Gingival recession and root caries in the ageing population: a critical evaluation of treatments


Abstract

Aim: To review evidence for the treatments of gingival recession and root caries in older populations.

Materials & Methods: A systematic approach was adopted to identify reviews and articles to allow us to evaluate the treatments for gingival recession and root caries. Searches were performed in PubMed, Medline and Embase, the Cochrane trials register and bibliographies of European and World Workshops.

Observations: Gingival recession: We identified no articles that focussed specifically on older populations. Conversely, no evidence suggested that Miller class I and II lesions should be managed differently in older patients when compared to younger cohorts. Six systematic reviews included older patients and suggested that connective tissue grafts are the treatment of choice, alone or in combination with enamel matrix derivative. Root caries can be controlled at the population level by daily brushing with fluoride-containing toothpastes, whilst active decay may be inactivated using professional application of fluoride varnishes/solutions or self-applied high-fluoride toothpaste. Active root caries lesions that cannot be cleaned properly by the patient may be restored by minimally invasive techniques.

Conclusions: Gingival recession and root caries will become more prevalent as patients retain their teeth for longer. Whilst surgical (gingival recession) and non-operative approaches (root caries) currently appear to be favoured, more evidence is needed to identify the most appropriate strategies for older people.

Historical Perspective

Gingival recession, exposure of the root surface due to apical migration of the gingival margin, affects a significant proportion of the adult population. The presence of gingival recession amongst subjects with a good standard of oral hygiene suggests that the aetiology is complex and multifactorial (Joshipura et al. 1994) and involves anatomical and iatrogenic factors as well as being associated with gingivitis and periodontitis (Baker & Spedding 2002, Litonjua et al. 2005).

The prevalence of gingival recession increases with age (Kitchen 1941, Sangnes & Gjermo 1976, Løe et al. 1978, 1992, Serino et al. 1994, Brown et al. 1996) but should not necessarily be seen as a consequence of ageing (Khocht et al. 1993). Getting long in the tooth is a patient-related observation that most likely reflects generalized loss of attachment as a result of the cumulative exposure to multiple causal exposures over many decades (Needleman 2015), and there is growing evidence to support the relationship between age and loss of attachment as being age-associated rather than being a consequence of ageing (Page & Beck 1997).
The classical studies of Ainamo & Talari (1976) and Ainamo et al. (1981) established that, in the absence of periodontal disease, the width of attached gingiva increases with age between 23 and 65 years which is most likely due to teeth moving occlusally (Ainamo & Talari 1976, Locker et al. 1998). Further, a detailed study of the NHANES I data deriving incidence from prevalence data supports the hypothesis that when excellent plaque control is maintained, age may be seen to correlate with, rather than be a true determinant of, attachment loss (Abdellatif & Burt 1987, Burt 1994). Such a hypothesis fits comfortably with the observation that over time, attachment loss at buccal sites may also accumulate as a consequence of toothbrushing trauma (Papapanou et al. 1991).

All exposed root surfaces run a risk of developing root caries. The root caries prevalence has been reported to vary significantly across populations. This could be due to differences in diagnostic criteria, treatment patterns, lifestyle and age. Because of the cumulative nature of caries, the root caries prevalence increases with age, ranging from 26% amongst 50- to 64-year-olds (Kirkegaard et al. 1986) to 65–93% in 60- to 79-year-olds (Salonen et al. 1989, Fure & Zickert 1990). One study of 60- to 80-year-old Danes recorded a 100% root caries prevalence with 70% of the individuals having eight or more surfaces affected when all scores (lesions and fillings) were included (Fejerskov et al. 1991). Similarly, the intra-oral distribution of root caries differs between studies. Mandibular molars and premolars seem to be the most frequently affected, followed by maxillary canines and incisors (Katz et al. 1982, Wallace et al. 1988, Fejerskov et al. 1991). Only a few studies have considered the activity status of root caries lesions. In two studies (Fejerskov et al. 1991, Ekstrand et al. 2013), the mean number of active lesions per patient was 2.7 and 2.6, respectively, and almost all individuals experienced one or more surfaces with inactive lesions.

So although the modelling of longitudinal change in incidence with time suggests that recession and subsequently root caries are not age changes (Abdellatif & Burt 1987, Burt 1994), cross-sectional data continue to tell us that loss of attachment, the risk of root caries and root caries itself are all more prevalent in older cohorts of dentate individuals. For example, data from the UK Adult Dental Health Survey (2009) showing percentage of pockets, loss of attachment, risk of root caries (exposed surfaces) and root caries are presented in Table 1 (White et al. 2011). Clinical examinations of 6469 people living at home comprise the largest ever epidemiological survey of adult dental health in the United Kingdom and show that amongst dentate adults, the percentage of pockets >4 mm gradually increases up to middle age, plateaus around 60% and then reduces in later life as, presumably, those teeth most severely affected by caries or periodontal disease are lost. The percentage of people with loss of attachment, however, increases through middle age to later life. Although gingival recession itself was not reported, the percentage of people with any exposed roots, the mean number of teeth/person with exposed roots and the percentage of all teeth with exposed roots all increase with age showing that, regardless of the cause, gingival recession is an increasing problem with increasing age. Similar data for root caries demonstrate that the percentage of people with active decay and the mean number of teeth/person with active decay also increase throughout the decades. Further, the subset of individuals with any exposed roots in their mouths show a steady increase in the overall number of teeth with exposed roots and the mean number of teeth with active decay up to around 50–60 years of age, and the data then remain constant until the ninth decade (Table 1) (White et al. 2011). These data must be considered against the prevalence of risk factors which are likely to impact upon periodontal disease and caries, in the population under observation. So, for example, in the overall UK population and across all age groups, 20% of adults were current smokers, 65% had visible plaque deposits and 15% had a poor diet represented by a high carbohydrate intake.

Table 1. Presence of loss of attachment, active root caries and risk of root caries in UK dentate adults by age (data from Adult Dental Health Survey UK 2009). The data were collected following clinical examination of 6469 adults in UK domestic households

<table>
<thead>
<tr>
<th>Age Group</th>
<th>16-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65-74</th>
<th>75-84</th>
<th>85 and over</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>19</td>
<td>36</td>
<td>43</td>
<td>52</td>
<td>61</td>
<td>60</td>
<td>61</td>
<td>47</td>
</tr>
<tr>
<td>Percentage of people with LOA ≥ 4 mm</td>
<td>61</td>
<td>67</td>
<td>76</td>
<td>72</td>
<td>72</td>
<td>66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of people with LOA ≥ 6 mm</td>
<td>18</td>
<td>22</td>
<td>25</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of people with any exposed (vulnerable) root surface</td>
<td>31</td>
<td>53</td>
<td>72</td>
<td>88</td>
<td>95</td>
<td>96</td>
<td>98</td>
<td>97</td>
</tr>
<tr>
<td>Mean number of teeth with exposed (vulnerable) roots</td>
<td>2.1</td>
<td>3.9</td>
<td>6.4</td>
<td>9.4</td>
<td>11.1</td>
<td>11.8</td>
<td>10.7</td>
<td>10.9</td>
</tr>
<tr>
<td>Percentage of all teeth with exposed (vulnerable) roots</td>
<td>7</td>
<td>14</td>
<td>23</td>
<td>36</td>
<td>48</td>
<td>56</td>
<td>62</td>
<td>78</td>
</tr>
<tr>
<td>Percentage of people with roots with active decay</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.2</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Mean number of teeth with active decay</td>
<td>6.9</td>
<td>7.4</td>
<td>8.9</td>
<td>10.7</td>
<td>11.7</td>
<td>12.3</td>
<td>10.9</td>
<td>11.2</td>
</tr>
<tr>
<td>Amongst those with exposed (vulnerable) roots</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.2</td>
<td>0.4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*An exposed (vulnerable) surface is anywhere the gingiva has receded, and the root surface may be in any condition (sound, decayed, filled or worn).

