Review Article

The shortened dental arch concept: A treatment modality for the partially dentate patient

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Acceptable oral health, throughout life, is the retention of a functional, esthetic, natural dentition of not less than 20 teeth and not requiring recourse to prostheses. This implies that adult patients have adequate oral functionality when the posterior-most teeth are the second premolars. The concept of the shortened but functional dental arch addresses this issue, and the literature indicates that the Shortened Dental Arch (SDA) does not contradict current occlusal theories, while offering some important advantages. In particular, the SDA protocol decreases the emphasis on restorative treatments for the posterior regions of the mouth. It, thus, avoids the risk of over-treatment of the patient, while still providing a high standard of care and minimizing cost.

Key words: SDA concept, partial edentulism, Elderly patient, functional occlusion

DOI: 10.4103/0972-4052.49016

INTRODUCTION

With significant advances in material science and the refinement of clinical techniques, a major challenge in prosthodontics today is not only the creation of dental restorations, but also the successful integration of these artificial replacements into a dynamic oral system.

Demographic data indicate that the relative incidence of the edentulous state is declining. It is believed that the percentage of edentulous persons in the 75+ age group will decrease by about 50% over the 35-year period from 1990-2025. Nevertheless, the absolute number of edentulous and partially edentulous patients is on the rise due to a significant increase in this segment of the population.[1]

As we move into the new millennium, a new class of partially edentulous patients presents a unique challenge to the treating clinician. The partially dentate patient is less likely to consider a removable partial denture (RPD) as an ideal option for rehabilitation of their dentition. However, financial concerns and other limitations (medical reasons) may render these patients untreatable with current fixed and implant treated modalities.[2]

There is controversy regarding the relationship between professionally assessed need and subjective treatment need, especially regarding dental care for elderly patients.[3-5]

The traditional approach to restorative dentistry stresses the use of idealized morphological criteria and mechanically oriented concepts. To many practitioners, the preservation of complete dental arches remains the prime aim of restorative dentistry.[5] This morphologically based approach was ironically called the '28 tooth Syndrome' by Levin.[6] An example is the large number of distal extension RPDs made for patients who do not demand such treatment. Furthermore, too many artificial teeth are often placed on the distal extensions of an RPD, in an attempt to resemble the natural dentition.[3,7,8]

DISCUSSION

Retention of a healthy, natural, functioning dentition comprising not less than 20 teeth and not requiring a prosthesis has been described as a goal for oral health by the WHO in 1922. This indicates a shift away from the traditional treatment philosophy of restoring a complete dentition in all cases.[9,10]

At present, the principle aim of dental care may be considered to be the maintenance of a natural functional dentition throughout life, including all the social and biological functions such as self-esteem, esthetics, speech, mastication, taste and oral comfort.

The current criteria for a healthy or physiologic occlusion as developed by Mohl *et al*. and Ash and Ramfjord reflect this shift:[4]

(a) Absence of pathologic manifestations
(b) Satisfactory function
(c) Variability in form and function
(d) Adaptive capacity to changing situations

Drummond *et al.*, suggest that there is a need to modify current treatment techniques to meet the

dental needs of the future elderly, as they are less likely to seek dental treatment than younger people. Elderly people also have different functional needs, as compared to younger people, and may not need treatment directed at maintaining complete dentitions.[10]

There have been several attempts to develop a restorative treatment concept for older patients with limited financial capacity. One example is the 'problem-oriented approach' suggested by Kayser *et al.*, in 1988. It includes limited treatment goals based on individual oral requirements among patients. The 'problem-oriented approach' serves as a guiding principle behind the Shortened Dental Arch (SDA) concept, which was developed mainly for older individuals and for those considered to be at high risk for developing dental caries and periodontal disease. The concept was aimed at preserving the most strategic parts of the dental arches: the anterior and premolar regions[6] [Fig. 1].

Is replacement of missing teeth essential in all cases?

Initially, it was considered essential to replace all missing teeth, as failure to do so would result in occlusal instability and craniomandibular dysfunction. Other reasons for replacement of missing teeth included oral function and esthetics. However, these assumptions have been challenged by a number of studies.

Kreulen, Witter *et al.*[11] reported that SDA showed no signs of occlusal instability, as long as there were three to four occluding units, while the signs seemed to increase with an extremely shortened dental arch (ESDA), that is, only 0 to 2 pairs of occluding premolars. Although minor migrations of teeth occur after extractions leading to SDA, stable occlusions do occur after a period of time. Age was found to be consistently associated with increased changes in the occlusal integrity.

