Intrusion of natural teeth when connecting teeth to implants

Patrik Zachrisson and ***Eddie Scher*** assess the impact of connecting implants to the neighbouring dentition in 'mixed bite' cases

When restoring a dentition, we are sometimes faced with a 'mixed bite', containing natural teeth that are to be kept and spaces that are to be restored with implant supported prosthesis.

The restoration of multiple teeth and implants has been debated for some time, and was discussed as part of long-span bridge treatments (Scher 1991) as early as the late 1980s.

The use of a rigid or non-rigid connection between a natural tooth and a dental implant has been shown to occasionally result in complications. One such reported side effect is the intrusion of the natural tooth.

While a retrospective case study of tooth- and implant-supported bridgework suggests that this is not commonplace, it is nevertheless a factor to be aware of.

This article aims to consider some of the various approaches to reducing intrusion tested by a number of authors.

Their results suggest that it is advisable in some situations to connect implants to natural teeth, but that this should be done with caution. The use of a permanently cemented, gold coping on the tooth and an open-ended slide PA connection will also be discussed.

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Aims and objectives

This article aims to discuss the risk factors of causing the intrusion of natural teeth when using patients' existing dentition as an additional support for bridgework in implant restorations.

Expected outcomes

Successfully answering the questions on page xx, worth one hour of verifiable CPD, will demonstrate that the reader understands the risks of intrusion and how to prepare for this rare but often-overlooked complication.

Background

In partially edentulous patients we are at times challenged with the dilemma of connecting natural teeth, with a periodontal ligament allowing some movement, to the rigid support of a bone-supported implant.

There have been reservations about the long-term success of connecting natural teeth to implants, mainly due to the difference in mobility. The term TISP (tooth implant-supported prosthesis) is sometimes used when referring to a restoration of this type.

The periodontal ligament (PDL) around a natural tooth allows 50-200µm of mobility.

An implant has been shown to allow less than 10µm of mobility (Cohen and Orenstein, 1994).

It has been suggested that the success of an implant is dependent on the lack of mobility (Brånemark et al 1985).

The inclusion of natural teeth in a restoration can be a benefit due to the improved proprioception.

In some situations it may also be beneficial to maintain natural teeth in order to preserve the soft tissue profile and appearance, as well as phonetics.

Natural teeth may also need to be used because of lack of bone or the anatomical features present, a need to reduce cost or avoid potential augmentation procedures, or to provide more support for the restoration.

Experience suggests that when faced with restoring multiple implants and natural teeth a number of factors affect the long-term success rate.

Parafunction is a major factor, as is also the degree of mobility on individual teeth.

The subsequent overloading of natural teeth and implants in a situation where parafunction is present has been thought to affect both the support of the implant as well as the mechanical structure of the TISP.

The number of teeth and implants to be restored is likely to affect the outcome as the load can be spread over a greater number of supports.

The use of a TISP cemented with temporary cement and supported by a natural tooth with a coping as one abutment and an implant as the other has been shown to allow apical intrusion of the natural tooth if the cement dissolves (Garcia and Oesterle 1998; Schlumberger et al 1998; Pesun 1997; Chee and Cho1997; Cho and Chee 1992).

The apical movement of a tooth is known as intrusion, and has been defined by Nikolai (1985) as 'a translational form of the tooth movement directed apically and parallel to the long axis', whereas Burstone (1977) defined it as 'apical movement of the geometric center of the root in respect to the occlusal plane or a plane based on the long axis of the tooth'.

Reasons for intrusion

It has been suggested that a number of factors may individually or in combination cause intrusion of natural teeth more frequently. Several theories have been suggested to explain the intrusion effect seen when combining implants and natural teeth (Pesun 1997).

Disuse atrophy

Several authors (Pesun et al 1999; Cohn 1965; Cohn 1966) suggest that when an implant (rigid in bone) is splinted to a natural tooth (with a periodontal membrane allowing some movement). This connection may lead to disuse atrophy of the PDL.

However as a tooth in hypofunction often tends to erupt spontaneously until in contact, this would suggest that it should maintain its position, rather than intrude (Rieder and Parel).

An interesting parallel is the intrusion that can be observed in orthodontic treatments using the Invisalign system where teeth are in effect splinted together in a plastic aligner. If there is a lack of space, teeth under load often intrude orthodontically. (REF Invisalign study)

The orthodontic movement of teeth is well documented in literature (Edwards 1979).

