Inlay-retained fixed dental prosthesis: a clinical option using monolithic zirconia

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I ntroduction

For the single tooth replacement in the posterior sextant, there are different fixed options available with a variety of dental materials. Implant-supported single crowns can be used, saving the natural tooth structure of the adjacent teeth. However, implant therapy may not be possible for cases where other variables are not conducive. These variables can be medical factors, scarce bone or anatomical constrains, the economic situation, a negative attitude of the patient toward surgical treatment.1 In these cases, an inlay-retained fixed dental prosthesis (IRFDP) is an appealing minimally invasive treatment modality, especially if there is a presence of restorative fillings adjacent to the missing tooth. IRFDP should be opted for instead of a full coverage dental prosthetic restoration.

Notwithstanding the fact that a full coverage fixed dental prosthetic (FDP) restoration is the gold standard for such tooth replacement. They have several disadvantages, to name some, risk of secondary caries, soft-tissue pigmentation, and an opaque-to- darkish appearance in the cervical area of the abutment teeth with metal coverage.2 Additionally, FDPs are known for their invasive nature, since they require anywhere from 67.5 per cent to 75.6 per cent of coronal tooth surface removal depending on the choice of material (ceramic, gold or metal).3

Dental restorations are placed under immense pressures in the clinical functions of biting and chewing. These mastication forces in the moral region can reach over 900N. As per the DIN standards, FDPs should be able to endure occlusal force greater than 1000 N in a static fracture resistance test.4 Tooth coloured high pressed ceramics have the probabilities for debonding.5,6 They have low fracture resistance.8,9 There is a risk of fibre exposure, hair line microcracks in the fibre-reinforced composite bridges.9,10,11

However, the new high strength ceramics, with their stiffness and high mechanical properties (i.e., resistance to fracture and/or fatigue), could be considered a right choice in an IRFDP rehabilitation.12

A number of studies have shown that monolithic zirconia inlay-retained FPDs exhibit a higher resistance to fracture when compared with lithium disilicate inlay-retained FPDs.13,14 It requires a conservative dental preparation, fewer dental sessions and less laboratory time. With its monolithic properties the risk of chipping is low, and it has satisfactory aesthetics. In addition, it helps achieve minimal wear on the antagonists.15,16,17 Monolithic zirconia IRFDP are good option even for the patients with unfavourable occlusion with parafunctional habits or fracture history.17,18,19

The only disadvantage monolithic zirconia IRFDP had was their inability to achieve satisfactory transparency, which has been overcome to provide superior aesthetics.16,20

"Zirconia ceramic RBFDPs yielded a 10-year survival rate of 98.2% and a success rate of 92.0%."21

Inlay-retained bridge design

IRFDPs require minimum coronal tooth height of 5mm, parallel abutments and a maximum mesiodistal edentulous gap of 12mm.23 The patient needs to have a good oral hygiene and low susceptibility to caries. The contraindications include severe parafunctions, the absence of enamel on the preparation margins, extensive crown defects and abutment-tooth mobility.

There are four different designs for monolithic zirconia IRFDPs:

1 Box design:

The proximal box featured as same dimensions as the proximal box of the inlay-shaped preparation. Figure 1 (a,b)

2 Inlay-box design:

The inlay-shaped design involves occlusal and proximal box preparation with round line angles, corners, and a rectangular floor. The occlusal preparation allows a 2.5mm depth and 4mm width of zirconia, with approximately 6 degree's divergence of the walls. The proximal box was prepared with 1mm width and 2mm extension apical to the floor of the isthmus with approximately 6 degree's divergence. This will contribute to a 4.5 × 4mm connector dimension as shown in Figure 1 (c,d) and Figure 3.