In a longitudinal study of occlusal stability in patients with SDA, Witter *et al.*[12] found minor changes with respect to interdental spacing, shortly after extractions, leading to SDA. This spacing is caused by a reduction of the anterior component of the occlusal force when the molars are absent, rather than by an overload in the anterior region [Figures 2 and 3]. However, existing periodontal involvement combined with increased occlusal loading, such as in a reduced dentition, seemed to be a potential risk factor for further loss of teeth.

Watanabe *et al.*[13] evaluated the occlusal and TMJ loads in patients with experimentally shortened dental arches. The results of their study revealed that the TMJ loads, during maximum voluntary clenching, were less in SDAs than in complete dentitions and, therefore, SDA never caused overloading in the TMJ. The increased ratio of TMJ load to muscular force was compensated for by the reduction of muscular force. They, thus, explained that the neuromuscular regulatory system is designed to control the clenching strength, so as not to exceed the critical limit of the load-bearing capacity of the periodontal tissues.

Witter *et al.*,[14] in a six-year follow-up study on craniomandibular dysfunction (CMD) and SDA, found that a reduction in the number of teeth (minimum of at least three to five occlusal units) is not a risk factor for CMD. In fact, free-end RPDs did not prevent signs and symptoms of CMD; neither did they

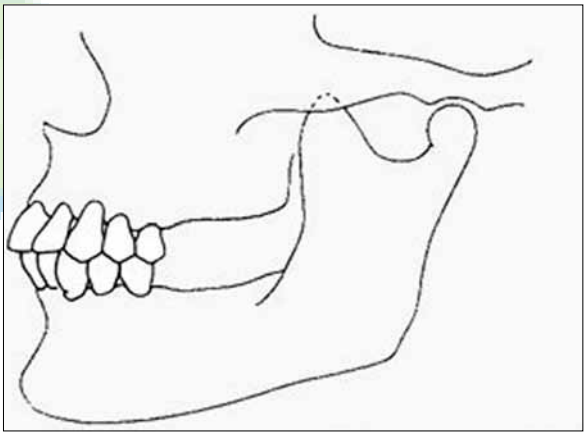

Figure 2: A dental arch shortened till the second premolars

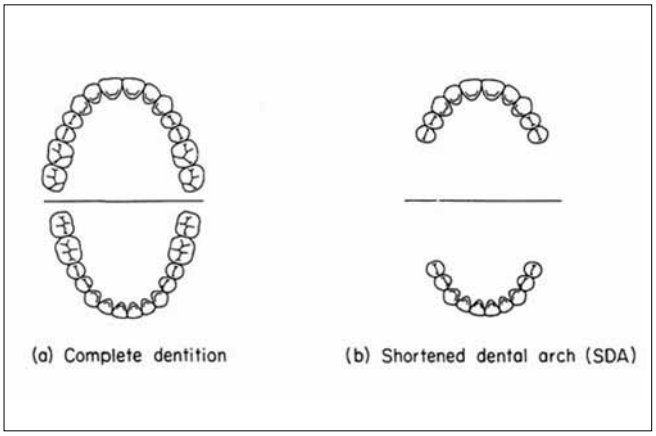

Figure 1: Schematic diagram of SDA

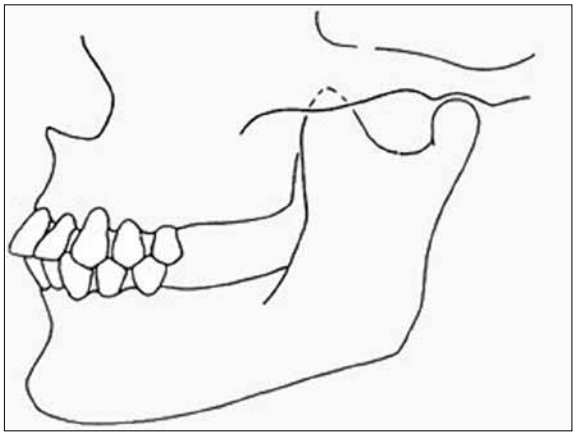

Figure 3: Migration in a shortened dental arch

improve oral function. Frequently, they were a cause of re-treatment. According to Kreulen *et al.*,[15] only the complete absence of posterior occlusal support, unilaterally or bilaterally, may increase the risk for developing signs and symptoms associated with TMD.

An early study by Kayser[16] involved a cross-sectional clinical investigation of 118 patients separated into six groups, according to the length and symmetry of the shortened dental arch. Two patterns of change in oral function were identified. In one group, masticatory efficiency changed slowly, until the dentition had been reduced to four occlusal units, and, thereafter, it decreased rapidly. In the second group, masticatory efficiency changed progressively at a uniform rate. The authors suggested that there was sufficient adaptive capacity for patients to maintain adequate oral function in shortened dental arches, provided at least four occlusal units remain, although these must be symmetrically placed.