An interesting parallel is the intrusion that can be observed in orthodontic treatments using the Invisalign system

Differential energy dissipation

The differential energy dissipation theory suggests that when a partial denture restoration is loaded the energy from the stress is dissipated through the abutments to the implants.

As the implants are rigid the natural tooth would end up with an increased level of energy which could potentially stimulate osteoclastic activity in the periodontal ligaments (Sheets 1993; 1997).

Mandibular flexure

A slight flex can be observed in the mandible under load and movement, as a result of the forces applied by jaw muscles (McDowell and Regli, 1961).

Likewise, a flex can be observed in the restoration, as a result of forces applied when loading the construction (Burch 1972; Mahan and Alling 1991).

Intrusion has been observed, not only in the mandible but also in the maxillae (Chee and Cho 1997).

This would suggest that the flex of the mandible during mastication and load is of less importance.

Impaired rebound memory

The impaired rebound memory theory suggests that the PDL can become compressed under load and lose its elastic memory due to a constant load (Chiba and Komatsa 1993).

This in turn would induce remodeling of the PDL at a lower level until no compressive forces push the tooth further apically. This is similar to the movements that take place during orthodontic treatments.

Ratchet effect

The ratchet effect theory is in some ways similar to the the impaired memory theory.

A heavy occlusal load resulting in vertical force may intrude a tooth orthodontically.

However, a precision attachment placed on a restoration may prevent the rebound and thus create an orthodontic force.

This may in turn cause the PDL to begin remodeling (Edwards 1979; Chiba and Komatsa 1993).

Debris impaction

If debris is impacted under a restoration, as occurs when chewing food, this may lead to a compression of the PDL, which in turn can induce remodeling of the bone.

If this is ongoing for long enough this may have an orthodontic effect (Edwards 1979).

Some studies (Rangert et al 1991; Cavicchia and Bravie 1994; Van Steenburghe 1989; Cohn 1965; Vohn 1966; Sheets and Earthman 1993) report no complications in the use of a tooth-implant support for a restoration.

Indeed anecdotally, one of the authors of this article (E Scher) found a large number of successful restorations that never caused any concern.

Discussion

Overloading of an implant when connecting teeth to implants may cause an implant or its restoration to fail. It has also been observed that intrusion of the natural tooth may take place.

There are concerns regarding the intrusion of natural teeth when connected to dental implants. The main issues are overloading, cementation failures, and the stress put on the implant components and restoration.

Multiple factors affect the success of an implant. The main concern is ensuring the implant has maximum surface area in contact with (ideally) dense bone (Misch 2004; Brånemark and Ismail 1993). Greenstein et al (2009) showed the angulations of abutments should be no more than 15-25 degrees.

Authors agree that a well-aligned implant in a balanced occlusion with good bony support has a good long-term prognosis.

The use of copings, ideally with grooves to increase the surface area, may be beneficial, as long as the cementation bond does not break down. The suggestion is that the coping should be cemented with definitive cement, and the copings will protect the tooth prep from decay.

It is essential that the prosthodontist's attention is brought to the fact that intrusion can occur when restoring implants and teeth with a fixed tooth-implant supported prosthesis. An intrusion rate ranging between 3% and 5.2% has been noted.

However, it has been reported by Rieder and Parel (1993) that patients with parafunctional habits seem to strongly affect the resulting intrusion, with a nearly 50% ratio of intrusion.

Intrusion has been observed in both rigid and non-rigid situations, with authors reporting that intrusion is more prevalent in patients with non-rigid restorations, due to the natural tooth acting as a female part of a stress breaker.

The assumption that the use of a rigid connection would cause additional strain and load on an implant when the tooth moved under functional stress lead to the use of a non-rigid connection or telescopic crowns (Sullivan 1986; Ericsson et al 1986; Kirsch and Mentag 1986; Kay 1993).

This however has allowed for intrusion in some cases.

A comparison by Nickenig et al (2006) compared the use of non-rigid and rigid connections and found that after five years, 8% of the abutment teeth required some sort of therapeutic measure (restorations, periodontal therapy and so on).

However, they found an increased incidence of problems of a technical nature in the non-rigid group. The rigid restorations showed only a limited number of technical problems and the study concluded that a high success rate was prevalent with rigid connections.

Review

The authors reviewed published data where important articles were analysed. The search terms were: connecting teeth to implants, tooth implant connections, intrusion.

A number of patients treated by a single experienced implant surgeon and restorative dentist were also reviewed, where an attempt was made to analyse the presence of intrusion. The outcomes were listed and in the case of intrusion the type of connection was recorded.