*Active decay, not including hard arrested decay.

© 2017 John Wiley & Sons A/S. Published by John Wiley & Sons Ltd
The observation that the prevalence of gingival recession increases with age is certainly not specific to the United Kingdom and has been observed in other populations, for example: the NHANES III data (US 1988–1994) show such a pattern whilst also reporting that the severity of gingival recession increases with age (Albander & Kingman 1999); and the NPASES I cross-sectional data (France) used a multivariate linear regression model to show that age can be considered a risk factor for both the extent and severity of gingival recession (Sarfati et al. 2010).

Geriatric patients in nursing homes may suffer particularly high root caries rates (Vigild 1989, Wyatt 2002, Simunkovic et al. 2005, Ferro et al. 2008) with a substantial proportion of active lesions (Guivante-Nabet et al. 1998) suggesting an extraordinary treatment need. Cognitive, medical and functional impairment plays a significant role in the severe deterioration of oral hygiene and the associated increase in coronal and root caries in these groups (Chalmers et al. 2002, Ellefsen et al. 2008, Chen et al. 2013). Although gingival recession and root caries may not be true age changes, there is clear evidence that both conditions show increased prevalence throughout life (Table 1).

The objective of this review therefore was to critically evaluate and compare treatments of gingival recession and root caries in older patients.

Materials and Methods

Gingival recession

The authors adopted the PRISMA Statement (checklist) and flow diagram. A protocol was developed a priori following initial discussion between members of the research team. The objective statement for this part of the review was “a critical evaluation of treatments for gingival recession in the ageing population.”

At the outset, we assumed that the literature associated with the treatment of gingival recession, either localized or generalized, in the older population would be sparse, so we adopted a structured approach to identify systematic reviews and relevant research articles that would inform our statement:

i Review previous systematic (including Cochrane) reviews (2002–2016) to identify those which included patients from an ageing population and from which a clinical evaluation could be made (essentially a systematic review of systematic reviews);

ii Undertake our own systematic search for original articles evaluating the treatment of gingival recession specifically in an ageing population.

Search strategy for treatment of gingival recession

The search strategy was developed in accordance with basic search criteria for systematic reviews (Khan et al. 2011). Medline and Embase were searched from 1946 and 1974 respectively and both to March 2016. Search terms were selected using the following descriptors: “gingival recession” OR “gingival recession/therapy” OR “gingival recession/surgery” OR “guided tissue regeneration” OR “membranes, barrier” OR “tooth root/surgery” OR “grafts, connective tissue” OR “graft, gingival” OR “gingiva-transplantation” OR “gingivoplasty–method” OR “connective-tissue-transplantation.”

The Cochrane Oral Health Group specialist trials register was also searched using the following: “Gingival-recession” OR “Gingival recession” OR “Guided-tissue-regeneration” OR “Guided tissue regeneration” OR “GTR” OR ("resorbable" OR “non-resorbable") AND ("connective tissue” AND ("graft*” OR “transplant*”) OR “free gingival graft” OR “coronally advanced flap**” OR “gingiva* transplant*” OR “gingivoplasty” OR “periodontal surg*” OR "root* surg") (modified from Roccuzzo et al. 2002a,b).

The searches were restricted to titles, abstracts and papers in English. Bibliographies of review articles, relevant texts and World and European Workshops were also screened. In addition, manual hand searches were performed of the Journal of Clinical Periodontology, the Journal of Periodontology, the Journal of Periodontal Research and the respective online databases of these journals (Accepted Articles, Ahead of Print and Early View) were also searched for relevant publications that might be “in press” for paper versions.

Adjustments were made using subject headings appropriate to each database and keyword terms and truncators used as appropriate. Limits of “human” were applied in both databases and “45+” in Medline. This limit is not in use in Embase, so all documents were retained in the search results. The two sets were combined and deduplicated.

Criteria for including studies

Types of studies

Studies to be included in the review would be randomized clinical trials (RCTs) [level I] and controlled clinical trials (CCTs) [level II] and excluding pilot and feasibility studies. Inclusion criteria for the studies were as follows: recruitment of human subjects or patients; clinical examination to determine the extent of gingival recession on natural teeth; clinical examination to determine post-treatment root coverage; and parallel-group design with a follow-up of at least 12 months.

Types of participants

Subjects/patients included were those aged 55 years or older.

Types of interventions

Conservative or surgical treatment of localized or generalized gingival recession.

The review process

Titles and abstracts from the electronic searches were managed by downloading to EndNote software. EndNote x7 0.2 was used to search remote databases, to import the reference data and to manage the imported references. The titles and abstracts were all in English and were screened by two reviewers (AA and MR). Disagreement following the review of titles was resolved by consensus following reading by a third reviewer (PAH); disagreement following the review of abstracts was also resolved by discussion with a third reviewer (PAH) to moderate if necessary. The full texts of all
studies reported in English that potentially might have been included were also reviewed by the same two reviewers against the stated inclusion criteria. Data extraction was completed before a decision was made regarding whether the article should be included in the review. If any missing data or information was identified, an attempt was made to contact the author(s) of the publication.

Root Caries

Search strategy for treatment of root caries

It was decided to adopt a search strategy aiming at non-operative and operative treatments of root caries. Search terms were selected using the following descriptors: (“Root caries” OR “Root surface caries”) AND (“Dental Care for Aged” OR “Geriatric Dentistry” OR older OR elderly OR elder).

For the search strategy aiming at non-operative treatments, the descriptors were combined with (“chlorhexidine OR “mouth hygiene” OR “oral hygiene” OR fluoride”). Searches were performed in PubMed on 7 October 2016. Two hundred and twenty-nine papers were identified, including 32 reviews and 12 systematic reviews. Only one review included a quantitative meta-analysis of current non-operative interventions for root caries (Wierichs & Meyer-Lueckel 2015).