3 Tub shape design:

This design involves occlusal surface preparation as the inlay design but without the preparation of the proximal box, with 2.5mm occlusal cavity preparation depth as shown in Figure 2 (a,b)

4 Butterfly wing design:

The wings are done to resemble that of the resin-bonded bridges on the lingual walls of the molar and the premolar. Wings were extended lingually to half the molar and premolar, covering most of the mesial cusp lingually on the molar and half the lingual cusp on the premolar. Occluso-gingivally, they stopped at the lingu-occlusal line angles, leaving the occlusal surface intact and extended 0.6mm depth.26

The cavity is prepared for inlay-retained monolithic zirconia IRFDPs according to the following guidelines:27 Figure 1 (e,f)27

- occlusal depth: 2.5mm (floor of isthmus to central groove)
- vestibular palatal/lingual width of the inter cuspal isthmus: 3mm.
- depth of proximal box: 2mm (shoulder with rounded internal angle)
- buccal vestibular width: maximum of 4.5mm (3mm of zirconia framework and 0.5– 0.6mm of ceramic veneer on each side)
- minimum dimensions of connectors:3 3mm
- cusps are included in preparation when an abutment tooth has a wide bucco-oral defect (>50 per cent) or has been devitalised.
- divergence angle of the cavity: approximately 6 degrees

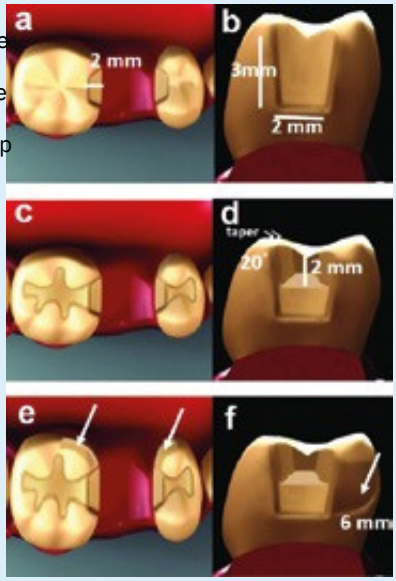

Figure 1: Schematic diagrams for three different preparation designs for monolithic zirconia IRFDPs; a and b, box design. c and d, inlay-box design. e and f, c. a, c, and e (top views). b, d, and f (proximal views). Arrows represent butterfly wings of 0.6mm which extend lingually to half of the molar and premolar.24

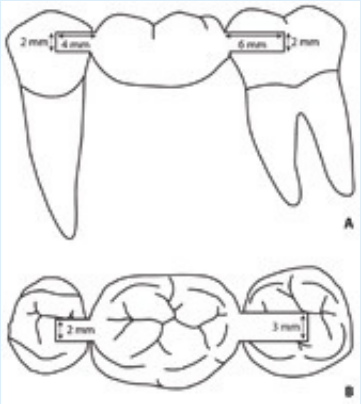

Figure 2: Tub shaped cavity design a buccal view, b occlusal view.25

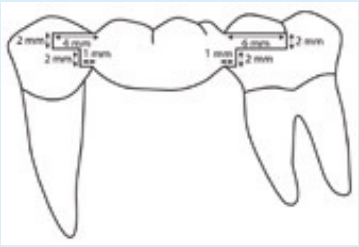

Figure 3: Inlay-box design.[25]

The recommended connector dimensions in all-ceramic posterior inlay-retained fixed partial dentures varied between 9mm2 to 16 mm2, with no significant differences when zirconia was used as the frame material14 while lithium-disilicate ceramic required 16mm2 at least.28

The inlay retainers were constructed from computer- aided-design/ computer-aided- manufacturer (CAD/ CAM) zirconia to improve the fracture resistance and veneering of the zirconia inlays was omitted.29

Cementation

Zirconia still presents a challenge when used with adhesive techniques due to their single-phase tetragonal crystalline structure that is not etchable by commonly used agents such as hydrofluoric acid. Debonding of the adhesive interface and delimitation and microcracks of the ceramic veneering material were the most long-term failures observed and reported.30,31,32

There are two types of surface treatment of zirconia after contamination with saliva remnants.[33]

Mechanical surface treatment

After try-in, rinse the restorations with water spray and dry with air. Cover all bonded surfaces of the restoration with a layer of ZirClean®-Bisco-USA, Ivoclean- Ivoclar or 0.5M NaOH and leave for 20 seconds, then rinse the restorations thoroughly with water spray and dry with air.

