sample distribution by gender.

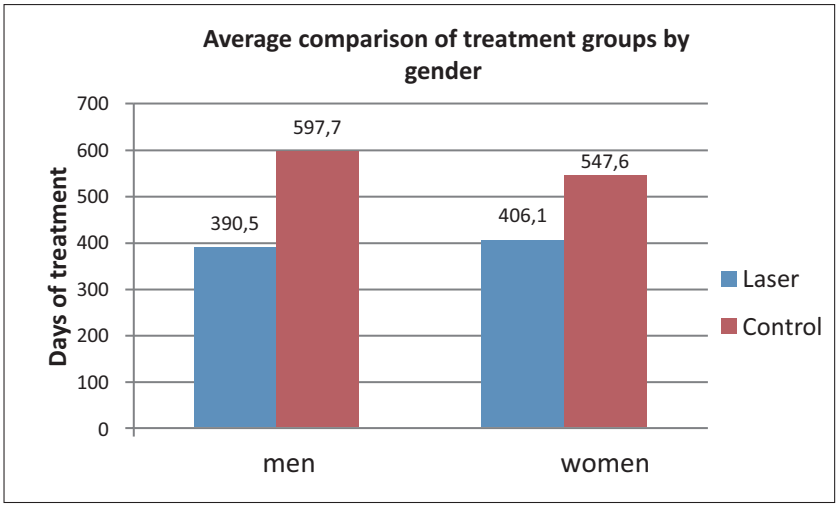

Fig 4 Comparison of treatment time by gender.

The mean ± standard deviation for total days of treatment in the laser group was 476 ± 87.8 days and in the control group was 565.5 ± 130.3 days (Fig 2).

Table 3 presents the age data that were not significantly different ($p > 0.05$). The age for the experimental cohort was 25.34 ± 2.84 years and for the control cohort was 25.63 ± 2.55 years. There is no difference in the age or gender distribution of the groups ($p > 0.05$) (Fig 3; 58% women, 42% men in the whole sample).

Figure 4 shows the data by gender: 390.5 ± 89 days in male and 406.1 ± 89.3 in female patients of the experimental cohort, and 597.7 ± 184.3 (men) vs 547.6 ± 103.4 (women) in the control cohort.

DISCUSSION

The results indicate a statistically significant difference between the group treated with laser and the control group, indicating that while using laser therapy with the protocol described, an acceleration of dental movement is achieved. The results are in agreement with previous studies.[15-16]

The study by Abello and Valbuena[15] was performed with 20 patients, where the experimental unit was the mandibular incisor movement until the alignment phase. They found that crowding resolution was achieved in the laser group in 6 weeks and in the control group in 12 weeks. The protocol for laser applica-

tion in the present study is similar to that followed by Abello and Valbuena,[15] confirming that this is a safe and effective protocol.

Cruz et al[16] evaluated the time for canine retraction in 11 patients, but they used therapeutic laser of 780 nm, 20 mW, 5 J/cm^2 for 10 s per month.

The present study used a higher number of consecutive patients followed as a prospective cohort until the end of treatment according to predetermined goals. Therefore, it indicates a total acceleration of the process, not for a specific phase of the treatment, something that was not achieved in previous studies.

In a previous in vitro report,[25] the irradiation of human osteoblasts increased the rate of proliferation above the controls up to the fifth day, and afterwards there was a reduction. This can be explained for an in vitro study by the effect of contact inhibition that is not likely to occur in vivo. Nevertheless, the in vitro study provided a biological basis to explain the dental movement acceleration, relating it to the osteoblast proliferation rate regulated via RANK-RANKL-OPG, which also increases the osteoclast activity, as noted by Aihara.[35]

Based on this clinical study and the previous in vitro studies,[25] a protocol modified to apply the laser every 6 days can be suggested to keep a constant osteoblast proliferation and constant increase in the rate of local bone metabolism.

Finally, it is pertinent to consider a follow-up study series using laser irradiation on prospective cases in different types of or approaches to treatment of malocclusion (mainly Class III), extractions cases, temporary anchorage devices, fixed appliances, and any other adult therapy used by orthodontists today.

CONCLUSION

Low-intensity laser, applied under the protocol described here, reduced the total treatment time in non-extraction orthodontic decrowding by 30%.

The process described here will open many treatment possibilities largely based on laser irradiation for numerous malocclusions, always bearing in mind that the whole treatment time will be reduced to greater or lesser degrees according to the therapeutic approach executed.

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