For the search strategy aiming at operative treatment of root caries, the descriptors were combined with (“Dental Atraumatic Restorative Treatment” OR “atraumatic restorative treatment” OR “ART restorations” OR “ART technique” OR ART OR “Dental Restoration, Permanent” OR “Permanent Dental Restoration” OR “Permanent Dental Restorations” OR “Dental Restoration, Permanent” [Mesh] OR amalgam OR “composite resin” OR “glass ionomer cement” OR “glass ionomer cements”). Searches were performed in PubMed on 26 October 2016 and identified 144 papers, 17 of which were reviews. Only one review adopted a systematic approach, but the material was insufficient to perform a meta-analysis (Amer & Kolker 2013).

Observations

Gingival recession

Treatment of gingival recession specifically in an ageing cohort of patients

The flow of articles through this aspect of the review is shown in Fig. 1. Three thousand six hundred and forty-two titles and abstracts were screened and produced 96 articles for which the full text was read. Twenty-eight papers were included: 27 describing systematic reviews and one original research article. In two instances, two papers described the same systematic review (Clauser et al. 2003, Pagliaro et al. 2003, Chambrone et al. 2009c, 2010a,b), so only 25 different systematic reviews were read. No research paper fulfilled all the inclusion criteria as none focussed entirely on the older population defined for this part of the review as those over the age of 55 years. The patient population described by Castellanos et al. (2006) combined a mean age of 42.5 years with a range of 28–71 years suggesting that a high proportion of the cohort will have been over 55 years of age. (The authors were contacted for the detailed data, but no response was forthcoming.) For the systematic reviews, only six included studies with participants over 55 years were identified (Pagliaro et al. 2003, Cairo et al. 2008, Chambrone et al. 2008, 2009c, 2012, Chambrone & Tatakis 2015) (Table 2).

Overview of Castellanos et al. (2006)

This article fulfilled all of the inclusion criteria with the exception that it did not focus exclusively on the older population. The clinical trial reported on 22 patients with single Miller class I or II defects and random assignment of two surgical treatments: coronally positioned flap with enamel matrix derivative (EMD) (test group) versus coronally positioned flap alone (control group). The 12-month data showed a significant reduction in vertical recession for those in the test group compared to those in the control group (2.32 ± 1.03 mm and 1.41 ± 0.57 mm respectively was equivalent to root coverage of 88.6% versus 62.2%). The conclusion was that whilst the coronally positioned flap was an effective procedure for covering single recession defects, the addition of EMD significantly improves root coverage (Castellanos et al. 2006).

Overview of the 25 systematic reviews

Details of the 25 systematic reviews identified in the search and published between 2002 and 2016 are shown in Table 2. The reporting of defect type was unclear in two reviews (Al-Hamdani et al. 2003, Clauser et al. 2003, Pagliaro et al. 2003) whilst the remaining 23 all reported on Miller type I and II defects. Six reviews included type III defects (Oates et al. 2003, Hwang & Wang 2006, Hofmann et al. 2012, Cairo et al. 2014, Graziani et al. 2014, Chambrone & Tatakis 2015), and one review included patients with type IV defects (Chambrone & Tatakis 2015). All reviews included either randomized controlled and/or controlled trials with the number of articles ranging from 6 to 94. Regarding clinical outcomes, the majority of reviews concluded that connective tissue grafts are significantly better at achieving root coverage than comparable procedures (and particularly guided tissue regeneration) (Clauser
Table 2. Twenty-seven systematic reviews (published as 25 articles between 2002 and 2016) evaluating surgical treatment strategies for lesions of gingival recession. Highlighted reviews provided information regarding the ages of the participants included in the articles/reviews

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Focussed question/objectives</th>
<th>Gingival recession: Single/ Multiple Classification</th>
<th>Types of studies</th>
<th>Number of articles included in review</th>
<th>Meta-analysis</th>
<th>Consideration of older cohorts?</th>
<th>Principal conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roccuzzo et al. (2002a,b)²</td>
<td>In patients with buccal GR, what is the effect of PPS on root coverage and attachment gain? <strong>•</strong> To define the clinical outcomes of GTR-based procedures in achieving CRC for GR lesions. <strong>•</strong> To compare the outcomes with these following conventional mucogingival surgery</td>
<td>Single Miller I, II</td>
<td>RCT CCT Case series (&gt;6 months)</td>
<td>30</td>
<td>YES</td>
<td>NO</td>
<td>All surgical procedures produced a significant improvement in GR and CTG were statistically significantly superior to GTR.</td>
</tr>
<tr>
<td>Al-Hamdan et al. (2003)²</td>
<td>To define the clinical outcomes of GTR-based procedures in achieving CRC for GR lesions. To compare the outcomes with these following conventional mucogingival surgery</td>
<td>Single Multiple Unclear</td>
<td>RCT Comparative Case controls Case reports</td>
<td>40</td>
<td>NO</td>
<td>NO</td>
<td>GTR resulted in 55% CRC compared to 41% for conventional microgingival surgery. The respective % means (sd) root coverage for the 2 procedures were: 81% versus 74%</td>
</tr>
<tr>
<td>Clauser et al. (2003) Pagliaro et al. (2003)²</td>
<td>To find evidence to guide decision-making in planning root coverage</td>
<td>Unclear</td>
<td>RCT CCT Case studies</td>
<td>65</td>
<td>3 separate meta-analysis comparing various surgical techniques</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Al-Hamdan et al. (2003)²</td>
<td>To find evidence to guide decision-making in planning root coverage</td>
<td>Unclear</td>
<td>RCT</td>
<td>32</td>
<td>YES</td>
<td>NO</td>
<td>Irrespective of surgical procedure, complete root coverage approaches 100% as initial GR depth decreases.</td>
</tr>
<tr>
<td>Oates et al. (2003)²</td>
<td>What is the effect of surgical therapy for root coverage in patients with GR compared with other treatment modalities?</td>
<td>Unclear Miller I, II, III</td>
<td>RCT</td>
<td>8</td>
<td>YES</td>
<td>NO</td>
<td>Autogenous CTG was significantly better than GTR in terms of achieving root coverage.</td>
</tr>
<tr>
<td>Gapski et al. (2005)²</td>
<td>In patients with GR and/or lacking KG, is there a benefit in treating the patient with ADM compared to traditional treatment modalities?</td>
<td>Unclear Miller I, II</td>
<td>RCT</td>
<td>8</td>
<td>YES</td>
<td>NO</td>
<td>Tentative conclusion that ADM-based mucogingival surgery can be used to successfully repair GR defects.</td>
</tr>
<tr>
<td>Hwang &amp; Wang (2006)²</td>
<td>To collect and summarize clinical data from root coverage studies analysing flap thickness in a systematic fashion</td>
<td>Single Multiple Miller I, II, III</td>
<td>RCT Cohort studies Case control Case series</td>
<td>15</td>
<td>NO</td>
<td>NO</td>
<td>A critical threshold flap thickness may exist for root coverage success but the heterogeneity of the data and studies compromise firm conclusions.</td>
</tr>
<tr>
<td>Cheng et al. (2007)²</td>
<td>To assess the efficiency of EMD and root conditioning on root coverage with coronally positioned flap in terms of GR depth and root coverage %</td>
<td>Single Multiple Miller I, II</td>
<td>RCT CT</td>
<td>18</td>
<td>NO</td>
<td>NO</td>
<td>At 12 months, root coverage was significantly improved (84%) when EMD was used with a coronally positioned flap when compared to CPF alone (54%)</td>
</tr>
</tbody>
</table>
Table 2. (continued)

