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Age-related treatment response following non-surgical periodontal therapy

Leonardo Trombelli[1], Alessandro Rizzi[1], Anna Simonelli[1], Chiara Scapoli[2], Alberto Carrieri[2] and Roberto Farina[1]

[1]Research Centre for the Study of Periodontal Diseases and [2]Department of Biology and Evolution, University of Ferrara, Ferrara, Italy

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Abstract

Background: To date, no studies have evaluated the effect of patient age on the treatment response following non-surgical periodontal therapy (NSPT).

Aim: To evaluate the outcomes of NSPT in two cohorts of patients with a substantial age difference.

Materials and Methods: Two groups of periodontitis patients with a substantial age difference (younger group, Y, and older group, O) were retrospectively selected. The effectiveness of NSPT was assessed by evaluating the changes in the prevalence of sites with different pocket probing depths (PPD) as well as the changes in patient- and site-specific bleeding on probing (BoP) scores.

Results: Y group comprised 57 patients, mean age: 34.7 $\pm$ 4.4 years, and O group comprised 60 patients, mean age: 58.9 $\pm$ 5.3 years ($p<0.0001$). NSPT resulted in a significant improvement of PPD and BoP in both age groups. No statistically significant inter-group differences were observed in the investigated clinical parameters as well as their changes with respect to pre-treatment. However, multiple regression analysis showed a significantly higher risk of showing residual pockets following treatment in group O.

Conclusions: The results of the present study seem to indicate that age has a limited effect on treatment response following NSPT in periodontitis patients.

Key words: age; bleeding on probing; causal therapy; initial therapy; periodontal pockets; periodontal therapy; probing depth

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Non-surgical periodontal therapy (NSPT) represents the standard approach for the treatment of periodontitis (Research, Science and Therapy Committee of the American Academy of Periodontology 2001, Cobb 2002). The aims of NSPT are (i) reduction of supra- and subgingival plaque deposits by mechanical instrumentation of the root surfaces (Slots et al. 1979, Bollen et al. 1998, Slots & Ting 1999) and (ii) control of patient-related and local risk factors for the onset and progression of periodontal breakdown (Douglass 2006).

Conflict of interest and source of funding statement

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Two major effects of NSPT consist of the reduction in pocket probing depth (PPD) and the regression of plaque-induced gingival inflammation (Cobb 1996, Cobb 2002). The reduction of the subgingival bacterial load by means of professional root instrumentation, as well as the improvement of supragingival plaque control by the patient, revert the inflammatory state of the supracrestal tissues. An increased prevalence of fibroblasts and a significant repair of connective tissue through apposition of collagen was also observed after treatment (Caton et al. 1988). As a consequence, the healing phase following NSPT usually results in a decreased bleeding tendency and an increased resistance to probe penetration of the gingival tissues.

There is wide consensus that all the stages of wound healing, including haemostasis, inflammation, cell proliferation/migration and extracellular matrix secretion, are negatively affected by the ageing process (Ashcroft et al. 2002, Gosain & DiPietro 2004). From a clinical standpoint, the effect of ageing on wound repair in cutaneous wound model seems to primarily result in a temporal delay rather than an impairment in the quality of healing (Ashcroft et al. 1997). This deficit may be ascribed, at least in part, to age-related histologic alterations of the injured tissues (Van de Kerkhof et al. 1994). In this respect, data from the periodontal literature demonstrate that the ageing process determines degenerative, arteriosclerotic changes in the blood supply to dental structures (Bernick 1967). Moreover, the periodontal ligament space becomes narrower with age, and the periodontal fibres appear less organized and numerous with a smaller cellular content (Grant & Bernick 1969, Grant & Bernick 1972, Severson et al. 1978). Areas of calcification are frequently observed in the periodontal ligament (Grant & Bernick 1969, Grant & Bernick 1972), and alveolar bone shows a decreased mineral density and remodelling activity (Manson & Lucas 1962, Atkinson & Woodhead 1968). Therefore, it may be speculated that the age-related alterations of the periodontal tissues might be potentially associated with an impaired healing response, at least in the early phase following treatment.

