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The possibility of application of endocrowns in prosthetic treatment

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Keywords

endocrown, endodontically-treated teeth, adhesive restoration

Summary

After root canal treatment, teeth are weakened and more prone to failure. Prosthetic reconstruction of these teeth should strengthen the remaining structure and ensure the long-term effect of the treatment. An endocrown is a monolithic restoration, which use adhesion and mechanical retention. Most often, it is used during the reconstruction of the non-vital molars. It is debatable whether the premolars due to its structure should be rebuilt without the use of post. An endocrown is also used in reconstruction of teeth with low crowns and with short, obliterated root canals. The main advantages of it are a simple procedure, shorter treatment protocol compared to the classic reconstruction, lower costs, satisfactory aesthetics, reduction of stress, minimal invasive preparation or a smaller number of complications. Most frequently mentioned drawbacks are the possibility of fracture of the tooth and debonding of reconstruction. Most commonly used materials in performing endocrowns are composite and glass ceramics. According to the advantages and clinical trials, endocrowns seem to be a good alternative to the classic restorations after endodontic treatment using posts and crowns.

Teeth deprived of vital pulp and the possibility of restoration are a source of various research and a subject of numerous articles. In their practice, clinicians have often confirmed that a tooth after root canal treatment is less durable and more prone to fracture than a non-treated tooth. Thus, an optimal solution which protects other tissues from possible complications is looked for. Reasons for the deterioration of mechanical properties of tooth after canal treatment are connected inter alia with weakening of other structures as a result of loss of tooth hard tissues (1). Loss of two marginal ridges during cavity preparation leads to the reduction of tooth durability by 63% yet performance of only an endodontic access in a healthy and non-treated tooth results in its weakening by only 5% (2). Protection and maintenance of hard tissues at least 1 cm above the neck of a tooth – a so called ferrule effect which boosts tooth's resistance to fracture – is also crucial (3). Furthermore, physical changes in dentine connected with its dehydration contribute to tooth fracture – dehydrated dentine becomes fragile due to a loss of 14% of its original durability and prioreception, which results in the lack of control over generated strengths (1, 2). Therefore, a proper restoration of a tooth after canal treatment conditions a further therapeutical effect. When choosing a type of tooth restoration, it is important to consider the following factors: an amount of the remaining tooth structures, location of a tooth in a dental arch, generated occlusive forces and an aesthetic aspect (4, 5). Until recently, a method of choice was restoration with posts and crowns (6). It was only when adhesive techniques were introduced that a bonding strength (microretention) could be applied without a necessity to provide mechanical retention for further restoration (macroretention) (7, 8). It is in accordance with a modern concept of a minimally invasive technique which is targeted at the lowest interference with a tooth structure and maintenance of a maximal amount

of other tissues (9). Neumann created a classification of dental cavities treated endodontically and a therapeutical concept (10). Having taken this scheme into account, a clinical situation in which performance of an endocrown or a post should be considered are cavities in which one tooth wall or none of them are preserved. An endocrown is a monolithic and adhesively bonded restoration (11). It is owing to the possibility of microretention that an endocrown became an alternative in prosthetic treatment of teeth after canal treatment. It allows for tooth reconstruction without application of a post (12).

Preparation technique

First of all, height of an occlusive surface of a minimum 2 mm must be reduced in order to obtain an optimal amount of space for an endocrown. Tooth walls thinner than 2 mm should be reduced. A preparation ridge ought to be located supragingivally. In some clinical situations, it is possible to place a preparation ridge subgingially, however, inclination between supragingival and subgingival preparation may not exceed 60°. A tooth chamber should be prepared in such a manner that eliminated all arches and a depth of the chamber ought to be at least 3 mm. Additional retention may be provided by removal of gutta-percha from a canal at the depth of maximum 2 mm. Such prepared tooth ought to be polished with a fine-grain bur (11). Despite guidelines on tooth preparation, literature provides cases when teeth, which did not follow these criteria, were successfully reconstructed with endocrowns. In their article, Biacchi et al. present the first case of a first mandibular molar with a significant loss of tooth structures, a fractured buccal wall, wide yet not sufficiently deep chamber and a preserved lingual wall. Although a preparation ridge did not cover enamel in its whole range, the tooth was reconstructed with an endocrown made of ceramics strengthened with leucite. After 3 years, the case was still airtight and periodontium – healthy (7). Whilst planning medical treatment, it is important to consider the guidelines. Yet, as shown above, in some cases not all criteria must be met in order to disqualify a tooth. Clinician's experience is crucial in the selection of a procedure.

