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TITLE PAGE

Periodontal maintenance following active specialist treatment: should patients stay put or return to primary dental care for continuing care? A comparison of outcomes based on the literature.

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KEY WORDS

Dental Hygiene profession; Maintenance; Oral Hygiene; Periodontitis;

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Abstract

Objectives: To review the evidence for the efficacy of periodontal maintenance (PM) carried out in primary dental care (PDC) compared to the specialist setting for patients previously treated in a specialist setting for chronic (ChP) or aggressive (AgP) periodontitis.

Methods: A focused PICO question and search protocol were developed. Online databases including MEDLINE, EMBASE, WEB OF SCIENCE™ and COCHRANE LIBRARY were searched along with specialist journals in the subject area of periodontal research. Selection criteria included studies that investigated delivery of PM in both specialist and PDC settings for patients with ChP or AgP over a minimum 12 months. We looked for studies that reported changes in clinical attachment levels (CAL), tooth loss, periodontal pocket depths (PPDs) and bleeding on probing (BoP) as outcome measures.

Results: Eight cohort studies were chosen for inclusion. There was considerable heterogeneity found between the eight studies, which did not allow for quantitative (meta) analysis and statistical testing of differences between groups. Clinical attachment levels (CAL) remained relatively stable in patients who received specialist-PM with mean changes of -0.42mm to +0.2mm while for those enrolled in PDC-based PM for periods >12 months, mean CAL losses were between -0.13mm and -2.80mm. Probing pocket depth reduction for those subjects receiving specialist-PM were between 0.05mm and 1.8mm for 5 studies but two cohorts experienced increases of 0.32mm and 0.80mm respectively. Increases of up to 2.90mm (range: -0.1 - +2.90) and a higher proportion of deeper pockets were noted among PDC-PM cohorts. Higher rates of BoP among those in receipt of PDC-PM were reported in half of all studies. There was insufficient long tem data to make any firm conclusions about the effect of the delivery of PM on tooth loss.

Conclusion: Within the limitations of the data available it appears that specialist-PM is effective in sustaining periodontal stability following active specialist intervention. There is

limited evidence that primary dental care provides the same level of care however the limited comparative data available suggests that outcomes could be slightly worse in primary dental care.

Introduction:

Periodontal maintenance (PM) follows active periodontal therapy (APT) and aims to prevent periodontal disease progression through close monitoring of the periodontal condition along with supra and subgingival debridement and behavior modification (1-3). PM begins when patients have achieved an acceptable degree of periodontal stability as demonstrated by clinical attachment level (CAL) gains, reduction in pocket probing depths (PPDs) and bleeding-on-probing (BoP) levels compared to baseline readings and a demonstrable improvement in plaque control (2). Maintenance is life-long and is tailored to patients individual needs based on susceptibility to disease and medical history, severity of initial disease and response to APT with a typical recall interval of 3 months being allocated in the first year (3,4). The evidence supporting the importance of regular, well-executed PM is unequivocal (5-15). Aside from the significant clinical benefit, preservation of periodontal health through PM can prevent tooth loss and prosthetic replacement involving further biologic risks and financial expenses (16). PM may be carried out in specialist practice, hospital or in primary dental care (PDC) however there is a need to ensure that the care provided is effective and value for money. Patients referred to specialist centers for APT are frequently discharged back into primary dental care for continuing care, however evidence to date suggests that, for cases of chronic periodontitis, PM might best be conducted in a specialist setting (17). With ever-increasing financial and manpower pressures within health services, ensuring the efforts put into achieving periodontal stability in specialist settings are not in vain should be at the forefront of long-term treatment planning as well as healthcare policy making. This review aimed to evaluate the evidence for the efficacy of PM carried out in PDC compared to the specialist setting for patients previously managed for periodontitis in specialist centers with respect to the following clinical parameters:

1. Clinical attachment level (CAL)

2. Tooth loss

3. Probing pocket depths (PPD)

4. Gingival inflammation/bleeding on probing (BoP)

Material and methods

The following PICO question was utilised to develop our review protocol:“ For patients who have received specialist treatment for periodontitis (P), does receiving periodontal maintenance in primary dental care (I) prove as effective as receiving it in a specialist setting (C) in preventing disease progression and recurrence? (O)” A checklist based on the PRISMA (Preferred Reporting Items for Systematic Review and Meta-analyses) statement (18) was used and is summarized below (Figure 1).