The age-related effects on the outcome of periodontal treatment were evaluated in a limited number of studies where different surgical approaches were used (Holm-Pedersen & Löe 1971, Abbas et al. 1984, Lindhe et al. 1985). Some studies showed a delayed and impaired healing process following gingival biopsies in older compared with younger patients Holm-Pedersen & Löe (1971); a few studies reported less pockets and gingival bleeding in older than younger periodontitis patients following an apically positioned flap with osseous surgery Abbas et al. (1984); and other studies failed to find any significant effect of age on short- and long-term treatment outcomes following surgical debridement (Lindhe et al. 1985). To date, no clinical studies have evaluated the effect of patient age on the treatment response following NSPT.

Therefore, the present retrospective case–control study was designed to evaluate the outcomes of NSPT in two cohorts of patients with a substantial age difference. The effectiveness of periodontal treatment was assessed by evaluating the changes in the prevalence of sites with different PPD as well as the changes in patient- and site-specific bleeding on probing (BoP) scores.

Materials and Methods

Selection criteria and data extraction

Data were retrospectively derived from the clinical record charts of adult ($\geqslant 18$ years old) patients who had received NSPT at the Research Centre for the Study of Periodontal Diseases, University of Ferrara, Italy.

Patients were included if (i) they were affected by generalized chronic (ChP) or aggressive (AgP) periodontitis with at least three sites with PPD $\geqslant 5$ mm per quadrant at the first visit; (ii) had at least 15 teeth present; and (iii) fully complied with the scheduled sessions of NSPT according to the treatment need.

Patients were excluded from the analysis if positive for at least one of the following criteria: pregnancy or lactation; presence of dental implants; orthodontic appliances; genetic defects with an established impact on periodontal status (e.g. Down's syndrome); diabetes mellitus; immune system disorders (e.g. HIV/AIDS); severe blood disorders, with a documented qualitative and/or a quantitative deficit of polymorphonuclears and/or platelets; physical or mental illness interfering with adequate oral hygiene performance; intake of anti-aggregants or anti-coagulants; intake of either local or systemic antibiotics 3 months before, during, or after NSPT until re-evaluation; intake of medications affecting the gingiva and/or the oral mucosa (e.g. diphenylhydantoin, calcium channel blockers, cyclosporin A, immunostimulants/immunomodulators), patients requiring prophylactic antibiotic treatment for infective endocarditis, need for temporary prosthetic restorations during NSPT.

The following patient-related parameters, as assessed at the first and re-evaluation visits, were extracted from the record chart and considered for analysis:

- *age*, expressed in years;
- gender;
- *smoking status*, recorded as ''never smoked'', ''former smoker'' or ''current smoker'';
- *periodontitis diagnosis*, recorded as ''chronic periodontitis'' (ChP) (Flemmig 1999) or ''aggressive periodontitis'' (AgP) (Lang et al. 1999);
- number of teeth present;
- *PPD*, measured from the gingival margin to the bottom of the pocket using a manual pressure-sensitive probe (at approximately 0.3 N force) with 3 mm increments (CP12; Hu-Friedy, Chicago, IL, USA). Measurements were recorded at six aspects for each tooth (mesio-buccal, buccal, disto-buccal, mesio-lingual, lingual and disto-lingual) and rounded to the nearest millimetre;
- *BoP*, recorded as positive when gingival bleeding had been detected at the site level within 10 s after PPD assessment;
- number of sessions of NSPT;
- *time* (in days) elapsed from the last NSPT session to the re-evaluation visit.