Another study by Aukes *et al.*[17] compared patient perceptions related to masticatory efficiency in 43 subjects with SDAs, with the findings from 54 patients with complete dentitions. The results indicated that while masticatory function, food perception, food selection, and actual food consumption were affected for SDA patients, the perceived reduction was acceptable to the patients.

In another study,[18] the oral functionality for patients with shortened dental arches was compared with that for patients with dental arches lengthened by distal extension removable partial dentures. No significant differences were found in the oral functionality of subjects with SDAs and those who wore RPDs. Overall, the findings of the study suggested that oral functionality was not improved for SDA patients when provided with a distal extension RPD, and most complaints appeared to be related to esthetics due to missing posterior teeth.

In contrast to the afore-mentioned study, Allen *et al.*[19] investigated patient satisfaction following restoration of shortened mandibular dental arches with free end saddle RPDs and distal cantilever resin-bonded FPD. They noted significant improvements in perceived masticatory efficiency as well as oral comfort in both groups. However, patients preferred the fixed type of prostheses.

Tooth loss is often accepted and tolerated by many adults, even when access to dental care is not a problem. This was shown by Jepson *et al*,[7] who, in a survey of patient acceptance of partial dentures, found that 40% of 300 patients did not wear their partial dentures. In fact, they found that absence of an anterior tooth was a major influencing factor in patient acceptance of a partial denture. They concluded that patients were unlikely to wear a partial denture in the absence of self-perceived need.

Frank *et al.*[3] explored the various factors found to be associated with dissatisfaction with mandibular RPDs. Dissatisfaction was greater when there was no previous RPD experience or when there was an opposing maxillary RPD. People who were younger than 60 years expressed more dissatisfaction than those who were older than 60; and, subjects with lower levels of general health also reported less satisfaction.

Witter *et al.*[20] found that the response of the periodontal tissues to shortening of the dental arches is favorable, except in cases of uncontrolled periodontal disease. They also found that there may be some drifting of teeth in SDA, but this is generally acceptable to patients.

Based on a six-year follow-up studies of subjects with SDA, the following conclusions were drawn:[12,14]

- SDA can provide sufficient occlusal stability.
- SDA has sufficient mandibular stability to prevent signs and symptoms of mandibular dysfunction.
- SDA provides sufficient oral comfort in terms of chewing ability and dental appearance.
- Oral function was not improved in SDA by a free-end RPD.

The above research findings indicate that while replacement of missing teeth may be possible, it may neither be necessary nor desirable in all cases.

When a partially dentate patient presents for treatment, the possible options are:[9,10]

- Removable prosthesis
  - Tooth retained
  - Implant retained
- Fixed prosthesis
  - Tooth retained
  - Implant retained
- Restoration/ maintenance of a functional (rather than complete) dentition
- Controlled progression to complete dentures

The decision on which of these options to provide depends on:

- Patient motivation
- Periodontal status
- Willingness to undertake complex treatment over multiple visits
- Cost

For the partially dentate patient with several posterior teeth, the dentist may design a fixed or removable partial denture, incorporating one or more natural teeth. When the first or second molars are present, they are

usually incorporated into the prosthesis design; but it is unclear whether this is necessary to maintain oral function. In other words, should the occlusal table be extended to the first and second molar teeth? A longer occlusal table may be achieved with implant-supported restorations by posterior placement of the implant, but this is usually limited to the first molar position. With implant supported restorations, it is possible to achieve posterior occlusion by cantilever extensions, although this should be limited to 6 to 8 mm in the maxilla and 10 mm in the mandible. It is unclear from dental literature whether this extension is necessary or justified.

Problems encountered when missing teeth are replaced by removable prosthesis[9]

When many teeth are missing, the use of an RPD is a commonly used treatment option.

- In the absence of meticulous oral hygiene measures, RPDs, particularly free-end saddle dentures, may accelerate progression of caries (especially root caries) and destruction of periodontal tissues.
- The contribution of RPD to oral comfort and oral function in many partially dentate patients may be questioned.
- Strict adherence to the principles of denture design during construction is not always evident and this also is a component of the iatrogenic problems associated with partial dentures.
- Tooth loss is often accepted and tolerated by many adults.

Problems encountered when missing teeth are replaced by fixed prosthesis:[9]

- Problems have been reported with loss of vitality of abutments and mechanical failure of the bridge.
- Difficulties in restoration of longer edentulous spans (> 2 teeth) with a fixed prosthesis
- Failure to maintain a satisfactory level of oral hygiene is likely to lead to caries or periodontal disease of the abutment teeth.