Eligibility criteria

The hierarchy of evidence search scope for this review included randomized controlled clinical trials (RCTs) as well as observational studies (e.g. longitudinal prospective/retrospective cohort studies). Studies eligible for inclusion were those written in English, where patients had a diagnosis of chronic (ChP) or aggressive periodontitis (AgP); where elements of PM were delivered in both PDC *and* specialist settings following specialist APT; with at least 1 year’s follow up from commencement of PM; using change in CAL and tooth loss to represent disease progression. PPD and bleeding on probing (BoP) change were adopted as further outcome measures as these represent active inflammation and disease recurrence.

Search strategy

The following databases were searched up to and including April 2015: MEDLINE and EMBASE (via OVID), WEB OF SCIENCE™ and the COCHRANE LIBRARY. The following keyword search was adopted for WEB OF SCIENCE™: TOPIC: ((periodontal OR chronic periodont* OR aggressive periodont* OR juvenile periodont* OR early onset periodont* OR perio*)) AND TOPIC: ((maintenance OR supportive periodontal OR supportive periodontal care OR supportive periodontal therapy OR SPT OR follow up)). A

hand search of the following high impact major periodontal journals was also performed up to and including April 2015 to ensure that non-indexed articles and those studies that may be missed by the search strategy were found: *Periodontology 2000*, *Journal of Clinical Periodontology*, *Journal of Periodontology*, and *Journal of Periodontal Research*.

Methodological quality

The methodological quality of studies was assessed based on the CASP (Critical Appraisal Skills Programme) "Making sense of evidence" (19) critical appraisal and Cochrane Collaboration's "Risk of bias" (20) tools. Analysis of included studies was carried out with respect to various aspects of methodology. A breakdown of these can be found in supplementary file 1.

Results

Search results & study selection

From an initial search yield of 1,149 potentially relevant articles based on titles and abstracts, 56 articles were accessed in full. Forty-eight were subsequently discarded because they did not meet the inclusion criteria. Eight cohort studies were chosen for inclusion (Figure. 1) (9,21-27). Seven studies (9, 21, 23-27) examined patients with a diagnosis of chronic periodontitis while one study (22) reported on patients with aggressive periodontitis. The main reason for exclusion was not having elements of both PDC *and* specialist PM within the same study (Figure 1). The number of participants per study varied from 16 to 171 and the time period during which they were enrolled in PM programs varied from 1 to 27 years. Patients received APT in either a university hospital or specialist practice. APT varied considerably across the studies and included oral hygiene instruction (OHI), scaling and root surface debridement, open flap debridement (OFD), guided tissue regeneration (GTR)

procedures and surgical pocket elimination. Six studies compared PM delivered in both settings by splitting their cohorts into test and control groups to receive either specialist or PDC maintenance or PM that might be deemed similar to that delivered in PDC but which was delivered in a hospital environment (Nyman *et al* (21), Jenkins *et al* (24). Wennstrom *et al* (22) and Ravald & Johansson (27) enrolled their entire cohorts onto programs in which elements of *both* specialist and PDC-PM were received- one after the other. Test and control cohorts did not differ widely in any of the studies in terms of reported baseline clinical parameters and severity of initial disease (Table 1). Cortellini *et al* (23) were alone in their reporting of mean full mouth CAL as were Axelsson & Lindhe (9) regarding baseline number of teeth. Baseline mean full mouth PPD, gingival inflammation and plaque levels were most widely reported. The role of confounding factors including smoking was alluded to in three studies (Preshaw & Heasman (25), Matuliene *et al* (26), Ravald & Johannson (27)) and is discussed later. Chronic and aggressive periodontitis PM outcomes are discussed separately and the studies are summarized in Tables 2 and 3.

Chronic periodontitis: clinical attachment level (CAL)

Four of the seven chronic periodontitis studies reported on mean changes in CAL during PM with Nyman *et al* (21) comparing values to pre-APT levels while Axelsson & Lindhe (9), Cortellini *et al* (23) and Jenkins *et al* (24) used the start of PM as their baselines. A summary of mean CAL changes (mm) according to the individual study cohorts is included in Table 4 below.

Chronic periodontitis: Tooth loss

This was the least reported clinical parameter. Axelsson & Lindhe (9) reported mean changes in the number of teeth (per patient) from the start of PM to re-evaluation as -0.2 for

the hospital group and -0.7 for the PDC group- a statistically insignificant difference. Ravald & Johansson (27) reported no extractions were carried out due to periodontitis during the first 2 years of specialist-PM whereas the mean rate of tooth loss during subsequent (PDC) PM was 0.23 teeth per patient per year. It should be noted however that patients were seen in PDC on an on-going basis over an average of 12.5 years.