NSPT

NSPT was based on supra- and subgingival removal of plaque and calculus performed by a combination of ultrasonic mechanical instrumentation (Piezosteril 5; Castellini S.p.A., Castel Maggiore, Bologna, Italy) with periodontal fine tips (Perio Slim Tip; EMS S.p.A., Milan, Italy), area-specific (Gracey curets; Hu-Friedy) and universal (Langer curets; Hu-Friedy) curets. For each patient, the number of NSPT sessions varied from 1 to 5, and both the staged/quadrant and the full-mouth approaches were adopted according to the treatment needs as judged by the clinician. Irrespective of the number of NSPT sessions, supra- and subgingival debridement was thoroughly performed in the entire dentition. Oral hygiene instructions were reinforced at each NSPT session.

Filling of decayed teeth, extraction of teeth with a hopeless prognosis, temporary splinting of extremely mobile teeth and occlusal adjustment were performed as needed. Smokers were verbally instructed to quit smoking or reduce their daily cigarette consumption; however, the level of compliance to anti-smoking counselling was not assessed at the re-evaluation visit.

Statistical analysis

Data from the record charts of 210 patients (78 males and 132 females; mean age: 46.9 ± 10.1 years) were used for data analysis. The age distribution of the study population was Gaussian ($d = 0.05$, $p > 0.05$). Therefore, we selected the 25th and 75th percentiles as an objective cut-off to isolate two groups of patients (of similar and reasonable sample size) with a substantial age difference. A sample size of 117 subjects, subdivided into a younger (Y) and an older (O) group, was selected for analysis.

The patient was considered as the statistical unit. Data were entered in a Statistica® database (StatSoft, Italia s.r.l., Vigonza, Italy). Data were expressed as mean ± standard deviation or median and inter-quartile range for parametric and non-parametric variables, respectively.

PPD was categorized into three groups ($\leqslant 3$, $4 \div 6$ and $\geqslant 7$ mm). For each patient, the prevalence of sites within each PPD category was calculated over the number of probed sites (%$PPD_{\leqslant 3}$, %$PPD_{4 \div 6}$ and %$PPD_{\geqslant 7}$). The prevalence of BoP-positive sites was calculated over the number of probed sites (%BoP_{total}) as well as within each PPD category (%$BoP_{\leqslant 3}$, %$BoP_{4 \div 6}$ and %$BoP_{\geqslant 7}$). For each parameter, the outcome variables *change* and *relative change* were calculated. *Change* represents the difference between the value recorded at the re-evaluation visit and the value recorded at the first visit. *Relative change* represents the ratio (%) between the parameter *change* and the value recorded at the first visit. For indeterminate ratios (i.e. ratio 0/0), the *relative change* was set as zero, whereas for undefined ratios (i.e. ratio change/0), the *relative change* was set equal to the numerator of the fraction.

The effect of NSPT on the number of teeth present at first and re-evaluation visit was also analysed.

Because all the outcome variables were not normally distributed (Kolmogorov–Smirnov test, $p > 0.05$), the Wilcoxon test and the Mann–Whitney test were used to evaluate intra- and inter-group differences, respectively. The χ^2-test was used to evaluate the association between categorical variables. α error was fixed at 0.05. The statistical power calculation was assessed on an inter-group difference of 10% in the *change* of both %BoP_{total} and %$PPD_{\leqslant 3}$ using an α error of 5%. The estimated powers for the selected sample size were 71% for %BoP_{total} change and 97% for %$PPD_{\leqslant 3}$ change.