Recommendations

Endocrowns have been the most widely used in non-vital molars. According to numerous authors, among all groups of teeth, it is molars that provide the best conditions for the sustenance of such a restoration (11-14). Anatomy of these teeth also allows for mechanical retention by anchoring in a pulp chamber owing to its size and root canals orifices (13). Moreover, due to molars width, strength arms applied onto cusps are higher than in narrower pre-molars. As a result, prying forces are lighter in case of morals (14).

Lin et al. assessed the risk of failure in reconstruction of pre-molars after canal treatment with endocrowns and crowns. According to the results, a risk of failure is similar in both cases. Thus, it may be assumed that in proper occlusion conditions, an endocrown may be applied in the restoration of pre-molars (8). However, these teeth have got a smaller area of adhesive bonding and a higher crown, which is unfavourable for their mechanical properties (12, 13). Furthermore, an operating force is larger, as it was already mentioned. Pre-molars may also be influenced by additional strengths in case of group function, which must be taken into consideration when planning treatment (5). According to most of the authors, pre-molars should be provided with restoration in order to minimise the risk of possible complications (5, 13). However, no clear agreement has been reached in this subject. An endocrown is also an alternative – and even a method of choice – in reconstruction of teeth with low crowns (where there is no place for classic reconstruction with a post and a crown) and for teeth with short roots and obliterated canals, where no restoration can be done (7).

Contraindications

Presented guidelines for preparation and mechanisms of retention – no possibility to apply an adhesive bonding, depth of chamber smaller than 3 mm, walls of teeth of less than 2 mm perimeter – are contraindications to the application of an endocrown. Additionally, if factors that depict occlusal overload or parafunctions are found during examination, it is necessary to restore a tooth with a post supplement (15).

Advantages

There are numerous advantages of endocrowns. A short treatment protocol and a short time of preparation and application, when compared to classic reconstruction, lower costs and satisfactory aesthetics account for only a small part of all the benefits (16). In the research on the place of a stress origin, it was estimated that stresses originate from the places where two materials with different elasticity modules meet. Various levels of materials stiffness trigger the stresses and increase the risk of root fracture (9). In the case of tooth reconstruction with a post and a crown, a number of various surfaces which meet is larger. Therefore, stronger stresses are triggered. An endocrown is a homogenous structure often referred to as a monoblock, which results in the origination of lower stresses. In the same research, a fatigue test was conducted, in which an endocrown obtained better results than classic crowns. The value of the force at which the restoration was destroyed, achieved higher values compared to classical crowns. This phenomenon may be explained with thicker ceramics and the reduction of materials which are restoration elements (8). In the presentation of endocrowns, it is important to mention also about simple guidelines for their preparation and benefits of minimal invasive preparations. A risk of root fracture, which accompanies posts preparation, is eliminated. No arching

of intrachamber root walls takes place and thus, there are no stresses near a tooth neck which might result in a tooth break or fracture (17). What is also an important advantage, is the strengthening of a tooth structure previously weakened with endodontic treatment (14, 18). In the case of complications after endodontic treatment, when an endocrown is applied, it is still possible to reintroduce root canal treatment. Revision of the treatment – preceded by the removal of post from a root – is at a much higher risk of failure and sometimes even impossible.

Disadvantages

Among most often described failures, is debonding of an endocrown. Such complication is explained with the fact that *in vivo* occlusal conditions differ when compared to the conditions possible to be generated during research. Forces act in various directions in relation to a tooth long axis and thus increase the risk of debonding of the restoration. Hassan et al. conducted research in which they compared an impact of an endocrown structure and the place of a force acing on debonding of the restoration. Molars and two endocrown constructions were analysed in the research. The first one was a monoblock adhesively bonded with a given tooth, the latter was composed of two parts – a root part and a crown – also bonded adhesively. These restorations were treated with a force of 1400 N at the heights of 5 and 8 mm from the connection between a tooth and an endocrown, respectively. According to the results, debonding of an endocrown was not influenced by a restoration construction, but by the place where the force was put. More favourable distribution of the load was observed only in locations of force acting which were located closer to a tooth-restoration ridge. From a clinical point of view, it is crucial to pay attention to endocrowns height and occlusal contacts (9). Furthermore, adhesive bond force deterioration may be conditioned by the presence of sclerotic dentin in a tooth chamber (8). The best adhesive bonding is created with enamel (19). It is obvious that the more enamel there is, the stronger the bonding becomes.