Chronic periodontitis: probing pocket depth (PPD)

Five studies (9, 21, 23-25) presented PPD data as mean changes (in mm) relative to either pre-APT or post-APT levels and a summary of their results is outlined in Table 4 below. Matuliene *et al* (26) recorded the percentage of patients having varying numbers of residual PPDs ≥ 5mm at the start (T1) and end (T2) of PM. The authors reported that while the percentage of hospital-PM patients with ≥ 9 residual pockets measuring ≥5mm remained broadly unchanged during the observation period (18.4% at T1 versus 17.4% at T2), the percentage of PDC-PM patients with ≥9 pockets nearly trebled (from 11.0% at T1 to 30.1% at T2) during this period. Ravald & Johansson presented their PPD data in a similar manner however they used mean number of PPDs measuring 4-6mm and >6mm present (per patient) following APT, 24 months of specialist-PM and after 11-14 years of PDC-PM. (27) They found 13 pockets (SD 11.6) measuring 4-6mm at both baseline and final examination (SD 8.3), two (SD 5.5) measuring > 6mm at baseline and one (SD 1.8) at re-evaluation. The authors noted that their results were not significant.

Chronic periodontitis: gingival inflammation

A summary of gingival inflammation outcomes can be found in Table 5 below.

Aggressive periodontitis

Wennstrom *et al* enrolled their entire cohort onto a programme that included both hospital and PDC-PM. (22) Sixteen patients with aggressive periodontitis (11 juvenile (JP), 5 post-juvenile periodontitis (PJP)) who had previously received OHI followed by non-surgical periodontal treatment (NSPT) alone or in addition to open flap debridement (OFD) via a split mouth design were maintained over a 2-year period before being discharged back into PDC for PM over 3 years. Patients received professional cleaning every 4 weeks during the initial 6 months followed by 3-monthly appointments at the hospital clinic. Details of subsequent PDC-PM were not reported. Separate results were provided for sites that received NSPT alone or with OFD. The authors reported on mean changes in CAL and PPD during PM as well as gingival inflammation outcomes by comparing values to pre-APT levels. An analysis of AgP outcomes can be found in Table 6.

Methodological quality

The eight studies included in our review were cohort studies. Summaries of the various aspects are outlined below along with a "Risk of Bias" summary table (Table 7).

Recruitment and randomization

All studies made some reference as to how cohorts were recruited. The majority (Nyman *et al* (21), Axelsson & Lindhe (9), Wennstrom *et al* (22), Cortellini *et al* (23), Preshaw & Heasman (25) and Ravald & Johansson (27)) reported that patients had been referred to or attended the relevant specialist centers for treatment while Jenkins *et al* (24) and Matuliene *et al*(26) selected their cohorts from a pool of patients previously treated in their respective dental schools. Randomization was reported in five studies (Nyman *et al* (21), Axelsson & Lindhe (9), Wennstrom *et al* (22), Preshaw & Heasman (25), Ravald & Johannson (27)) however information about the methods used was lacking. Axelsson & Lindhe reported,

"every third patient was sent back to the referring dentist".(9) No further information is given regarding this sequence generation however it would appear that some form of systematic selection was used.

Blinding & allocation concealment

Outcome assessor blinding was only explicitly reported in one study (Preshaw & Heasman). (25) The authors reported, "All measurements were recorded by one calibrated individual who was blind to the group allocation." Due to the study designs and nature of PM interventions, participant blinding was not a feature in any study. No reports of allocation concealment could be found among any of the eight studies.

Exposure and outcomes

Reporting of exposure to PM interventions differed considerably across the studies. Exposure was measured by looking at the frequency, number and length of visits, duration of PM in years and patient compliance. Details of both specialist and PDC-PM were scarce or non-existent in Wennstrom *et al* (22) or Matuliene *et al*. (26) In those studies where PM was delivered in PDC, information on care provided was also absent. The frequency of appointments and duration of follow-up at specialist establishments was reported in each study (see Table 7). Axelsson & Lindhe were the only authors to give details on appointment duration with their hospital group having 30-minute long appointments. (9) Compliance with PM was reported in three studies (Preshaw & Heasman (25), Matuliene *et al* (26) and Ravald & Johansson (27)). All but one patient attended each of their appointments at the hospital clinic in the study by Preshaw & Heasman while information on PDC attendance was limited. (25) One patient in the hospital group failed to attend for reassessments at 6 and 12 months while two patients in the PDC group failed their 12-month assessments. Similarly,