Problems encountered when missing teeth are replaced by implant supported prosthesis:[9]

The option of restoring a fixed prosthesis or removable denture on endosseous implants is being more frequently used recently.

- Data on long-term survival rates of implant therapy in the posterior mandible or maxilla is limited.
- The procedure to place implants in the posterior maxilla or mandible can be complex, either due to lack of bone, or proximity of the inferior dental nerve to the proposed implant site.
- Implant procedures are expensive.

The Shortened Dental Arch concept (SDA)

The term 'shortened dental arch' was first described in 1981 by the Dutch prosthodontist Arnd Kayser and his co-workers at the dental school of the University of Nijmegan, the Netherlands. After clinical studies, Kayser concluded that there was sufficient adaptive capacity in subjects with SDA when at least four occlusal units are left (one unit corresponds to a pair of occluding premolars; a pair of occluding molars corresponds to two units).[2,21]

This concept suggests that the minimum number of occluding pairs of teeth required to provide satisfactory levels of oral function may vary according to age and other factors:[9]

Age	Functional level	Occluding pairs
20 - 50	I optimal	12
40 - 80	II sub-optimal	10 (SDA)
70 - 100	III minimal	8 (ESDA)

Kayser and Witter suggested that the anterior and premolar teeth are the strategic part of the dental arch and are essential for satisfactory oral function and oral comfort.

Kayser estimated the minimum number of teeth needed to satisfy functional demands of modern man:

biting→ 12 anteriors + 4 premolars
mastication→ 8 premolars + 4 molars
speech→ 12 anteriors
esthetics→ 12 anteriors + 4 premolars in the maxilla
mandibular stability→ 12 anteriors + 8 premolars + (4 molars in some cases)

Thus, in the SDA concept, the treatment is directed at preserving the anterior and premolar teeth. Complex restorations of the molar teeth should only be undertaken in the absence of limiting factors. Such limiting factors are considered to include a history of poor dental health, particularly in the molars, and financial restrictions. Witter suggests limiting the treatment goals to provide SDA when these limiting factors are present, as this would provide a suboptimal, but acceptable oral function. [21]

Probable advantages of SDA are:[10,22]

- Simplification of extensive restorative management
- Easier maintenance (subsequent to the SDA) for both the patient and the dentist
- Simplification of oral hygiene maintenance
- Good prognosis for the remaining teeth, if the patient learns to maintain his/her own dentition

Although SDA has been suggested as being preferable to maintaining a complete dentition, it may not be advisable or feasible in all situations.

According to Kayser, SDA may be appropriate for patients meeting the following criteria: [9]

- Progressive caries and periodontal disease confined mainly to the molars
- Good long term prognosis for the anterior teeth

and premolars
- Financial and other limitations to dental care

Contra-indications to SDA would include:[9,10,21]
- Severe maxillomandibular discrepancy (e.g. Severe angle class II and class III relationship)
- Anterior open bite
- Parafunctional habits
- Pre-existing craniomandibular dysfunction
- Marked pathological tooth wear
- Marked reduction in alveolar bone support (eg.e.g. advanced periodontal disease)
- Patient below 50 years of age

The prognosis of the SDA depends on:[2,22]
- Maintenance of good oral health
- The maxillomandibular jaw relationship
- The age of the patient
- The periodontal status of the anterior and premolar teeth
- The adaptive potential of the TMJ
- Occlusal stability

Several investigations have been performed to assess the attitudes of dentists regarding management of patients with a shortened dental arch. Allen *et al.*,[4] found that most of the dentists in Netherlands viewed the SDA concept as having a useful place in clinical practice. Although the SDA concept was used only occasionally in <10% of the patients, the outcome of SDA management was generally satisfactory or at least sufficient in the care of special category of patients. A similar opinion was expressed by Korduner *et al*.[1]

Dental literature indicates that dental arches comprising the anterior and premolar regions meet the requirements of a functional dentition. However, functional demands, and the number of teeth to satisfy such demands, vary with the individual, and, consequently, dental treatment must be tailored to each individual's needs and adaptive capability. The SDA concept does not contradict current occlusion theories and appears to fit well with the problem-solving approach favored in modern dentistry. Advocating the SDA offers some important advantages, one of which may be a decreased emphasis on restorative treatments for the posterior regions of the mouth.

CONCLUSION

Despite limitations in the existing knowledge and the need for further research, it has been suggested that SDA will be of increasing significance as a treatment strategy in the management of reduced dentitions in the middle-ages and elderly patients. By offering the partially dentate patient a treatment option that ensures oral functionality, improved oral hygiene, comfort and possibly reduced costs, the SDA treatment approach appears to provide an advantage without compromising treatment care.

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Source of Support: Nil, **Conflict of Interest:** None declared.