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INVITED EDITORIAL

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Success in periodontology: An evolutive concept

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Abstract

Aim: The purpose of this editorial was to discuss a definition of success after periodontal therapy based on the retention of natural dentition.

Materials and Methods: Based on topic and relevance, references were collected and then divided into four categories: (a) the influence of available therapeutic techniques on the definition of hopeless teeth, (b) the long-term rate of tooth loss during supportive periodontal therapy, (c) the duration of time that the treatment outcomes may be considered stable and (d) patients' perception and satisfaction of periodontal therapy.

Results: Periodontal therapy can change the prognosis of hopeless teeth, making them maintainable in the long term. The rate of tooth loss can be minimized in a way that a period of 10 years or more is needed to evaluate further periodontal breakdown. In addition, patients' perception and satisfaction of the treatment should be considered as the main therapeutic endpoints of the provided periodontal therapy.

Conclusions: Definition of success is linked to the available therapeutic tools. Due to the recent advancement of treatment modalities, periodontally hopeless teeth can now be treated and maintained for a long period of time with health, function and patient satisfaction.

KEYWORDS

periodontitis, prognosis, quality of life, regeneration, tooth loss

1 | INTRODUCTION

Defining success in the medical field is a subtle objective, dynamic in nature and often based on criteria used to determine a positive outcome. As reported in the 2017 World Workshop, pristine clinical health, characterized by no attachment loss, is an impossible treatment outcome for diseased dentition (Lang & Bartold, 2018). However, current therapeutic approaches allow for improvements never seen before. Reduction of the probing pocket depths and numbers of deep pockets are the two most commonly used criteria to define periodontal treatment success (Becker, Becker, & Berg, 1984; Matuliene et al., 2008). Pocket depth of ≤5 mm was proposed as one of the requirements for long-term periodontal stability (Matuliene et al., 2008), influencing most early periodontal treatments. As a result, many severely compromised teeth were considered hopeless and thereafter extracted (Chambrone & Armitage, 2016).

Over the years, periodontal treatment has evolved and the ability to maintain natural dentition has slowly become a higher priority than the complete resolution of disease itself. Implants represent an adequate treatment for rehabilitation of edentulous ridges but are not an absolute substitution of periodontally compromised teeth (Greenwell, Wang, Kornman, & Tonetti, 2018). In addition, the future definition of success in periodontology could be changed under a new approach in precision medicine in which genome, environment and lifestyle of each individual are taken into consideration (Bartold, 2018).

Despite improved understanding of biological processes and the available techniques, the daily clinical decision-making process

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takes into consideration classical concepts such as using strategic extractions to achieve mean probing depth (PD) reduction in severe periodontal disease cases (Kaldahl, Kalkwarf, Patil, Molvar, & Dyer, 1996). Interestingly, the definition of hopeless teeth has never evolved from the classical points based on the severity of disease presentation (Becker, Becker, et al., 1984; McGuire, 1991; McGuire & Nunn, 1996). Key topics that deserve further attention are whether hopeless teeth can be predictably treated and maintained in the long term, and patient perspective of periodontal treatment.

Therefore, the aim of this editorial is to discuss the link between improvements in treatment efficacy and a definition of therapeutic success based on: (a) a revised limit between treatable and untreatable periodontal conditions, (b) a reduced rate of tooth loss in the long term, (c) the duration of time that could be objectively considered as long-term follow-up and (d) the role of patients' satisfaction of treatment and perceived quality of life.

Clinical relevance

Scientific rationale for the study: Criteria of success have not been universally agreed in periodontal literature. The question of whether a severe periodontal diseased patient can be successfully treated and maintained over decades with perceived satisfaction remains to be determined.

Principal findings: Criteria defining success are in perpetual evolution since they are influenced by technical innovations that in turn allow for better outcomes.

Practical implications: Contemporary periodontology allows for a great attempt to retain severely compromised teeth with long-term satisfaction.