The multiple regression approach was used to investigate the relationship between patient-related parameters and the main outcome variables as well as to adjust the statistical analyses for the baseline observations. A generalized linear model (GLM) was built to investigate predictor variables affecting PPD categories (i.e. younger *versus* older, gender, PPD categories at first visit, never smoked/former smoker *versus* current smoker, number of teeth lost during NSPT, AgP *versus* ChP) as well as the prevalence of BoP-positive sites within each PPD category (i.e. younger *versus* older, gender, prevalence of BoP-positive sites within each PPD category at first visit, never smoked/former smoker *versus* current smoker, number of teeth lost during NSPT, AgP *versus* ChP) as assessed at the re-evaluation visit, because they followed multinomial ordinal distributions. The logit function was used to link the cumulative odds models (COMs) with the assumed distribution of the main outcome variables. The values of the parameters in the GLM were obtained by maximum likelihood estimation, and the significance tests for the effects in nested models were performed via the likelihood ratio (LR) test based on the reduction in -2LL ($-2 \times$ log-likelihood) with a χ^2 distribution. To evaluate predictor variables affecting the %BoP_{total} as assessed at the re-evaluation visit, whose distributions fit the Gaussian distribution after logarithmic transformation, a GLM was built. The values of the parameters in the GLM were obtained by iterative generalized least squares (Johnston 1984, Singer & Willett 2003), and the significance tests for the effects in nested model were performed via the LR test based on the reduction in -2LL ($-2 \times$ log-likelihood) with a χ^2 distribution. Younger *versus* older, gender, %$PPD_{\geqslant 4}$ at first visit, never smoked/former smoker *versus* current smoker and number of teeth lost during NSPT (AgP *versus* ChP) were regarded as predictors.

All analyses were performed using Statistica® software version 7.1 (StatSoft, Italia s.r.l.). The level of significance was set at 5%.

Results

Study population

Y group comprised 57 patients (mean age: 34.7 ± 4.4 years, 21 males and 36 females), and O group comprised 60 patients (mean age: 58.9 ± 5.3 years, 25 males and 35 females). The age difference between groups was statistically significant ($p < 0.0001$). The demographic characteristics, smoking status and periodontitis diagnosis as recorded at the first visit for Y and O groups are illustrated in Table 1. ChP and AgP were unequally distributed in the Y and O groups ($p < 0.0001$), with the Y group showing a higher prevalence of AgP. No significant inter-group differences were detected for *gender* and *smoking status* (Table 1).

Patients of Y and O groups underwent 3.2 ± 1.1 and 2.9 ± 1.1 sessions of NSPT, respectively, with no significant inter-group differences. The time elapsed from the last NSPT session to the re-evaluation visit was 40.5 ± 17.0 days for group Y and 34.1 ± 9.0 days for group O ($p > 0.05$).

Response to treatment

The characteristics of Y and O groups according to *number of teeth*, PPD categories and BoP scores at first and re-evaluation visits are illustrated in Tables 2 and 3. At the first visit, no significant differences were found between groups for either PPD categories or BoP scores. The O group had a significantly lower number of teeth when compared with the Y group ($p < 0.0001$) (Table 2).

At the re-evaluation visit, a significant increase in %$PPD_{\leqslant 3}$ was observed in both Y and O groups compared with the first visit ($p < 0.0001$ for both intra-group comparisons) (Table 2). In contrast, %$PPD_{4 \div 6}$ and %$PPD_{\geqslant 7}$ were significantly reduced following treatment in both groups (Table 2). Frequency distributions of PPD categories at the re-evaluation visit were not statistically significant between groups (Table 2). No statistically significant inter-group differences in *change* as well as *relative change* were recorded for each PPD category (Table 4). However, when multivariate analysis (COMs)

Table 1. Descriptive statistics for group Y (younger subjects) and O (older subjects) according to age, gender, smoking status and periodontitis diagnosis at first visit

	Y group ($n = 57$)	O group ($n = 60$)	Inter-group comparison
Age (years)	34.7 ± 4.4	58.9 ± 5.3	$t = -26.9$ $p < 0.0001$
Gender			$\chi^2 = 0.285$; $p = 0.593$
Male	21	25	
Female	36	35	
Smoking status			$\chi^2 = 5.828$; $p = 0.054$
Non-smokers	23	27	
Former smokers	9	18	
Current smokers	25	15	
Periodontitis diagnosis			$\chi^2 = 35.631$; $p < 0.0001$
Aggressive periodontitis	21	0	
Chronic periodontitis	36	60	