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Focussed question/objectives</th>
<th>Gingival recession: Single/Multiple Classification</th>
<th>Types of studies</th>
<th>Number of articles included in review</th>
<th>Meta-analysis</th>
<th>Consideration of older cohorts?</th>
<th>Principal conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cairo et al. (2008)</td>
<td>What is the clinical benefit of adding to CAF: CTG; BM; EMD; ADM; PRP; or HF-DDS?</td>
<td>Single/Multiple Miller I, II</td>
<td>RCT</td>
<td>27</td>
<td>YES</td>
<td>11 Studies included participants &gt;55 years</td>
<td>CTG or EMD in conjunction with CAF enhances the likelihood of CRC in Miller I and II lesions</td>
</tr>
<tr>
<td>Chambrone et al. (2008)</td>
<td>Can subepithelial CTGs be considered the Gold Standard procedure in the treatment of GR-type defects?</td>
<td>Single/Multiple Miller I, II</td>
<td>RCT</td>
<td>23</td>
<td>NO</td>
<td>10 studies included participants &gt;55 years</td>
<td>CTGs provide significant root coverage and comparisons to other surgical procedures allow it to be considered as the “Gold Standard” of interventions</td>
</tr>
<tr>
<td>Chambrone et al. (2009a)</td>
<td>Does tobacco smoking influence outcome measures achieved by root coverage procedures?</td>
<td>Single/Multiple Miller I, II</td>
<td>CCT Case series</td>
<td>6</td>
<td>YES</td>
<td>1 study included participants &gt;55 years</td>
<td>Very few data consider patient-reported outcome measures, CTGs provide significantly greater root coverage for non-smokers compared to smokers (27-80% versus 0-25%)</td>
</tr>
<tr>
<td>Chambrone et al. (2009b)</td>
<td>To evaluate different root coverage procedures in the treatment of multiple recession-type defects</td>
<td>Multiple Miller I, II</td>
<td>RCT CCT Case series</td>
<td>4</td>
<td>NO</td>
<td>No study included any participant over 48 years</td>
<td>Noticeable variation in root coverage between studies and procedures</td>
</tr>
<tr>
<td>Chambrone et al. (2009c, 2010a, b)</td>
<td>To evaluate the effectiveness of different root coverage procedures in the treatment of recession-type defects</td>
<td>Single/Multiple Miller I, II</td>
<td>RCT</td>
<td>24</td>
<td>YES</td>
<td>10 studies included participants &gt;55 years</td>
<td>CAF alone or in combination with CTG led to improvements in GR depths; Patients’ needs should be carefully evaluated to ensure their complaints can be addressed</td>
</tr>
<tr>
<td>Ko &amp; Lu (2010)</td>
<td>To assess the effectiveness of CTG and GTR in treating patients with GR</td>
<td>Unclear Miller I, II</td>
<td>RCT CCT Cohort study Case report</td>
<td>18</td>
<td>YES</td>
<td>NO</td>
<td>Significantly greater reduction in GR for CTG when compared to GTR with restorable membranes, Limited data exist on patients’ opinions and preferences for treatment</td>
</tr>
<tr>
<td>Chambrone et al. (2012)</td>
<td>Which recession-, patient- and/or procedure-related factors can influence CRC?</td>
<td>Single/Multiple Miller I, II</td>
<td>RCT</td>
<td>22</td>
<td>YES</td>
<td>9 studies included participants &gt;55 years.</td>
<td>CTG is significantly more effective than GTR in achieving root coverage of Miller I, II lesions after 12 months.</td>
</tr>
</tbody>
</table>

© 2017 John Wiley & Sons A/S. Published by John Wiley & Sons Ltd
<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Focussed question/objectives</th>
<th>Gingival recession: Single/Multiple Classification</th>
<th>Types of studies</th>
<th>Number of articles included in review</th>
<th>Meta-analysis</th>
<th>Consideration of older cohorts?</th>
<th>Principal conclusions</th>
</tr>
</thead>
</table>
| Oliveira & Muncinelli (2012) | Does root surface bio-modification have an effect before root coverage procedures? | Unclear Miller I, II | RCT | 6 | NO | NO | • CTG and CAF produced a high rate of success in terms of root coverage  
• Root surface bio-modification protocols (ND:YAG, citric acid, EDTA) yielded no additional benefits |
| Hofmänner et al. (2012) | What is the predictability of PPS in achieving complete root coverage of GR lesions? | Multiple Miller class I, II, III | RCT | 16 | NO | No | • CAF or MCAF with or without CTG will give predictable root coverage that can be maintained over 5 years. MCAT is a valued technique for Miller class III lesions |
| Koop et al. (2012) | Is the additional use of EMD more effective than control treatments for the management of GR? | Undear Miller I, II | RCT | 6 | YES | NO | • EMD + CAF produced significantly more CRC compared with CAF alone  
• No significant difference in CRC when comparing CAF + EMD versus CAF + CTG |
| Oliveira & Muncinelli (2012) | Does root surface bio-modification have any positive or negative effect when used before root coverage procedures? | Single Multiple Miller class I, II | RCT | 6 | NO | | |
| Buti et al. (2013) | What is the best approach to obtain GR reductions and root coverage? | Miller class I, II | RCT | 31 | YES | | • CAF + CTG is the most effective procedure for root coverage of Miller I and II lesions |
| Cairo et al. (2014) | What is the clinical efficiency of PPS procedure in the treatment localized GR with or without interdental CAL? | Single Unclear Miller I, II, III | RCT | 53 | YES | NO | • CAF + CTG achieved the best clinical outcome for single GR defects with or without interdental CAL  
• EMD improves the efficiency of CAF  
• In addition to the traditional CAF approach, the use of CTG, flap modifications and tunnel procedures may improve clinical results |
| Graziani et al. (2014) | In subjects affected by multiple recessions, which PPS procedure is most effective in terms of % root coverage and CRC? | Multiple Miller I, II, III | RCT | 9 | YES | NO | |
Table 2. (continued)