Matuliene *et al* reported high compliance with hospital-PM with just under 95% of patients attending their recall appointments at least twice a year compared to 67.6% in the PDC group. (26) While only 5 patients out of a total of 97 (5.1%) attended for hospital-PM once a year or less, the figure for those attending PDC stood at almost a third (32.4%) or 23 out of 71 patients. Matuliene *et al* commented that the discrepancy seen in the number of pockets measuring ≥5mm among hospital and PDC-PM patients might be due to the highly significant ($p < 0.0001$) differences in the frequencies at which patients were seen at their respective clinics. Although we cannot be certain as to why these inconsistencies exist, it is plausible that patients were either non-compliant with PDC-PM programs or practices failed to assign appropriate recall intervals. Compliance in Ravald & Johansson's study was self-reported with 91% of patients reporting they had visited a PDC dentist once or twice a year and 71% having visited a dental hygienist 1-4 times per year. (27)

Confounding factors

The role of confounding factors was taken into account in three studies. (25-27) Preshaw & Heasman reported thirteen patients (37%) who were current smokers averaging 13 cigarettes per day. (25) The authors found statistically significant higher mean mouth pocket depths in smokers compared to non-smokers and former smokers ($p < 0.05$). Matuliene *et al* examined the association between several risk factors including gender, smoking status and diabetes and tooth loss during PM. (26) Using standard multivariable logistic regression analysis, the authors found a significantly increased risk of periodontal disease progression among heavy smokers (≥ 20 cigarettes per day) compared to non-smokers (OR 5.9, 95% CI; 1.6-21.3, $p = 0.007$). At re-evaluation, 27.4% of patients were current smokers, of which, just under half were heavy smokers. Location of PM was not found to be a significant risk factor in tooth loss. Ravald & Johansson (26) reported that eighteen (28%) of their patients reporting daily

smoking habits of which eleven (17%) smoked ≥10 cigarettes a day. The results of a stepwise logistic regression analysis using tooth loss as the dependent variable retrospectively found smoking significantly contributed to tooth loss ($p = 0.01$) with an odds ratio of 8.0 (95% CI 1.6-39.0). Of note, the only other variable found to have significantly contributed to explain tooth loss was the number of visits to a dental hygienist each year ($p = 0.05$, OR 2.1, 95% CI; 1.1-4.2). The authors postulated that this might be due to the fact that those with the most advanced periodontal disease (and at highest risk of tooth loss) are more likely to be enrolled in regular recall programs and therefore, frequently seen by a hygienist for PM.

Discussion

Summary and review context

Our review set out to appraise the existing evidence in order to compare the efficacy of primary dental care and specialist-based periodontal maintenance for patients previously treated for chronic or aggressive periodontitis in a specialist setting. The results demonstrate that patients who are enrolled in regular, intensive specialist-based PM programmes can expect clinical attachment levels to remain stable with minimal loss and even a slight gain in attachment achievable. Similarly, minor but sustained reductions in probing pocket depths and low incidence of gingival inflammation can also be expected for these patients. Findings with respect to tooth loss are inconclusive as few studies reported on this particular outcome. Conversely, there is less evidence that these findings are replicated in PDC and there is a lack of studies on the proven benefits of PDC-PM. Due to the substantial heterogeneity among the included studies, deriving a robust and clinically relevant conclusion has proved challenging and readers are advised to interpret our findings with caution. The findings of this review are broadly consistent with those of Gaunt *et al* (17). Their 2008 systematic review also compared the efficacy of PM carried out in PDC with specialist practice or

hospital. They found clear clinical benefits of specialist-delivered PM over PDC but concluded that higher costs might be incurred. The authors of that review chose to include studies in which PM was conducted solely in specialist centers for cases of ChP only and they limited outcome measures to CAL. Furthermore, they searched for articles in which APT was delivered in PDC, however they did not include any in their final list of 14. Another review by Nibali *et al* looked at disease progression in AgP patients using tooth loss as the primary outcome measure (28). Sixteen cohort studies were reported on taking into account the APT and PM delivered and found a consistent tooth loss rate of 0.09 teeth per patient per year during PM. Seven out of the sixteen studies chosen for inclusion reported on tooth loss and of these, five reported separate results for APT and PM. None of these five studies saw patients receiving maintenance in PDC. In addition to CAL, clinicians frequently record PPDs and BoP levels as part of routine periodontal assessments. It was for this reason that these outcome measures were included in our current review. Despite being a proxy measure for treatment success or failure, CAL changes are the most appropriate way to detect progression of periodontitis and are therefore frequently adopted as the primary outcome measure. BoP and PPD changes are, however important secondary outcome measures despite also being markers of other conditions (e.g. gingivitis) (29). Indeed, in some cases, periodontitis resolution may not necessarily be accompanied by a change in CAL, but instead by a reduction in pocket depth and elimination of bleeding on probing (30). As an “end-point” marker in periodontitis activity, tooth loss is perhaps the most important outcome measure and one that patients often regard as being of most importance however this is a late end point and most studies were too short to yield meaningful information on this (31).