2 | PERIODONTAL HOPELESS TEETH, THE LIMIT BETWEEN TREATABLE AND UNTREATABLE CONDITIONS

Different models have been described to establish the clinical limits between treatable and untreatable conditions. Severe bone loss, deep PDs, furcation involvement, tooth mobility, unfavourable crown–root ratio, root proximity or presence of abscess have been used to categorize teeth as hopeless (Becker, Becker, et al., 1984; McGuire & Nunn, 1996). Despite extraction being proposed as the treatment of choice, 77% of non-extracted hopeless teeth were retained after a mean period of 5.25 years (Becker, Becker, et al., 1984) without loss of attachment of the adjacent sites (Machtei & Hirsch, 2007), and lower probability of tooth loss was reported for greater intrabony components (Muzzi et al., 2006). Regeneration, especially when combined with advancements in flap design, represented a landmark improvement towards preservation of natural dentition. A 5-year randomized clinical trial (RCT) (Cortellini, Stalpers, Mollo, & Tonetti, 2011) allocated 50 hopeless teeth with bone level at or beyond the apex to receive regenerative treatment or extraction with prosthetic replacement. Twenty-three out of 25 hopeless teeth treated with regeneration (92%) were successfully maintained after 5 years with a PD reduction of 8.8 mm and a mean clinical attachment level (CAL) gain of 7.7 mm. As stated by Cortellini and Tonetti: "The potential for periodontal regeneration can be expressed in defects from very shallow to very deep, up to extreme conditions in which the application of regenerative therapy can change the prognosis of a hopeless tooth into a maintainable unit" (Cortellini & Tonetti, 2015). A recent 20-year RCT finally confirmed that teeth with a mean of 10 mm of attachment loss can be predictably treated and maintained with an overall survival rate of 95% and a subgroup survival rate of 100% for the regenerated teeth (Cortellini, Buti, Pini Prato, & Tonetti, 2017). The outstanding outcomes achieved with regenerative techniques represent a call for tooth retention; however, it is important to note that well-experienced care providers and a selected population under strict maintenance protocol were key elements to achieve the reported outcomes.

Tooth extraction should only be considered in cases of patient discomfort, concern for patient's general health or documented loss of attachment of adjacent teeth, and a successful treatment plan should always evaluate the potential effectiveness of regeneration therapy before opting for any extractions.

3 | LONG-TERM TOOTH RETENTION, WHAT WOULD BE AN ACCEPTABLE RATE OF TOOTH LOSS?

A 40-year follow-up of a caries-free population never exposed to oral care defined the baseline tooth mortality due to untreated periodontitis as 0.33 teeth lost every year (t/y) per patient (Ramseier et al., 2017). The beneficial effect of periodontal care was then reported, with a mortality between 0.11 and 0.24 t/y after both surgery and supportive therapy, and between 0.22 and 0.29 t/y in case of treatment not followed by supportive care (Becker, Becker, et al., 1984; Becker Berg, & Becker, 1979, 1984; Tonetti, Muller-Campanile, & Lang, 1998). A systematic review part of the 2017 World Workshop reported that annual tooth loss increases with advancing age and does not differ when comparing geographic groups (Needleman et al., 2018). In the same review, counting a pool of over 8,600 patients without periodontal intervention, the mean rate of t/y was 0.2 with no gender differences. Finally, a milestone article concluded that the rate of tooth loss in a well-controlled Norwegian population (0.018 t/y) was five times lower than in a Sri Lankan population (0.1 t/y) that was never exposed to periodontal care (Loe, Anerud, Boysen, & Smith, 1978).

The rate of tooth loss has been reported in several classical longitudinal studies leaded by groups different from the Sri Lankan one. The Michigan group reported a loss of 0.07 t/y over a 5-year period (Hill et al., 1981; Ramfjord et al., 1987). Longitudinal studies from Minnesota reported an annual tooth loss of 0.2 t/y the first 4 years and 0.17 t/y after 6.5 years from the same pool of patients

(Pihlstrom, Oliphant, & McHugh, 1984; Pihlstrom, Ortiz-Campos, & McHugh, 1981). A study from Nebraska reported a loss rate of 0.14 t/y per patient after 2 years and a rate of 0.11 t/y after 7 years (Kaldahl, Kalkwarf, Patil, Dyer, & Bates, 1988; Kaldahl et al., 1996). A rate of 0.13 t/y was then reported by Becker et al. (2001) in a multicentre study over 5 years. More recent studies documented mortality between 0.05 and 0.1 t/y as a common endpoint. When only flap for reattachment was used, the documented tooth loss during supportive therapy was 0.1 t/y over 18 years (Graetz et al., 2017). A loss of 0.08 t/y was reported over 10 years (Muzzi et al., 2006), and an overall rate of loss of 0.06 t/y was noted in seven years (Nibali et al., 2017). A total rate of tooth loss of 0.05 t/y was shown over 10 years (Chambrone & Chambrone, 2006). Additionally, a mortality of 0.05 t/y has been confirmed in a 20-year follow-up (Martinez-Canut, 2015). The existing variability in outcome could be attributed to patient selection related to the practice setting, with a concentration of patients of higher economic status in private practices and patients with low social economical status (higher periodontal susceptibility) in academic settings.