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Focussed question/objectives</th>
<th>Gingival recession: Single/Multiple Classification</th>
<th>Types of studies</th>
<th>Number of articles included in review</th>
<th>Meta-analysis</th>
<th>Consideration of older cohorts?</th>
<th>Principal conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chambrone &amp; Tatakis (2015)</td>
<td>• What is the efficiency/effectiveness of root coverage procedures by degree of GR? • What are the risks from the patients' perspective?</td>
<td>Gingival recession: Single/Multiple Classification</td>
<td>SRs, RCT, CCT, Case series, Case reports</td>
<td>94</td>
<td>YES</td>
<td>33 studies included participants &gt;55 years</td>
<td>• All root coverage procedures provide significant reductions in GR for Miller I, II defects • CTG provides the best outcome regarding root coverage and increase in the keratinized tissue • Limited data from case reports suggest that class IV defects may be improved but may not deliver the expected aesthetic outcome • Class III defects may significantly benefit from CTG-based procedures and EMG + CAF, ADM + CAF, and GTR + CAF may be used as graft substitutes.</td>
</tr>
<tr>
<td>Karam et al. (2015)</td>
<td>Does the use of root surface modifiers improve clinical outcomes in GR lesions treated with CTG?</td>
<td>Gingival recession: Miller class I, II</td>
<td>RCT</td>
<td>6</td>
<td>NO</td>
<td>1 study included participants &gt;55 years</td>
<td>• The use of root surface modifiers (citric acid, EDTA, Nd:YAG, EMD) is not justified as an adjunct to PPS to treat GR</td>
</tr>
<tr>
<td>Luo et al. (2015)</td>
<td>Do platelet concentrates affect the outcome of regenerative procedures for the treatment of GR?</td>
<td>Gingival recession: Miller class I, II</td>
<td>RCT</td>
<td>9</td>
<td>YES</td>
<td>1 study included participants &gt;55 years</td>
<td>• The use of platelet concentrate as an adjunct to grafting procedures led to a significant additional reduction in GR of 0.34 mm</td>
</tr>
<tr>
<td>Moraschini &amp; dos Santos Porto Barboza (2016)</td>
<td>What are the effects of PRF membranes on the treatment of GR?</td>
<td>Gingival recession: Miller class I, II</td>
<td>RCT, Prospective CT</td>
<td>7</td>
<td>YES</td>
<td></td>
<td>• PRF membranes did not improve the root coverage of GR defects when compared to CAF alone</td>
</tr>
</tbody>
</table>

ADMG, acellular dermal matrix graft; BM, barrier membrane; CAF, coronally advanced flap; CAL, clinical attachment loss; CCT, controlled clinical trial; CPF, coronally positioned flap; CRC, complete root coverage; CTG, connective tissue graft; EDTA, ethylenediaminetetraacetic acid; EMD, enamel matrix derivative; Er:YAG, erbium:yttrium–aluminium–garnet; GR, gingival recession; GTR, guided tissue regeneration; HF, human fibroblast-derived dermal substitute; KG, keratinized gingiva; MG, matrix graft; MCAF, modified coronally advanced flap; MCAT, modified coronally advanced tunnel; Nd:YAG, neodymium-doped yttrium aluminium garnet; PPS, periodontal plastic surgery; PRF, platelet-rich fibrin; PRP, platelet-rich plasma; RCT, randomized controlled clinical trial; SR, systematic review.

bSystematic review data published as two articles.
and modified from Chambrone et al. 2010a,b)

**Overview of the six systematic reviews with participants over 55 years**

Of the 25 reviews included, six reported more than a third of the included studies as recruiting participants over 55 years of age: 34% (Clauser et al. 2003, Pagliaro et al. 2003), 35% (Chambrone & Tatakis 2015), 41% (Cairo et al. 2008), 41% (Chambrone et al. 2012), 42% (Chambrone et al. 2009c) and 43% (Chambrone et al. 2008). The quality of the reviews was assessed using the Overview Quality and Assessment Questionnaire (OQAQ) (Oxman & Guyatt 1991, Shea et al. 2007). Five of the six reviews scored an overall 6/7 (Cairo et al. 2008) or 7/7 (Chambrone et al. 2008, 2009c, 2012, Chambrone & Tatakis 2015) on the OQAQ indicating a high level of quality assurance (Table 3). Only one review included studies that recruited participants with type III and IV defects, and none of the reviews reported a clear, objective assessment of outcome aesthetics nor considered the cost-effectiveness of the interventions.

**Table 3. Overview Quality and Assessment Questionnaire (OQAQ) applied to systematic reviews on root coverage procedures.** (Adopted and modified from Chambrone et al. 2010a,b)

| 1. Were the search methods reported? | Yes | Yes | Yes | Yes | Yes | Yes |
| 2. Was the search comprehensive? | No | Yes | Yes | Yes | Yes | Yes |
| 3. Were the inclusion criteria reported? | Yes | Yes | Partially | Yes | Yes | Yes |
| 4. Was selection bias avoided? | No | Yes | Yes | Yes | Yes | Yes |
| 5. Were the validity criteria reported? | Partially | Yes | Yes | Yes | Yes | Yes |
| 6. Was validity assessed appropriately? | No | Yes | Yes | Yes | Yes | Yes |
| 7. Were the methods used to combine studies reported? | Yes (no meta-analysis) | Yes | Yes | Yes | Yes | Yes |
| 8. Were the findings combined appropriately? | Unclear | Yes | Yes | Yes | Yes | Yes |
| 9. Were the conclusions supported by the reported data? | Yes | Yes | Yes | Yes | Yes | Yes |
| 10. What was the overall scientific quality of the overview? (1–7) | 2 | 7 | 6 | 7 | 7 | 7 |


**Overview of the six systematic reviews with participants over 55 years**

Of the 25 reviews included, six reported more than a third of the included studies as recruiting participants over 55 years of age: 34% (Clauser et al. 2003, Pagliaro et al. 2003), 35% (Chambrone & Tatakis 2015), 41% (Cairo et al. 2008), 41% (Chambrone et al. 2012), 42% (Chambrone et al. 2009c) and 43% (Chambrone et al. 2008). The quality of the reviews was assessed using the Overview Quality and Assessment Questionnaire (OQAQ) (Oxman & Guyatt 1991, Shea et al. 2007). Five of the six reviews scored an overall 6/7 (Cairo et al. 2008) or 7/7 (Chambrone et al. 2008, 2009c, 2012, Chambrone & Tatakis 2015) on the OQAQ indicating a high level of quality assurance (Table 3). Only one review included studies that recruited participants with type III and IV defects, and none of the reviews reported a clear, objective assessment of outcome aesthetics nor considered the cost-effectiveness of the interventions.

All six reviews concluded in favour of connective tissue grafts (CTGs) as the treatment of choice (Clauser et al. 2003/Pagliaro et al. 2003, Chambrone et al. 2008, 2009c, 2010a,b, Chambrone & Tatakis 2015), and whilst there are limited data to suggest that EMD may be a useful biomaterial in current periodontal plastic surgery (Chambrone et al. 2012), further studies are necessary to definitively evaluate indications for treatment and associated clinical benefits (Cairo et al. 2014).