Debonding of the restoration may be accompanied by tooth fracture. According to Biacchi and Basting, it occurs in 90% of cases. In none of the examined teeth, retention loss was observed without damage to the tooth structure. In the other 10% of cases, the authors found only tooth fracture, which is another possible complication (12). Hamdy conducted research on the resistance of endodontically treated teeth reconstructed with various methods. A control was healthy teeth without treatment. Other groups were teeth restored with an endocrown and teeth reconstructed with fiber posts and with a crown/an inlay/an onlay. Among these groups, healthy teeth, teeth restored with endocrowns and the ones restored with a post and an crown had the highest (and similar) resistance to fracture. The author claims that an endocrown is the most beneficial treatment method for damaged molars (20).

Materials

In production of endocrowns, composite materials, composite reinforced ceramics – ceromer materials and ceramics are used (21). Nowadays, there is no clear opinion on which of these materials is the best and advisable in the preparation of endocrowns. When planning further restoration, one should consider benefits and limitations connected with the application of a given material.

Both composite and porcelain materials have good marginal sealing, possibility to reconstruct functions and contact points, high resistance to abrasion and satisfactory aesthetics (22). Furthermore, due to the application of pressure and temperature (apart from light) in a polymerization process, laboratory composite allows to obtain a material of higher mechanical durability and resistance to wear than a composite material hardened with light only (23). Transfer of a polymerization process to a laboratory allows for the reduction of polymerization shrinkage responsible for marginal leakage and deterioration of the material parameters (24). Advantages of composite materials are easiness of reparation of a damaged restoration and the ability to absorb stresses (25). Furthermore, the costs of preparation are much lower when compared to ceramic endocrowns.

In the research on an impact of wet environment on hardness and durability to compression, it was found that storing samples in distilled water of 37 ± 1°C temperature for 180 days does not influence their durability to compression yet it lowers hardness of all composite materials. None of the ceramics properties deteriorated during the research (26). Among all ceramic materials, glass ceramics are used in the manufacturing of endocrowns due to the possibility of its etching and thus – obtaining an adhesive bond (7, 22). It should be ceramics reinforced with leucite or lithium disilicate as lithium disilicate ceramics is considered the best material for endocrowns (7, 12, 22). Chen et al. assessed the distribution of stresses under load. They found that materials with a higher elasticity module carry less stress to the tooth structure. They dubbed ceramic materials "teeth-friendly" and providing teeth with more protection (21). In her comparative research on ceramic and composite crowns, Dejak found that the values of stresses reduced of a modified von Misea criterion were two to three times lower around ceramic inlays than around composite ones (27). Disadvantages of ceramic restorations are higher enamel abrasiveness on opposing teeth, low resistance to flexion, difficulties in reparation, a complicated implementation procedure and a higher price (28).

What is more, in manufacturing of endocrowns, CAD/CAM technology may be used, i.e. computer assisted restoration designing and preparation. Advantages of computer techniques are higher resistance to fracture, structural homogeneity and a possibility to complete treatment during one visit (22). Vaselinović et al. presented

a case in which two endocrowns were prepared with various techniques: CEREC system (with application of CAD/CAM technology) and Empress II (a press technique with application of lithium disilicate ceramics). According to authors, the main advantage of press technique is the possibility to prepare an endocrown with a longer root part (CEREC system uses an optical impression which limits the depth of imagined structures). Restorations are made manually, which makes endocrowns quality rely on the technician's skills and is a limitation. CEREC system allows for the application of various materials – ceramics or composite – and the procedure is only limited to one visit, as mentioned above. Aesthetics and the risk of debonding are considered equal (29). Other research focused on marginal tightness and inner fitting of pressed ceramics and CAD/CAM ceramics after mechanical and thermal load. In case of both techniques, similar and clinically accepted marginal adherence of restorations was observed, however, inner fitting of a restoration was better in case of pressed ceramics (30).

Ceromer (i.e. composite reinforced ceramics) is the most popular material which combines characteristics of both materials. It is more resistant to stretching and compression, and has a lower elasticity module when compared to ceramics and composite (21). According to the research by El-Damanhoury et al., ceromer was much more resistant to fracture and had a more beneficial fracture pattern, however, also a microleakage and colour penetration were observed (31).

Conclusions

Due to the weakening of their structure, endodontically treated teeth need a systematic and durable reconstruction which preserves the maximal amount of tissues and minimises the risk of possible complications. One should take into consideration that a post does not strengthen a tooth structure, yet it is a retention element for an crown. Thus, it may be claimed that in specific clinical cases, an endocrown may even be a method of choice in the restoration of endodontically treated teeth.

Conflict of interest

None

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