Evaluation of patients following a strict oral hygiene regimen showed that total teeth retention could be achieved (Chambrone & Chambrone, 2011). Fifty children with a history of periodontitis among their parents followed a strict programme of plaque control and, after 20 years, no teeth were lost for caries or periodontitis. Later, in a 20-year landmark study of long-term success after regeneration with titanium reinforced expanded-polytetrafluoroethylene (ePTFE) membranes and flap surgery, no tooth loss was documented in the regenerative groups and a loss of 0.007 t/y was reported for the flap group (Cortellini et al., 2017). As reported, outstanding results are possible for patients with excellent oral hygiene, confirming the aetiological role of plaque as a prerequisite for periodontitis (Murakami, Mealey, Mariotti, & Chapple, 2018). In a pool of motivated patients with systemic health and socio-economical support, tooth mortality can be minimized to a ratio of less than 0.1 t/y.

4 | OBJECTIVE DEFINITION OF LONG TERM, HOW LONG IS LONG TERM?

Terminologies like short and long term were usually arbitrary (Hirschfeld & Wasserman, 1978; Kaldahl et al., 1996; Kwok & Caton, 2007; McFall, 1982). Hence, the concentration of periodontal breakdown in a relatively defined range of time could be the best parameter to provide an objective evaluation. Stability of PD reduction and CAL was documented in 5- and 7-year studies (Cortellini, Paolo, Prato, & Tonetti, 1996; Kaldahl et al., 1996). However, a recent 20-year RCT (Cortellini et al., 2017) comparing three different approaches (modified papilla preservation technique with ePTFE membrane, access flap with ePTFE membrane and flap alone) reported that loss of teeth in the flap group occurred 11 and 15 years after surgery. Flap surgery and regeneration were equally effective in the short term; however, in a time frame longer than 10 years, attachment loss and visits for re-intervention were significantly more frequent for the flap than for the regenerative group (Cortellini et al., 2017).

Due to the moderately young age of disease onset (22–28 years) (Thorbert-Mros, Cassel, & Berglundh, 2017), the lifelong risk and the higher incidence of disease recurrence after 10 years from treatment, documentation of at least 10 years of follow-up is required to be representative of a long-term successful outcome.

5 | SATISFACTION OF TREATMENT AND QUALITY OF LIFE AS THE MAIN ENDPOINTS

In a systematic review on oral health-related quality of life, Buset et al. (2016) reported that patients' well-being is greatly influenced by the health of their oral cavity (Nieri et al., 2013). Satisfaction, function and aesthetic limitations are key features of the perceived state of disease (Locker, 1988). Although patients' beauty represents the main desired outcome in aesthetic or cosmetic dentistry, disease control is of greater importance when it comes to treating periodontitis and the patient's appearance (satisfaction) could worsen as a result (Agudio, Pini Prato, Nevins, Cortellini, & Ono, 1989). In this case, a clear pre-therapeutic explanation of the reasons for periodontal therapy plays a crucial role.

Since treatment of periodontitis requires economical efforts for multiple phases (such as aetiologic therapy, followed by corrective therapy if needed, and lifetime lasting supportive care), access to care and cost–benefit of treatments are currently emerging topics associated with quality of life. Schwendicke et al. reported that preventive extraction of all furcated molars during the hygienic phase was more expensive than no extractions or selective extraction of molars with grade III furcation involvement (Schwendicke, Stolpe, & Graetz, 2017). Implant replacement of failing teeth was more expensive than periodontal treatment (Schwendicke, Graetz, Stolpe, & Dorfer, 2014), and the minimal additional cost represented by the regular appointments for maintenance, if compared with sporadic visits, was well rewarded with a longer tooth life expectancy (Schwendicke, Stolpe, Plaumann, & Graetz, 2016). Regarding the cost of different periodontal treatments, flap surgery alone was cheaper than regenerative procedures in the short term (549 vs. 1,183 euro). However, over 20 years of follow-up, people treated with flap alone showed higher rate of recurrence and more re-intervention visits. Due to the need of new active periodontal care, expenses for people treated with flap surgery increased over time, while those who received regeneration had no expenses other than supportive periodontal care (Cortellini et al., 2017). The hypothesis that incomplete resolution of periodontitis could be related with additional costs in the long term is supported by other studies reporting that residual PD, mobility and furcation involvement were associated with higher cost of maintenance over 16 years (Schwendicke, Plaumann, Stolpe, Dorfer, & Graetz, 2016).