Three reviews reported patient-related outcome measures (Chambrone et al. 2008, 2009c, Chambrone & Tatakis 2015). Chambrone et al. (2008) identified two articles where the patients were completely satisfied with the clinical result independent of the surgical technique used (Bouchard et al. 1994, Rosetti et al. 2000). A further trial reported greater patient satisfaction with acellular dermal matrix grafts when compared to connective tissue grafts (Aichelmann-Reid et al. 2001). Chambrone et al. (2009c) also reported the observations made by Bouchard et al. (1994) as well as those of Rosetti et al. (2000) who found that all patients were equally satisfied with the aesthetic outcome following GTR and CTG procedures.

In a more generalized conclusion, Chambrone & Tatakis (2015) reported that patients considered all of a wide range of root coverage procedures to be safe and effective but with a preference for procedures that involve only one surgical site.

The lack of an evidence base for the management of gingival recession in older patients makes it impossible to critically evaluate interventions specifically in this cohort. It is reasonable to assume, however, that conclusions regarding periodontal plastic procedures in younger populations or in those cohorts that include a minority group of older patients can also be applied with some confidence to the older group in general. Consequently, the six reviews that are consistent in promoting CTGs as the “Gold Standard” for the management of localized and generalized, Miller class I and II defects should not be overlooked. Gingival recession in older cohorts may, of course, not be restricted to Miller class I and II defects and the prevalence of class III and IV defects, and a more generalized pattern of gingival recession should encourage not only surgical (where indicated) but also more conservative approaches to management such as reassurance, placement of pink and/or white restorations, positioning of margins of full coronal restorations and gingival veneers. This would then provide the opportunity to critically evaluate the interventions across a much broader profile of criteria apart from the
attainment of complete (or partial) root coverage. Indeed, it may be conjectured that aesthetics, particularly of single, localized lesions, may not be of much relevance or importance to older subjects; had this been the case, then intervention would have been sought much earlier assuming they were of a long-standing nature. Further, the pattern of gingival recession in older patients may well be different to that in younger patients, perhaps as a consequence of periodontal disease, periodontal treatment or a heavily restored dentition with multiple restorations at or below the gingival margin. Such presentations may not be manageable by periodontal plastic surgery and more conservative measures indicated.

Patient-reported opinions are infrequently reported on clinical outcomes following surgery (Chambrone et al. 2008, Graziani et al. 2014) when clearly their views of their initial clinical status would be invaluable to help inform the selection of the appropriate treatment regimen. Similarly, aesthetic evaluations of outcomes by independent observers are seldom reported, a crucial oversight as aesthetic considerations such as tissue thickness, colour match, scarring and misalignment of the mucogingival margin cannot be determined by recording the extent of root surface coverage alone (Cairo et al. 2009, Graziani et al. 2014). Further, we found no evidence that any treatment for gingival recession, surgical or conservative, has been evaluated from the position of health economics; cost-minimization, cost-effectiveness, cost-utility and cost-benefit analyses would all be relevant and applicable to the management of gingival recession (Vernazza et al. 2012) and particularly so in older cohorts.

Treatment of root caries

Management of root surfaces from a cariological perspective

Root surfaces differ from enamel surfaces by a lower mineral content and a higher amount of organic material. Because of the smaller size of the apatite crystals, root surfaces are highly receptive to mineral uptake in the oral environment. This explains why exposed root surfaces usually present a hypermineralized surface zone, the mineral content of which may be higher than that of sound unexposed tissue (Selvig 1969). Experimental studies in vivo have shown that topical treatments with fluoride may enhance mineral precipitation in root surfaces (Furseth 1970). On the contrary, periodontal surgery and aggressive mechanical debridement may break or remove the surface layer (Jepsen et al. 2004) and expose the underlying dentinal tubules, leading to hypersensitivity and possibly biofilm accumulation and caries. What the periodontist may see as a successful treatment could thus be counterproductive for the cariologist, who praises preservation of the root surface! Fortunately, when the patient is able to carry out an adequate daily hygiene with fluoride toothpaste, a new hypermineralized surface layer may develop within a few months after overinstrumentation of root surfaces (Selvig 1969).

Scaling and root planing could be even more problematic in the presence of root caries. Root caries lesions present a subsurface type of mineral loss, similar to enamel caries lesions. However, if the surface layer of the lesion is damaged due to vigorous probing or mechanical debridement, the body of the carious lesion may develop into an uncleanable cavity requiring restoration. Anyone who has performed a filling on a root surface knows the difficulties encountered with such treatment. Therefore, from a cariological point of view, the surface integrity of root caries lesions should be preserved by non-operative treatments.

Root caries lesions may occur on all exposed root surfaces but are mainly found in biofilm retention sites, such as along the cemento-enamel junction, in mesial and distal concavities, and along margins of restorations. Such sites may not always be the sites most frequently checked by the periodontist who mainly focusses on sites next to the gingival margin. Diagnosis of root caries is difficult because of impaired visibility, and the diagnosis must be performed cautiously without forceful poking into the tissue. Formerly, root caries lesions were predominantly classified according to their severity (Billings et al. 1985). However, recognizing the dynamic nature of root caries (Nyvad & Fejerskov 1986), modern classification methods are now recommending a distinction of lesions into active and inactive stages (Fejerskov et al. 1991, Ekstrand et al. 2008). Briefly, the typical active lesions are soft on gentle probing and show a yellowish or light brown colour without obvious cavitation. The inactive or slowly progressing lesions may present a leathery or hard darkly discoloured surface, even if the lesion has reached the stage of cavitation (Nyvad & Fejerskov 1982). Such classification is now commonly used in clinical trials of root caries.

Non-operative treatments

Most of our knowledge about the effects of non-operative treatment of root caries originates from narrative reviews. Many reviews describe a broad variety of treatments without due consideration of their relative clinical significance (Leake 2001, Rodrigues et al. 2011, Walls & Meurman 2012, Gluzman et al. 2013, Bignozzi et al. 2014). This could mislead practitioners to think that a palette of preventive methods applied simultaneously might result in better outcomes than a single effective treatment. Only one systematic review has conducted a quantitative meta-analysis of current non-operative interventions of root caries (Wierichs & Meyer-Lueckel 2015). The authors concluded that regular use of dentifrices containing 5000 ppm fluoride and quarterly professionally applied chlorhexidine (CHX) or silver diamine fluoride (SDF) seem to be efficacious in reducing the initiation and progression of root caries. Yet, the authors toned down their conclusions due to the low numbers of clinical trials for each of the explored methods, the high risk of bias within studies, and the limiting grade of evidence. There are no recent publications that could justify a new meta-analysis. Therefore, the following presents a critical re-digestion of existing data with the aim to obtain a clearer picture of potential knowledge gaps.