A large number of implants were seen to be successfully restored both individually, in implant-to-implant situations and in implant-to-tooth situations over a number of years (all cases were over 10 years old).

The use of implants in a restoration together with natural teeth has for this practitioner proved successful but a small number of cases demonstrated clinical intrusion over time.

The relationship between the bridgework and the tooth coping was observed at the treatment planning stage, the fit stage and at

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While we don't believe in 'defensive dentistry', we feel all practices should be mindful of hitting, and recording, the standards of care required by the GDC while still doing the very best for their patients. This article aims to help you do that by raising awareness of a possible complication that clinicians may encounter in implant dentistry.

various follow-up appointments. The presence of intrusion was noted on X-rays and where possible measured in a comparison of the distance (on X-ray) of the margin of restoration to the margin of the gold coping.

Results and discussion

An abundance of data indicated that intrusion of natural teeth can occur in situations where natural teeth and implants are connected but through careful planning the risks can be minimised and a successful outcome achieved.

It is suggested that in some situations, when we connect teeth and implants, the benefits outweigh the risks and it is worth considering keeping a natural tooth.

The use of a screw-retained restoration can be beneficial due to the ease of retrievability. The use of cement carries a risk of cement failure, but this technique is widely seen as good practice. Intrusion can be observed in some cases where cement has been used.

Dr John Ismail, speaking at a British Oral Implant Society conference in 1989, advised the use of a permanent cement, although this is not retrievable. In the authors' hands, a firmer cement such as Improv implant cement allows a degree of retrievability while still allowing greater adhesion.

A number of approaches can be envisaged in order to improve the success rate of a TISP situation.

The use of stronger or permanent cement is likely to improve the outcome and reduce the risk of cementation failure between restoration and coping.

The introduction of grooves to increase the surface area should be considered. This, however, may make the provision of the labwork more difficult to produce in a predicable way, and should be considered with caution, but may be advisable as a softer cement such as Temp Bond NE may still be considered.

Finally, the use of an open-ended slide is an option to get a more functional use and flexible support: this has however, been debated and a mix of results achieved.

It has been reported by several authors that the use of stress-breaking connectors are associated with more intrusion than rigid connections (Lang et al 2004; Naert et al 2001; Linde et al 2001; Greenstein et al 2009).

On the other hand, some authors (Sullivan 1986; Reider 1990) suggest that as a way of reducing or avoiding overloading the use of various types of connections should be considered.

Authors (Naert et al 2001; Block 2002; Bragger et al 2005) report a mix of success both using rigid and non-rigid connections, with some reporting more intrusion in cases with non-rigid connections. Biomechanically, the stress on a superstructure varies depending on the type of connector used.

Rigid connections cause extensive load on the implant and internal screw. There is a risk of fracture of the prosthesis, abutment screw or the actual implant, or loss of bone or even the actual implant itself. Overloading a natural tooth may lead to a widening of the periodontal ligament, increased tooth mobility, bone loss and pain or discomfort.

Non-rigid connections potentially cause intrusion. A non-rigid connection may result in benefits from preserving teeth, preventing rotation of implant-supported restoration and to get support from natural teeth that may be present. It has been suggested that the non-rigid connection may increase the load on the implant but help to reduce the load in the TISP.

A rigid connection may cause failure of the implant or screw loosening due to uneven forces applied. Stable support for the natural tooth is important. Some authors believe that there is sufficient flexibility in the implant systems to allow a rigid connection.

Ericsson et al (1986), Rangert et al (1995), Lundgren and Laurell (1994), Rangert et al (1991) all considered these factors.

When connecting teeth permanently to implants the use of a gold coping allows control of the alignment of natural teeth and also a degree of retrievability.

The use of a softer semi-permanent or temporary cement allows retrievability but there is a risk in that if it dissolves there is a higher likelihood of intrusion.

The use of a rigid connection and permanent cement may provide a lower risk of intrusion but a higher risk of secondary caries and less retrievablity.

A lack of long-term data and limited number of cases suggest that there is no clear picture, but the presence of intrusion in some TISP situations should be a complication to consider.

The general consensus seems to be that when connecting teeth to implants the use of gold

copings, use of a rigid connector and permanent or semi-permanent cements are beneficial.

The problem of differing support between the implant and the natural tooth has been discussed for many years (Reider 1990).

There is only limited long term data available for the use of tooth and implants together as abutment support.

In practice, a long-term retrospective follow-up from clinical cases (Scher, 1991) suggests that intrusion of natural teeth does occur, ranging from a mild but significant to a considerable intrusion in one case.