Finally, periodontal health is largely associated with patient biology and self-care. Long-term studies report that most of the teeth

lost are concentrated in a small group of highly susceptible people. Hirschfeld and Wasserman reported that 83% of investigated population lost a rate of 0.03 t/y, 13% of population lost a rate of 0.2 t/y and 4% was affected at a rate of 0.6 t/y per patient (Hirschfeld & Wasserman, 1978), suggesting that behavioural and biological factors may play a dominant role for disease progression. Smoking has been related to a four times higher risk of periodontitis and higher rate of tooth loss (Chambrone & Chambrone, 2006; Martinez-Canut, 2015; Ramseier et al., 2017; Tomar & Asma, 2000). Type II diabetes is linked with periodontitis through a bidirectional relationship. Diabetic people have a higher risk of developing periodontal disease (Sanz et al., 2018), and periodontal patients have a higher risk of developing diabetes (Graziani, Gennai, Solini, & Petrini, 2018). Despite the well-recognized negative influence of smoking and diabetes, their role as modifiers of periodontitis has been included in an official classification only in the recent 2017 World Workshop classification (Tonetti, Greenwell, & Kornman, 2018).

Patient's well-being derived from functionality, aesthetics and satisfaction should be assessed in the short and long term. Costs of treatments could be reduced with therapies devoted to preservation of dentition rather than extraction. Furthermore, motivating patients to have a better lifestyle through a smoking cessation plan or control of systemic diseases is essential in preventing periodontitis onset, progression and ultimately tooth loss.

6 | CONCLUSIONS

In the era of classical periodontology, success was regarded as resolution of the disease including strategic extractions to achieve mean PD reduction. The current definition of success is best expressed as an effort towards preservation of natural dentition associated with patients' well-being. To date, criteria suggesting a sound definition of success in periodontal therapy should include (a) treatment and re-evaluation of severely diseased teeth before considering extraction, (b) a tooth loss rate as low as possible as the main endpoint, (c) long-term documentation of periodontal stability and (d) patient satisfaction with improvements in their quality of life.

Proposed points are not immune to limitations. RCTs often report results from a highly selected population with excellent oral hygiene, systemic health and socio-economical support. Besides, a learning curve is needed by clinicians to reproduce results achieved by experts. Although the discussed limitations make the present proposal difficult to generalize, the challenge represented by learning and consolidating cutting-edge techniques does not justify suboptimal clinical choices like extraction of teeth eligible of therapy and is well rewarded by preservation of natural dentition.

In the fast transforming era of contemporary periodontology, new branches of knowledge like epigenetics, genetic testing and personalized medicine may change again the paradigm of periodontal treatment success.

In conclusion, success is a definition in continuous evolution which can only be limited to a certain period of time.

CONFLICT OF INTEREST

All the authors have stated explicitly that there are no conflicts of interest in connection with this article. Dr. Pini Prato has nothing to disclose. Dr. Di Gianfilippo has nothing to disclose. Dr. Wang has nothing to disclose.

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REFERENCES

Agudio, G., Pini Prato, G. P., Nevins, M., Cortellini, P., & Ono, Y. (1989). Esthetic modifications in periodontal therapy. *International Journal of Periodontics and Restorative Dentistry*, *9*, 288–299.

Bartold, P. M. (2018). Lifestyle and periodontitis: The emergence of personalized periodontics. *Periodontology 2000*, *78*(1), 7–11. https://doi.org/10.1111/prd.12237.

Becker, W., Becker, B. E., & Berg, L. E. (1984). Periodontal treatment without maintenance. A retrospective study in 44 patients. *Journal of Periodontology*, *55*, 505–509. https://doi.org/10.1902/jop.1984.55.9.505

Becker, W., Becker, B. E., Caffesse, R., Kerry, G., Ochsenbein, C., Morrison, E., & Prichard, J. (2001). A longitudinal study comparing scaling, osseous surgery, and modified Widman procedures: Results after 5 years. *Journal of Periodontology*, *72*, 1675–1684. https://doi.org/10.1902/jop.2001.72.12.1675

Becker, W., Berg, L., & Becker, B. E. (1979). Untreated periodontal disease: A longitudinal study. *Journal of Periodontology*, *50*, 234–244. https://doi.org/10.1902/jop.1979.50.5.234

Becker, W., Berg, L., & Becker, B. E. (1984). The long term evaluation of periodontal treatment and maintenance in 95 patients. *International Journal of Periodontics and Restorative Dentistry*, *4*, 54–71.