Fluoride

Brushing the teeth with fluoride toothpaste is a strong recommendation for caries control. Daily
brushing with fluoride toothpaste confers a 24% reduction in caries over 2–3 years in children and adolescents compared to placebo (Marinho et al. 2003), and a similar effect has been estimated for enamel and root surfaces in adults (Griffin et al. 2007). Interestingly, the prevented fraction of community water fluoridation or rinsing with a fluoride solution on root caries could be in the same order of magnitude as brushing with fluoridated toothpaste (Twetman et al. 2004, Wyatt & MacEntee 2004, Griffin et al. 2007). This might indicate that mechanical oral hygiene does not matter. Yet, cross-sectional studies have shown that the strongest factor explaining the presence of root caries, with control for other factors, was oral hygiene (DePaola et al. 1989, Vehkalahti et al. 1997). Properly designed experimental in situ studies have suggested that only half of the treatment effect of brushing with fluoride toothpaste could be ascribed to fluoride, and the other half was due to a cleaning effect (Dijkman et al. 1990). These observations imply that the quality of oral hygiene might play a significant role for the outcome of interventions with fluoride. The design of future intervention studies with fluoride should therefore allow for a distinction between the fluoride component and the mode of application.

In recent years, research has focussed on boosting fluoride concentrations in toothpaste for improved control of root caries. This development was possibly triggered by early clinical studies of DePaola (1993) showing that professional application of 12,000 ppm NaF gel to active non-cavitated root caries lesions every four months over a year was successful in arresting root caries. More recently, four short-term clinical trials of 6- to 8-month duration (Bayasan et al. 2001, Ekstrand et al. 2008, 2013, Srinivasan et al. 2014) have concluded that root caries progression might be halved by exchanging a conventional toothpaste (1100, 1350, 1450 ppm F) with a 5000-ppm-F toothpaste (Wierichs & Meyer-Lueckel 2015). In particular, the studies by Ekstrand and co-workers are of interest. In one study, 1450- or 5000-ppm-fluoride toothpastes were tested in elderly disabled nursing home residents who had their teeth brushed by the nursing staff twice a day. After 8 months, lesion arrest (“re-hardening”) was more prevalent in the high-F group. As there were no differences in plaque conditions between the two groups at the end of the study, the authors ascribed differences in the outcome to the higher fluoride content (Ekstrand et al. 2013). In the other study, home-bound 75+-year-olds were assigned to one of three groups. Participants in group 1 brushed their teeth with 1450-ppm-fluoride toothpaste, and once a month, a dental hygienist brushed the teeth with the same toothpaste and applied 5% F varnish (23,000 ppm F) to active root caries lesions. Participants in groups 2 and 3 received 5000- and 1450-ppm-F toothpaste, respectively, and brushed twice daily. At the end of the study, the root caries status of the participants in groups 1 and 2 had improved significantly compared with group 3. Interestingly, participants in group 2 brushing with the high-F paste did not fare better than participants in group 1 using a low-F paste and receiving monthly professional cleaning and fluoride varnish application. These results imply that brushing with high-F toothpaste should not necessarily be considered “best practice” for root caries control. It should also be noted that in both of the above studies, professional dental cleaning was applied in at least one of the experimental arms. Indeed, when adults were using 5000-ppm-F paste for 6 months on their own, without professional plaque control, root caries arrest varied widely across individuals (Srinivasan et al. 2014). Further studies of longer duration including crossover design are therefore required to confirm the potential superiority of high-F toothpastes compared with other topical fluoride interventions for root caries.

Fluoride derivatives

Ammonia-based 28% SDF was promoted as an alternative treatment to halt and prevent the development of new dentin caries (Rosenblatt et al. 2009). The philosophy behind SDF is based on the antimicrobial effect of silver and the formation of a “sclerotic coating” at the surface of carious dentin. Bacterial killing is, however, not a long-lasting cure for root caries (Kidd et al. 2015), and any topical fluoride treatment could facilitate hypermineralization of the surface layer during root caries arrest (Nyvad et al. 1997). Although originally developed for controlling cavities in children, SDF has also been tested for the prevention of root caries in functionally independent adults. Tan et al. (2010) compared the effect of annual application of 38% SDF in conjunction with individualized oral hygiene (OHI) with 3-monthly applications of 1% chlorhexidine varnish and OHI, 3-monthly applications of 5% NaF varnish and OHI, or OHI alone. All participants were recommended to use fluoridated toothpaste for daily cleaning of the teeth. At the end of the 3-year trial, all the therapeutic interventions were more effective in preventing new root caries lesions than giving oral hygiene instruction alone. No one intervention (38% SDF, 1% chlorhexidine varnish or 5% NaF varnish) was significantly superior to the other. The authors did not report on lesion arrest, but subsequent studies found that annual SDF treatment may also promote lesion arrest (Zhang et al. 2013, Li et al. 2016). Nevertheless, these premature studies do not provide evidence to support that SDF treatment should be preferable in root caries control.

Proponents of SDF treatment often ignore the potential harmful side effects. In addition to blackening of carious dentin, an effect of purely cosmetic concern, SDF treatment causes mildly painful chemical burns of the oral mucosa (see illustration by Deutch 2016) that may last for up to 48 h (Rosenblatt et al. 2009). The European Union classify silver nitrate as both corrosive and dangerous for the environment, and SDF has not yet been cleared by the US Food and Drug administration (Fung et al. 2013). To circumvent this problem, Deutch (2016) developed an alternative topical fluoride strategy for treating root caries lesions using a combination of aqueous 40% AgF and 10% SnF2. It was stated that the advantage of AgF and SnF2 over SDF is that AgF + SnF2 does not cause gingival irritation. The method was applied on a 3- to 4-monthly basis to arrest multiple active root caries lesions in frail elderly without
causing discomfort, and it was suggested that the approach might be particularly useful when treating cognitively impaired elderly who may not have the ability to comply with conventional dental treatment. Deutsch (2016) also advocated that AgF + SnF₂ could be used as an alternative to excavation prior to placing atraumatic restorative treatment (ART) restorations. Further testing of the efficacy of these methods in physically and cognitively debilitated patients is clearly warranted.

**Chlorhexidine**

One systematic review has evaluated the effect of chlorhexidine varnish on root caries incidence and activity (Slot et al. 2011). Evaluation of data provided no conclusive evidence that regular application of chlorhexidine varnish to root surfaces is effective for caries control in patients receiving regular professional tooth cleaning. Slot et al. (2011) proposed that in the absence of regular professional interventions, chlorhexidine varnish might have a beneficial effect in special care patients. However, other authors found that the evidence was too weak to support this conclusion (Tweedman 2004, Duane 2011). Likewise, regular mouthrinsing with 0.12% chlorhexidine solution did not have an effect on the preservation of enamel and root surfaces in older adults (Wyatt & MacEntee 2004, Wyatt et al. 2007).