Table 2. Number of teeth and prevalence (%) of sites with pocket probing depth $\leqslant 3$ mm (%$PPD_{\leqslant 3}$), $= 4 \div 6$ mm (%$PPD_{4 \div 6}$) and $\geqslant 7$ mm (%$PPD_{\geqslant 7}$) in group Y (younger subjects) and O (older subjects) at first and re-evaluation visits

	First visit		Re-evaluation		Intra-group comparison
	median	inter-quartile range	median	inter-quartile range	Wilcoxon test for paired data (*p* value)
Y group (n = 57)					
No. of teeth	28*	26–29	28*	26–29	<0.02
%$PPD_{\leqslant 3}$	72.2	57.5–83.3	79.9	67.9–87.7	<0.0001
%$PPD_{4 \div 6}$	26.7	15.3–39.9	19.2	10.7–28.0	<0.0001
%$PPD_{\geqslant 7}$	1.4	0–4.6	0.6	0–3.0	<0.005
O group (n = 60)					
No. of teeth	24.5*	21.5–28.0	24.0*	20–27	<0.01
%$PPD_{\leqslant 3}$	63.7	50.0–78.2	80.7	63.6–87.2	<0.0001
%$PPD_{4 \div 6}$	31.7	19.2–44.8	17.3	10.7–31.3	<0.0001
%$PPD_{\geqslant 7}$	2.9	0.3–5.9	1.6	0–3.9	<0.0001

*Statistically significant difference between Y and O groups (Mann–Whitney test; $p<0.0001$).

Table 3. Prevalence of BoP-positive sites calculated over the number of probed sites (%BoP_{total}) as well as for each PPD category (%$BoP_{\leqslant 3}$, %$BoP_{4 \div 6}$, %$BoP_{\geqslant 7}$) in group Y (younger subjects) and O (older subjects) at first and re-evaluation visits

	First visit		Re-evaluation		Intra-group comparison*
	median	inter-quartile range	median	inter-quartile range	Wilcoxon test for paired data (*p* value)
Y group (n = 57)					
%BoP_{total}	30.9	21.8–44.0	16.0	9.8–32.7	<0.0001
%$BoP_{PPD \leqslant 3}$	11.7	6.0–18.7	8.0	3.5–16.9	<0.01
%$BoP_{PPD4–6}$	14.9	7.0–24.1	6.8	2.9–13.4	<0.0001
%$BoP_{PPD \geqslant 7}$	1.2	0.0–3.7	0.0	0.0–1.5	<0.01
Older (O) group (n = 60)					
%BoP_{total}	27.5	17.9–43.6	15.6	8.0–26.0	<0.0001
%$BoP_{PPD \leqslant 3}$	9.6	5.9–11.9	7.5	3.3–12.1	<0.005
%$BoP_{PPD4–6}$	15.0	7.6–24.4	6.0	2.2–9.8	<0.0001
%$BoP_{PPD \geqslant 7}$	1.7	0.0–3.5	0.8	0.0–2.3	<0.005

*All inter-group comparisons resulted not significant ($p>0.05$) at Mann–Whitney test.

Table 4. Post-treatment *change* and *relative change* in the prevalence (%) of sites with pocket probing depth $\leqslant 3$ mm (%$PPD_{\leqslant 3}$), $4 \div 6$ mm (%$PPD_{4 \div 6}$) and $\geqslant 7$ mm (%$PPD_{\geqslant 7}$) in group Y (younger subjects) and O (older subjects)