Buset, S. L., Walter, C., Friedmann, A., Weiger, R., Borgnakke, W. S., & Zitzmann, N. U. (2016). Are periodontal diseases really silent? A systematic review of their effect on quality of life. *Journal of Clinical Periodontology*, *43*, 333–344. https://doi.org/10.1111/jcpe.12517

Chambrone, L., & Armitage, G. C. (2016). Commentary: Statistical significance versus clinical relevance in periodontal research: Implications for clinical practice. *Journal of Periodontology*, *87*, 613–616. https://doi.org/10.1902/jop.2016.150554

Chambrone, L. A., & Chambrone, L. (2006). Tooth loss in well-maintained patients with chronic periodontitis during long-term supportive therapy in Brazil. *Journal of Clinical Periodontology*, *33*, 759–764. https://doi.org/10.1111/j.1600-051X.2006.00972.x

Chambrone, L. A., & Chambrone, L. (2011). Results of a 20-year oral hygiene and prevention programme on caries and periodontal disease in children attended at a private periodontal practice. *International Journal of Dental Hygiene*, *9*, 155–158. https://doi.org/10.1111/j.1601-5037.2010.00455.x

Cortellini, P., Buti, J., Pini Prato, G., & Tonetti, M. S. (2017). Periodontal regeneration compared with access flap surgery in human intrabony defects 20-year follow-up of a randomized clinical trial: Tooth retention, periodontitis recurrence and costs. *Journal of Clinical Periodontology*, *44*, 58–66. https://doi.org/10.1111/jcpe.12638

Cortellini, P., Paolo, G., Prato, P., & Tonetti, M. S. (1996). Long-term stability of clinical attachment following guided tissue regeneration and conventional therapy. *Journal of Clinical Periodontology*, *23*, 106–111. https://doi.org/10.1111/j.1600-051X.1996.tb00542.x

Cortellini, P., Stalpers, G., Mollo, A., & Tonetti, M. S. (2011). Periodontal regeneration versus extraction and prosthetic replacement of teeth severely compromised by attachment loss to the apex: 5-year results of an ongoing randomized clinical trial. *Journal of Clinical Periodontology*, *38*, 915–924. https://doi.org/10.1111/j.1600-051X.2011.01768.x

Cortellini, P., & Tonetti, M. S. (2015). Clinical concepts for regenerative therapy in intrabony defects. *Periodontology 2000*, *68*, 282–307. https://doi.org/10.1111/prd.12048

Graetz, C., Plaumann, A., Schlattmann, P., Kahl, M., Springer, C., Salzer, S., … Schwendicke, F. (2017). Long-term tooth retention in chronic periodontitis - results after 18 years of a conservative periodontal treatment regimen in a university setting. *Journal of Clinical Periodontology*, *44*, 169–177. https://doi.org/10.1111/jcpe.12680

Graziani, F., Gennai, S., Solini, A., & Petrini, M. (2018). A systematic review and meta-analysis of epidemiologic observational evidence on the effect of periodontitis on diabetes An update of the EFP-AAP review. *Journal of Clinical Periodontology*, *45*, 167–187. https://doi.org/10.1111/jcpe.12837

Greenwell, H., Wang, H. L., Kornman, K. S., & Tonetti, M. S. (2018). Biologically guided implant therapy: A diagnostic and therapeutic strategy of conservation and preservation based on periodontal staging and grading. *Journal of Periodontology*, https://doi.org/10.1002/JPER.18-0495

Hill, R. W., Ramfjord, S. P., Morrison, E. C., Appleberry, E. A., Caffesse, R. G., Kerry, G. J., & Nissle, R. R. (1981). Four types of periodontal treatment compared over two years. *Journal of Periodontology*, *52*, 655–662. https://doi.org/10.1902/jop.1981.52.11.655

Hirschfeld, L., & Wasserman, B. (1978). A long-term survey of tooth loss in 600 treated periodontal patients. *Journal of Periodontology*, *49*, 225–237. https://doi.org/10.1902/jop.1978.49.5.225