**Dental hygiene**

A few reviews stress the overriding importance of dental hygiene in root caries control (Fejerskov 1994, Bignozzi et al. 2014, Wierichs & Meyer-Lueckel 2015). In their systematic review, Wierichs & Meyer-Lueckel (2015) observed that several trials reported improved oral hygiene for all participating patients, even in the control groups, emphasizing the significance of dental cleaning in the management of root caries (Nyvad & Fejerskov 1986, Emilion et al. 1993). Yet, intensive professional plaque control programmes in special care patients (Johnson & Almqvist 2005) and periodontal patients (Kavalov & Birkhed 1992, Emilion et al. 1993) have shown differing effects on root caries. This may not be surprising. Root caries is a multifactorial condition that relies on several factors. In addition to poor dental hygiene, hyposalivation and frequent sugar intake are risk factors that stimulate acidification of the dental biofilm (Takahashi & Nyvad 2011). Any caries treatment must therefore start by identification of individual risk factors which should be modified according to individual needs (Nyvad & Kidd 2015). There is no standard cure for caries. Caries control is a matter of establishing the right balance between major risk factors such as plaque control, sugar exposure and fluoride. Particularly, it should be appreciated that although fluoride is important, fluoride alone cannot be expected to stop root caries as long as the dental biofilm is producing high amounts of acids.

**Operative treatment**

Operative treatment of root caries should be avoided as far as possible. This is because of the relatively poor prognosis of restorations. Studies in elderly patients have shown that the survival of root caries restorations is about 90% and 65% after 1 and 2 years, respectively (Hu et al. 2005, Lo et al. 2006, Gil-Montoya et al. 2014). No studies have evaluated the longevity of restorations for more than 2 years. Irrespective of the restorative material applied (glass ionomer or composite resin), the majority of fillings fail because of dislodgement (Levy and Jensen 1990, Hu et al. 2005), possibly because of difficulty in achieving adequate moisture control. Another problem in the elderly may be associated with decreased ability to cooperate resulting in poor visibility and access to the caries lesion. Therefore, it is always recommended to consider whether an active root caries lesion might be managed non-operatively rather than operatively. Operative treatment is purely symptomatic and does not deal with the patient’s caries problem (Nyvad & Fejerskov 2015). Only when the patient cannot clean an active (cavitated) root caries lesion properly is an operative intervention required.

In recent years, high-viscosity glass-ionomer cements have been the preferred mode of restoring root caries lesions in the elderly (Amer & Kolker 2013). These materials benefit from binding chemically to the root surface and may be used in minimally invasive approaches such as the ART technique (Frencken 2014). In ART, only hand instruments are used to remove soft carious dentine. Comparative studies have shown that the survival of root caries restorations using this technique is similar to the traditional approach using rotary instruments for excavation (Lo et al. 2006). The low-technology approach of ART may be particularly useful and cost-effective for outreach dental services such as in homebound and institutionalized elderly with physical or cognitive disorders (Da Mata et al. 2014, Gonzales & Zuluaga 2016). Further clinical trials are needed to explore the benefits of these treatments for the vulnerable elderly.

**Trends and Future Perspectives**

Although trend and projection data for the prevalence of either localized or generalized gingival recession in older age groups are not readily identifiable, it is reasonable to use the retention of teeth as a broad but nevertheless indicative surrogate marker for the prevalence of gingival recession and subsequently root caries. The national surveys of Adult Dental Health in the United Kingdom have been undertaken every 10 years (1988, 1998 and 2009) since 1978, and trends indicate clearly that there is a decline in the rate of tooth loss with each decade (Fuller et al. 2011). The percentage of dentate UK adults in all age groups, and particularly those over 55 years, is increasing significantly over the decades (Steele et al. 2000, Fuller et al. 2011), and future projections using the data of 1988 and 1998 predicted that approximately 43% of adults over the age of 85 in 2008 would retain at least one natural tooth (Steele et al. 2000). The actual figure was 53% (Fuller et al. 2011) indicating that the retention of natural teeth in the oldest age groups, at least in the United Kingdom, is far exceeding expectation. Further, the percentage of adults in the United Kingdom, over the age of 55 years, and retaining at least 21 natural teeth has increased by approximately 10% each decade from 30% in 1978 to 63% in 2009. Over the same period, the mean number of natural
teeth/individual has risen from 16 to 21.2 (Fuller et al. 2011); if the trend continues, by around 2030, 80% of adults over 55 years in the United Kingdom will have at least 21 natural teeth, with a mean number of approximately 25. The implication for the prevalence of gingival recession and root caries is clear.

It follows from the above that there is no easy cure for root caries. Current methods involving fluorides may at best reduce the progression of root caries by about 50%. We are gradually learning more about the pathogenic processes in root caries, especially the biochemical processes that occur in the dentin organic materials as a result of demineralization (Takahashi & Nyvad 2016). It is hypothesized that as bacterial acids demineralize and expose the organic matrix, host-derived proteases from saliva and dentin itself (matrix metalloproteinases and cathepsins) become activated to promote the initial degradation of the dentin matrix. Novel strategies based on protection of the dentin matrix by protease inhibitors might potentially improve therapies for root caries in the future (for review, see Takahashi & Nyvad 2016). Such strategies are urgently needed as our populations are growing older with an increasing number of teeth at risk of root caries.

Recommendations for Clinical Practice

1 There is no evidence to suggest that periodontal surgical procedures to manage gingival recessions in younger age groups are not equally successful and should be used for older patients in older cohorts, and particularly those with Miller class I and II lesions.

2 Root caries lesion development can be controlled at the population level by brushing the teeth twice a day with conventional fluoride toothpaste (1000–1500 ppm F).

3 Active root caries lesions can be converted into inactive lesions by twice-daily brushing with conventional toothpaste (1000–1500 ppm F), combined with professional applications of 5% NaF varnish or 2% NaF solution 3–4 times a year. Alternatively, lesion arrest might be obtained by brushing lesions twice a day with high-F toothpaste (5000 ppm F).

4 Fluoride interventions should be combined with meticulous dental hygiene and sugar control to optimize the caries-controlling effect. If proper dental hygiene cannot be performed, for example in the elderly medically compromised patient, daily use of a fluoridated mouthrinse may help in controlling root caries lesion development. Chlorhexidine has no additional effect in combination with regular use of fluoride.

5 Active root caries lesions that cannot be cleaned properly by the patient should be restored by minimally invasive techniques using glass-ionomer cements.

Acknowledgements

The authors would like to thank Ninah Patterson for her valuable assistance and attention to detail in preparing the tables for this review.

References


Gingival recession and root caries
Clinical Relevance

Scientific rationale for the study: Gingival recession and root caries become prevalent as patients retain their teeth throughout their lives. A systematic approach was warranted to ascertain whether the management of recession and root caries in older patients necessitates a different approach to that undertaken for younger cohorts.

Principal findings: Connective tissue grafts achieve substantial root coverage of localized lesions in patients of all ages. Root caries may be controlled without operative interventions.

Practical implications: Surgical management for Miller I and II defects achieves predictable root coverage. Where root caries has already developed, the integrity of the root should be preserved by non-operative treatments using topical fluorides.