	Y group (*n* = 57)		O group (*n* = 60)		Inter-group comparison
	median	inter-quartile range	median	inter-quartile range	Mann–Whitney test (*p* value)
Change					
%$PPD_{\leqslant 3\,mm}$	7.1	− 1.3–16.9	11.3	4.0–18.3	NS
%$PPD_{4–6\,mm}$	− 8.0	− 16.0–0	− 9.5	− 17.1–3.1	NS
%$PPD_{\geqslant 7\,mm}$	0	− 3.0–0	− 1.3	− 3.3–0	NS
Relative change					
%$PPD_{\leqslant 3\,mm}$	0.1	0–0.3	0.2	0–0.3	NS
%$PPD_{4–6\,mm}$	− 0.3	− 0.5–0	− 0.4	− 0.6–0.1	NS
%$PPD_{\geqslant 7\,mm}$	0	− 0.9–0	− 0.4	− 0.7–0	NS

NS, not statistically significant ($p>0.05$).

was used to investigate the relationship between patient-related predictors and PPD categories at re-evaluation visit, age (i.e. Y *versus* O group) ($\beta = 0.347$, SE 0.047; OR 1.415, $p = 0.000$), gender ($\beta = 0.049$, SE 0.024; OR 1.050, $p = 0.045$), PPD categories at first visit ($\beta = 0.101$, SE 0.002; OR 1.107, $p = 0.000$) and smoking status ($\beta = 0.294$, SE 0.025; OR 1.342, $p = 0.000$) significantly affected the outcome variable. In particular, the O group showed a significantly higher risk of showing residual pockets following NSPT.

%BoP_{total} significantly shifted from 30.9% (21.8–44.0%) at the first visit to 16.0% (9.8–32.7%) after NSPT in group Y, and from 27.5% (17.9–43.6%) to 15.6% (8.0–26.0%) in group O ($p<0.0001$ for both intra-group comparisons). None of the investigated predictors, including Y *versus* O group, was shown to significantly affect the %BoP_{total} at the re-evaluation visit.

Consistently, a significant decrease was observed for %$BoP_{\leqslant 3}$, %$BoP_{4 \div 6}$ and %$BoP_{\geqslant 7}$ in both groups from the first visit to re-evaluation (Table 3). No statistically significant inter-group differences in *change* as well as *relative change* were recorded for either %BoP_{total} or any BoP category (Table 5). Multivariate analysis (COMs) showed a significant influence of smoking status on the prevalence of BoP-positive sites within each PPD category as assessed at the re-evaluation visit, the smokers having an increased risk of showing a higher frequency of BoP sites compared with non-smokers/former smokers ($\beta = 0.236$, SE 0.035; OR 1.266, $p = 0.000$).

After NSPT, the number of teeth significantly decreased in both groups while remaining significantly lower in the O group compared with the Y group at the re-evaluation visit ($p<0.0001$) (Table 2).

Discussion

The present retrospective case–control study was designed to evaluate the influence of age on the clinical outcomes of NSPT. Treatment effects were based on the prevalence of sites with different PPD as well as patient- and site-specific BoP scores in two cohorts of periodontitis patients with a significant age difference. While NSPT resulted in a significant improvement of PPD and BoP in both age groups, no statistically significant differences in BoP scores for both the overall dentition (%BoP_{total}) and each PPD categories were found between younger and older patients. Although no significant differences in *change* as well as *relative change* were recorded for each PPD category (Table 4) between Y and O groups, multiple regression analysis showed a significantly higher risk of

Table 5. Post-treatment *change* and *relative change* in the prevalence of BoP-positive sites calculated over the number of probed sites (%BoP_{total}) as well as within each PPD category (%$BoP_{\leqslant 3}$, %$BoP_{4 \div 6}$, %$BoP_{\geqslant 7}$) in group Y (younger subjects) and O (older subjects)