Kaldahl, W. B., Kalkwarf, K. L., Patil, K. D., Dyer, J. K., & Bates, R. E. Jr (1988). Evaluation of four modalities of periodontal therapy. Mean probing depth, probing attachment level and recession changes. *Journal of Periodontology*, *59*, 783–793. https://doi.org/10.1902/jop.1988.59.12.783

Kaldahl, W. B., Kalkwarf, K. L., Patil, K. D., Molvar, M. P., & Dyer, J. K. (1996). Long-term evaluation of periodontal therapy: I. Response to 4 therapeutic modalities. *Journal of Periodontology*, *67*, 93–102. https://doi.org/10.1902/jop.1996.67.2.93

Kwok, V., & Caton, J. G. (2007). Commentary: Prognosis revisited: A system for assigning periodontal prognosis. *Journal of Periodontology*, *78*, 2063–2071. https://doi.org/10.1902/jop.2007.070210

Lang, N. P., & Bartold, P. M. (2018). Periodontal health. *Journal of Clinical Periodontology*, *45*(Suppl 20), S9–S16. https://doi.org/10.1111/jcpe.12936

Locker, D. (1988). Measuring oral health: A conceptual framework. *Community Dental Health*, *5*, 3–18.

Loe, H., Anerud, A., Boysen, H., & Smith, M. (1978). The natural history of periodontal disease in man. Tooth mortality rates before 40 years of age. *Journal of Periodontal Research*, *13*, 563–572. https://doi.org/10.1111/j.1600-0765.1978.tb00210.x

Machtei, E. E., & Hirsch, I. (2007). Retention of hopeless teeth: The effect on the adjacent proximal bone following periodontal surgery. *Journal of Periodontology*, *78*, 2246–2252. https://doi.org/10.1902/jop.2007.070125

Martinez-Canut, P. (2015). Predictors of tooth loss due to periodontal disease in patients following long-term periodontal maintenance. *Journal of Clinical Periodontology*, *42*, 1115–1125. https://doi.org/10.1111/jcpe.12475

Matuliene, G., Pjetursson, B. E., Salvi, G. E., Schmidlin, K., Bragger, U., Zwahlen, M., & Lang, N. P. (2008). Influence of residual pockets on progression of periodontitis and tooth loss: Results after 11 years of maintenance. *Journal of Clinical Periodontology*, *35*, 685–695. https://doi.org/10.1111/j.1600-051X.2008.01245.x

McFall, W. T. Jr (1982). Tooth loss in 100 treated patients with periodontal disease. A long-term Study. *Journal of Periodontology*, *53*, 539–549. https://doi.org/10.1902/jop.1982.53.9.539

McGuire, M. K. (1991). Prognosis versus actual outcome: A long-term survey of 100 treated periodontal patients under maintenance care. *Journal of Periodontology*, *62*, 51–58. https://doi.org/10.1902/jop.1991.62.1.51

McGuire, M. K., & Nunn, M. E. (1996). Prognosis versus actual outcome. II. The effectiveness of clinical parameters in developing an accurate prognosis. *Journal of Periodontology*, *67*, 658–665. https://doi.org/10.1902/jop.1996.67.7.658

Murakami, S., Mealey, B. L., Mariotti, A., & Chapple, I. L. C. (2018). Dental plaque-induced gingival conditions. *Journal of Clinical Periodontology*, *45*(Suppl 20), S17–S27. https://doi.org/10.1111/jcpe.12937

Muzzi, L., Nieri, M., Cattabriga, M., Rotundo, R., Cairo, F., & Pini Prato, G. P. (2006). The potential prognostic value of some periodontal factors for tooth loss: A retrospective multilevel analysis on periodontal patients treated and maintained over 10 years. *Journal of Periodontology*, *77*, 2084–2089. https://doi.org/10.1902/jop.2006.050227

Needleman, I., Garcia, R., Gkranias, N., Kirkwood, K. L., Kocher, T., Iorio, A. D., … Petrie, A. (2018). Mean annual attachment, bone level, and tooth loss: A systematic review. *Journal of Clinical Periodontology*, *45*(Suppl 20), S112–S129. https://doi.org/10.1111/jcpe.12943