Owing to the challenges encountered during this review process, there is a need for further research on this topic. In the first instance a prospective, high quality randomized controlled clinical trial comparing the efficacy of PM delivered in specialist centers and PDC with respect to clinical outcomes and cost effectiveness would be of benefit. This might be further supplemented by controlled trials comparing the efficacy of different PM regimes including appropriate time scales. Investigation of the reasons behind these differences could be explored through evaluation of the knowledge and practice of dental professionals involved in providing PM across the sectors. It is important to identify the potential barriers and facilitators to the provision of care in PDC and help inform the development of targeted education interventions, updated clinical guidance and appropriate support for primary care practitioners.

Limitations

This review of the literature was made very difficult by the significant heterogeneity of the studies. There were differences in sample sizes, APT and PM regimes, recall intervals and duration of follow up meaning quantitative data analysis was impossible. Gaunt *et al* and Nibali *et al* also experienced this difficulty demonstrating that the challenges posed by these substantial variations were by no means unique to our review. Furthermore, variations in how results were reported increased the heterogeneity. Extant disparities between Matuliene *et al*, Ravald & Johansson and the other six studies with respect to reporting of PPD results hindered meaningful comparisons (e.g. comparing mean full mouth PPD values with proportion of patients or teeth having deep pockets). Tooth loss data provided by Ravald & Johansson must be interpreted with caution as patients were only maintained within a specialist clinic for 2 years (during which time no teeth were lost), drawing a comparison with 11-14 years' worth of PDC aftercare. Given the different time periods under

consideration this is negatively biased against PDC. Increasing incidence of tooth loss over a decade or more can be expected even in well maintained patients and indeed the evidence shows that, despite best efforts, PM cannot entirely eliminate the risk of tooth loss (12). There is no obvious explanation for the contradictions that exist between Jenkins *et al*, Preshaw & Heasman and Ravald & Johansson and the other studies with respect to gingival inflammation, CAL and PPD. We can speculate that in the case of the two UK studies, patients were only followed up for a period of 12 months and therefore perhaps, insufficient time was allowed for a comparison of the two PM regimes. Limitations within studies themselves such as failure to report patient compliance with PM arrangements and the effect of confounding factors such as smoking make interpretation of results difficult. Furthermore, regression analysis with respect to the number of PM visits per year and increasing PPDs, CAL loss, gingival inflammation and tooth loss was absent from all but one study (Matuliene *et al*) as previously discussed. Differences in compliance and/or the number of PM visits per year may help explain the observed differences between cohorts in the various studies however we cannot dissect out the effect of regular attendance from the provider of the maintenance. Other drawbacks of this current review include the low number of studies identified and the fact that many of the included studies are older studies meaning that protocols in the delivery of PM may have adapted over the years.

Conclusion

Our review confirms that periodontal maintenance is likely to be effective in sustaining periodontal stability when delivered in a specialist environment. This is especially true for patients maintained over longer periods of time (> 12 months). Due to limited comparative evidence however, we are currently unable to say whether primary dental care does or does not provide the same level of care with respect to periodontal maintenance. Further studies

are required to show the efficacy of periodontal maintenance in primary dental care in patients who have previously suffered from severe periodontitis.

Clinical relevance

Scientific rationale for the study

Periodontal maintenance is essential for the preservation of periodontal health following active therapy for periodontitis. PM is life long, labour intensive and costly therefore much of this is carried out in primary dental care after a course of specialist treatment. This review aimed to identify the strength of the evidence supporting PM in primary dental care compared with that provided in a specialist environment.

Principal findings

Despite widespread variation in the literature and an inability to perform meta-analysis, there is evidence to suggest that PM delivered in primary dental care might prove disadvantageous compared to care delivered in a specialist setting.

Practical implications

For patients who have successfully completed active periodontal therapy in a specialist practice or hospital, discharging practitioners and institutions should ensure that primary care practitioners are provided with a comprehensive prescribed maintenance plan. Furthermore, there is a potentially a need for further education and training for PDC clinicians to ensure they have sufficient knowledge and support to provide on-going care for patients.

Conflict of interest statement

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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