Tooth-implant connections have a higher rate of complications than restorations based on conventional bridgework or fully implant-supported bridgework.

There have been suggestions that root-treated teeth are more prone to intrude, possibly because of the lack of proprioception when compared to natural, non-root-treated teeth.

This was observed in the cases of Dr Scher that were studied anecdotally, but may be due to the fact that extensive root treatments are more common in patients with an already heavily restored dentition.

This may affect the load the tooth is subjected to as the patient may lack some of the proprioception compared to a healthy tooth.

Personal experiences

Dr Eddie Scher has been restoring and placing implants in complex cases since the mid 1980s.

A retrospective study of his cases suggest that although most have no or very limited complications, some show a degree of intrusion in TISP situations.

In some instances, the effect was enough to justify corrective procedures such as redesigning the bridgework or replacing the superstructure.

The use of lab-made gold copings cemented with a permanent cement such as zinc-phosphate cement or glass ionomer cement to the natural tooth was observed in all cases with intrusion, in combination with a superstructure cemented with Tempbond with a modifier, IRM or in later cases Improv cement.

It was noted that a dominating number of TISP restorations with intrusion were supported by root treated teeth, and a majority of the failed connections were in teeth with a root treatment present.

Precision attachments with an open-ended slide

Some complications in the form of intrusion were noticed, to a varying degree. Some cases had some remedial work carried out. No fractures of superstructure were noted, nor loss of implants or decay in the natural teeth.

One method of avoiding the pitfalls of a tooth-implant supported prosthesis is to use a shorter bridge span to reduce the load. Occlusal equilibration prior to placement and careful management of the occlusion in the provisional and final prostheses is also likely to be beneficial.

The use of a Michigan splint (nocturnal hard splint) to allow a stable bite and protect the implant and superstructure as well as maintaining a healthy TMJ is recommended. The use of gold copings allows correction of the angulation of the prosthesis as well as preventing decay in the natural tooth.

The use of placing sleeper implants to allow for a future design can also be useful in case the design needs to be altered at a later date, or should a tooth or implant fail.

The use of precision attachments and open ended-slides have had a mixed reception, as several published studies indicate, and no obvious outcome was observed from the cases studied.

It has been discussed that root-treated teeth fail more often. A number of Dr Scher's intrusion cases include root-treated teeth. There is a possibility that the lack of proprioception in a root-filled tooth may lead to higher load and more intrusion, but this may just be down to the fact that patients with heavily restored dentitions have more root-filled teeth.

No difference was noted between male/female cases (8/7), nor was there any obvious medical history background. Although Dr Scher believed that teeth were potentially less likely to intrude in bisphosphonate treated patients, there were not enough cases to be able to assess this.

All cases were treated with gold copings and cemented bridgework.

This subject needs a bigger study but our best results occurred when we use gold copings, with a rough surface or an increased surface area with parallel grooves and more permanent but still retrievable cement.

Conclusion

Having reviewed cases where intrusion is present, it can be suggested that it is a complication that may occur in a TISP situation, albeit relatively rare.

The data suggests that the majority of intrusion-related complications are noted on teeth with a root filling present. The intrusion occurred several years after placement, and may be caused by a multitude of factors.

The use of a gold coping in order to prevent decay on the natural tooth in case of cementation failure is strongly advised. The authors suggest the use of a stronger and more permanent cement, such as Improv, in order to reduce the risk of intrusion from cementation failure.

The use of a rough surface on the coping or the inclusion of parallel grooves may also be considered in order to maintain better cementation. The use of an open-ended slide can also be considered as a way to allow a non-rigid connection and act as a stress breaker, but the best results seem to be reported from the use of rigid connections.

The most predictable results seem to occur when a restoration is supported wholly by implants, but in some cases the inclusion of natural teeth may be beneficial and should be considered.

The use of a short span bridge is recommended; if more than one pontic is to be used then additional support from tooth or further implants is advisable.

A well-balanced occlusion is of importance to ensure an evenly distributed

occlusal load. Reider and Parel (1993) reported that 50% of intrusions occurred in patients with parafunctional habits such as bruxism. They also noted intrusion was more common in situations where the TISP had non-rigid semi-precision attachments.

One must give careful consideration to the use of a TISP in a patient that exhibits parafunction.

Data and experience suggest that implants can be connected to natural teeth, provided that care has been taken to consider the risk of implant overload and the intrusion of natural teeth. Proper treatment planning and informed consent is essential. **IDT**

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