Nibali, L., Sun, C., Akcali, A., Meng, X., Tu, Y. K., & Donos, N. (2017). A retrospective study on periodontal disease progression in private practice. *Journal of Clinical Periodontology*, *44*, 290–297. https://doi.org/10.1111/jcpe.12653

Nieri, M., Pini Prato, G. P., Giani, M., Magnani, N., Pagliaro, U., & Rotundo, R. (2013). Patient perceptions of buccal gingival recessions and requests for treatment. *Journal of Clinical Periodontology*, *40*, 707–712. https://doi.org/10.1111/jcpe.12114

Pihlstrom, B. L., Oliphant, T. H., & McHugh, R. B. (1984). Molar and nonmolar teeth compared over 6 1/2 years following two methods of periodontal therapy. *Journal of Periodontology*, *55*, 499–504. https://doi.org/10.1902/jop.1984.55.9.499

Pihlstrom, B. L., Ortiz-Campos, C., & McHugh, R. B. (1981). A randomized four-years study of periodontal therapy. *Journal of Periodontology*, *52*, 227–242. https://doi.org/10.1902/jop.1981.52.5.227

Ramfjord, S. P., Caffesse, R. G., Morrison, E. C., Hill, R. W., Kerry, G. J., Appleberry, E. A., … Stults, D. L. (1987). 4 modalities of periodontal treatment compared over 5 years. *Journal of Clinical Periodontology*, *14*, 445–452. https://doi.org/10.1111/j.1600-051X.1987.tb02249.x

Ramseier, C. A., Anerud, A., Dulac, M., Lulic, M., Cullinan, M. P., Seymour, G. J., … Lang, N. P. (2017). Natural history of periodontitis: Disease progression and tooth loss over 40 years. *Journal of Clinical Periodontology*, *44*, 1182–1191. https://doi.org/10.1111/jcpe.12782

Sanz, M., Ceriello, A., Buysschaert, M., Chapple, I., Demmer, R. T., Graziani, F., … Vegh, D. (2018). Scientific evidence on the links between periodontal diseases and diabetes: Consensus report and guidelines of the joint workshop on periodontal diseases and diabetes by the International Diabetes Federation and the European Federation of Periodontology. *Journal of Clinical Periodontology*, *45*, 138–149. https://doi.org/10.1111/jcpe.12808

Schwendicke, F., Graetz, C., Stolpe, M., & Dorfer, C. E. (2014). Retaining or replacing molars with furcation involvement: A cost-effectiveness comparison of different strategies. *Journal of Clinical Periodontology*, *41*, 1090–1097. https://doi.org/10.1111/jcpe.12315

Schwendicke, F., Plaumann, A., Stolpe, M., Dorfer, C. E., & Graetz, C. (2016). Retention costs of periodontally compromised molars in a German population. *Journal of Clinical Periodontology*, *43*, 261–270. https://doi.org/10.1111/jcpe.12509

Schwendicke, F., Stolpe, M., & Graetz, C. (2017). Cost comparison of prediction-based decision-making for periodontally affected

molars. *Journal of Clinical Periodontology*, *44*, 1145–1152. https://doi.org/10.1111/jcpe.12796

Schwendicke, F., Stolpe, M., Plaumann, A., & Graetz, C. (2016). Cost-effectiveness of regular versus irregular supportive periodontal therapy or tooth removal. *Journal of Clinical Periodontology*, *43*, 940–947. https://doi.org/10.1111/jcpe.12595

Thorbert-Mros, S., Cassel, B., & Berglundh, T. (2017). Age of onset of disease in subjects with severe periodontitis: A 9- to 34-year retrospective study. *Journal of Clinical Periodontology*, *44*, 778–783. https://doi.org/10.1111/jcpe.12757

Tomar, S. L., & Asma, S. (2000). Smoking-attributable periodontitis in the United States: Findings from NHANES III. National Health and Nutrition Examination Survey. *Journal of Periodontology*, *71*, 743–751. https://doi.org/10.1902/jop.2000.71.5.743

Tonetti, M. S., Greenwell, H., & Kornman, K. S. (2018). Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *Journal of Clinical Periodontology*, *45*, S149–S161. https://doi.org/10.1111/jcpe.12945

Tonetti, M. S., Muller-Campanile, V., & Lang, N. P. (1998). Changes in the prevalence of residual pockets and tooth loss in treated periodontal patients during a supportive maintenance care program. *Journal of Clinical Periodontology*, *25*, 1008–1016. https://doi.org/10.1111/j.1600-051X.1998.tb02406.x

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