	Y group ($n = 57$)		O group ($n = 60$)		Inter-group comparison
	median	inter-quartile range	median	inter-quartile range	Mann–Whitney test (p value)
Change					
%BoP_{total}	− 9.4	− 22.9–2.4	− 13.4	− 25.0–1.6	NS
%$BoP_{PPD \leqslant 3}$	− 3.1	− 8.3–3.2	− 3.1	− 6.5–1.4	NS
%$BoP_{PPD\ 4–6}$	− 3.6	− 11.3–1.2	− 8.8	− 14.4–2.2	NS
%$BoP_{PPD \geqslant 7}$	0	− 3.2–0	− 0.2	− 2.4–0	NS
Relative change					
%BoP_{total}	− 0.3	− 0.7–0.1	− 0.5	− 0.7–0.1	NS
%$BoP_{PPD \leqslant 3}$	− 0.3	− 0.6–0.4	− 0.3	− 0.7–0.3	NS
%$BoP_{PPD\ 4–6}$	− 0.4	− 0.7–0.2	− 0.6	− 0.8–0.3	NS
%$BoP_{PPD \geqslant 7}$	0	− 0.9–0	− 0.1	− 0.8–0	NS

NS, not statistically significant ($p > 0.05$).

showing residual pockets following treatment in the O group. These results seem to suggest that age has a limited impact on the treatment response following NSPT.

In the present study, all patients received a thorough supra- and subgingival debridement of the entire dentition in association with supervised oral hygiene instructions for self-performed supragingival plaque control. Both staged/quadrant and full-mouth approaches were used. It might be questioned that the lack of standardization of the treatment administered to the patients may represent a limitation of the study. This could not be avoided due to the retrospective nature of the study, potentially leading to differences in the efficacy and effectiveness of self-performed plaque control among patients, which may, in turn, have reflected on NSPT outcomes. However, the number of NSPT sessions was similar in the Y and O groups, thus limiting a potential bias of this factor in inter-group comparisons. Moreover, recent systematic reviews demonstrated that the staged/quadrant and the full-mouth approach were equally effective in the non-surgical treatment of periodontitis patients (Eberhard et al. 2008, Lang et al. 2008).

In our study, all probing recordings were assessed by means of a periodontal probe (CP 12) equipped with 3 mm increments. Although this resulted in a standardized method to assess probing parameters, thus potentially limiting the inter- and intra-examiner variability, the use of this probe may have affected the precision of the probing measurements. However, whether and to what extent the use of level of periodontal probes with different markings may influence the reliability/repeatability of the probing measurements is still undetermined. In this respect, previous studies suggested that a probe design with more detailed markings is not necessarily characterized by an improved accuracy and reproducibility during probing measurements (Buduneli et al. 2004).

At the first visit, the Y and O groups were matched for both PPD frequencies and gingival bleeding because previous studies have shown that the patient response to non-surgical treatment may be, to some extent, associated with the initial severity of periodontal disease as assessed by probing depths and BoP (Claffey et al. 2004, Offenbacher 2005). Treatment outcome was based on the reduction in the prevalence of moderate/deep pockets and bleeding sites due to the prognostic value of residual BoP and the presence of pockets following periodontal treatment for further attachment loss on a patient-specific level (Lang et al. 1990, Joss et al. 1994, Claffey & Egelberg 1995). Nevertheless, the age-related effect on other clinical parameters, such as clinical attachment level, which relate to the wound-healing process following NSPT, cannot be excluded and needs further evaluation.

The results of the present study suggest that, at least during the early healing phase following NSPT, age exerts no effect on the treatment response in terms of gingival bleeding. Although the treatment response on PPD was similar between O and Y groups, patient's age significantly affected the prevalence of residual pockets following NSPT, the older patient showing a higher frequency of sites with PPD > 3 mm at the re-evaluation visit. In our study, we allowed younger and older patients to heal for a mean period of 5–6 weeks before the re-evaluation visit. The timing for assessing the treatment outcome was selected in view of the fact that age seems to have an impact on early phases of wound healing (Ashcroft et al. 2002, Gosain & DiPietro 2004), primarily delaying the phase of wound repair (Ashcroft et al. 1997). Our findings are at least in part consistent with those of Lindhe et al. (1985), where two samples of patients of different ages received either periodontal debridement with and without a Modified Widman access flap (sample A) or flap surgery only (sample B). In sample A, the authors failed to find any effect of age on treatment outcomes, including BoP and probing depth, at 6 months post-surgery. Consistently, in sample B, a similar prevalence of sites with different probing depths was observed in young and old patients up to 14 years following surgery (Lindhe et al. 1985). In contrast, other studies showed an age-related effect on clinical outcome following surgery. Abbas et al. (1984) observed a greater probing depth reduction in older compared with younger patients during the early healing phase (3–8 weeks) following an apically positioned flap associated with osseous resective surgery. In addition, younger patients showed a significantly higher prevalence of bleeding sites, particularly at 5–8 weeks after surgery. Overall, these observations seem to suggest that the age-related effects on clinical outcomes following periodontal treatment may be strictly dependent on the nature and severity of the mechanical trauma exerted on the periodontal tissues during differently invasive treatment procedures. It may also be speculated that, due to the limited invasiveness of the NSPT procedure, age-related differences in wound healing following periodontal debridement may require more sensitive methods as well as different observation intervals to be detected.

The rationale for the present study resides in the observed age-related degenerative alterations of the periodontal tissues and their potential effects on the wound-healing process (Manson & Lucas 1962, Bernick 1967, Atkinson & Woodhead 1968, Grant & Bernick 1969, 1972, Severson et al. 1978). Using a rodent model characterized by age-related histologic changes in the periodontal tissues similar to those observed in humans, it has been shown that the periodontal tissues of young rats exhibit higher cell-proliferative activities compared with older rats (Stahl et al. 1969). These findings are consistent with the observed age-related effects of treatment on probing depth. However, when the tissues of old rats were stimulated by a mechanical injury, their biological response was as vigorous as in young animals (Stahl et al. 1969). Therefore, it may be hypothesized that a potential re-activation of the cellular compartment of the periodontal tissues during wound healing may have compensated the age-related histologic differences in the attachment apparatus, leading to a similar healing response in young and old individuals.

A possible explanation for the limited age-related effect on the treatment outcome may relate to patient selection. Although statistically significant, the age difference between groups (Y group: 34.7 ± 4.4 years, O group 58.9 ± 5.3 years) may have been too limited to substantially affect the treatment response. However, our study cohorts have similar age ranges as in other study populations where the age-related effect on periodontal healing was detected (Holm-Pedersen & Löe 1971, Abbas et al. 1984).

At the first visit, Y and O groups presented a comparable disease status as assessed by PPD and BoP. Similar disease severity in patients with a substantial age difference may suggest a different susceptibility to periodontal disease between younger and older patients (van der Velden et al. 1985). This observation is further supported by a significantly different prevalence of AgP and ChP in Y and O groups (Table 1). Therefore, in assessing the age-related differences in treatment response, a bias derived from an uneven distribution of different periodontitis forms in the age cohorts cannot be excluded (Abbas et al. 1984). However, when the periodontitis diagnosis (i.e. chronic/aggressive) was entered as a predictor into the multiple regression analysis for the considered outcome variables, no significant effect was found.

In conclusion, the results of the present study seem to indicate that age has a limited effect on the treatment response following NSPT.

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Address:
Leonardo Trombelli
Research Centre for the Study of Periodontal Diseases
University of Ferrara
Corso Giovecca 203
44100 Ferrara
Italy
E-mail: leonardo.trombelli@unife.it

Clinical Relevance

Scientific rationale for the study: Ageing seems to result in delayed wound healing of injured human tissues. To date, no studies have evaluated the effect of patient age on the treatment response following NSPT.

Principal findings: When NSPT was performed in two groups of patients with a significant age difference, a limited effect of age on treatment response following NSPT was observed.

Practical implications: In periodontitis patients, a different clinical approach for NSPT based on patient age does not seem to be justified.