Chemical surface treatment

Sandblast the fitting surfaces of the inlay bridges with Al2O3 particles with 50µm diameter, 2.8 bar and 1cm distance water sprayed for 60 seconds and cleaned using the ultrasonic cleaner in 95 per cent ethyl alcohol for 10 minutes.

After surface treatment of zirconia, apply 10- methacryloyloxydecyl dihydrogen phosphate (MDP) containing primer (Z Prime Plus, Bisco, USA) on the fitting surfaces of zirconia bridges.

However, there is no need for special surface treatment for the abutment as the cement is self-adhesive.

Final cementation of the restoration

We will need to apply the dual-cure self-adhesive resin cement to the intaglio surfaces of the bridges and to the preparation surfaces. Place the restorations in the site and apply finger pressure. Remove excess cement carefully using a brush. Apply a layer of glycerine gel to inhibit air. Light cure at the four axial line angles and in the occlusal direction for one minute. Finish and polish the margins using finishing diamond burs, rubber polishing points, and diamond polishing bur.33

A correct FDP and tooth cavity surfaces conditioning before adhesive cementation procedures is necessary to avoid mechanical and biological complications.34,35

Case study

A 45-year-old woman requested replacement of her UL4, UL5 crowns and replacement of missing UR6 on the same quadrant (Figure 4a, b and c). She did not like colour of her upper left crowns (Figure 4a).

Detailed options discussed for replacement of UL6 with a fixed bridge, or a cantilever bridge, or an IRFDP, or an implant. Patient was not comfortable with any of the invasive options and consented for an IRFDP bridge to replace UR6 after whitening.

Treatment planning

Patient was assessed for IRFDP in upper left side. There was space a minimum coronal tooth height of 5mm, parallel abutments and a maximum mesiodistal edentulous gap of 12mm with good oral hygiene.14 Figure 4 (a,b,c).

The bone level of the vital abutment teeth was radiologically investigated. There were no signs of active bone resorption or any contraindicating periodontal and periapical pathology. UL6's maximum mobility of grade 1 was considered acceptable. As shown in Figure 4c there were no marginal leakage, discolouration, or secondary caries in the amalgam restoration.14

Figure 4a

Figure 4b

Figure 4c

Preparation and scan

As there was no proximal box present after removal of old amalgam, tub shape design was chosen. In tub shape design the occlusal surface was prepared as the inlay design but without the preparation of the proximal box, with 3mm occlusal cavity preparation depth. The cusps were not included as UL7 has <50% bucco-oral defect. iTero was used for scanning the tooth preparation. Face bow was used to avoid cant (tilt). Prepared dentin was sealed with an adhesive system (Scotchbond, 3M ESPE and flowable composite Venus's diamond flow, Kulzer) to prevent contamination by bacteria and components coming from provisional cementation materials.

Pro temp 3M ESPE was used for temporisation.

The minimum dimensions of the connector were 3×3mm, to enhance optimum mechanical stress distribution.

Figure 5: Monolithic zirconia IRFDP (UL5- UL6)

Figure 6: A pressed lithium disilicate crown UL4.
B Milled monolithic zirconia UL5- UL7 IRFPD

Placement

The temporary restoration was removed with spoon excavator. Rubber dam was applied to isolate tooth preparation from the oral environment. The abutment was cleaned with prophy brush. The IRFDP was tried in mouth and saliva remnants were removed after soaking in 5M NaOH for 20 seconds. The restoration was sandblasted with 50ums of alumina for60 seconds and cleaned with water spray. The restorations and abutments were dried with air. There is no need to sandblast if it has been done in lab.

The coat of zirconia primer (Scotchbond Universal Adhesive, 3M ESPE) containing 10- methacryloyloxydecyl dihydrogen phosphate (MDP) is used to increase the bond strength.

Maxcem Elite Kerr Corp self-adhesive cement was used for bonding IRFDP. Self-adhesive cement was cured for 10 seconds to increase bond and flexure strength. Static and dynamic occlusion was checked with 40ums articulating paper. The IRFDP occlusion was adjusted with fine diamond bur and then polished with compo glaze. Figure 7 (a,b,c).

Figure 7a

Figure 7b

Figure 7c

Conclusion

IRFDP restorations are good and least invasive alternatives for the replacement of a missing tooth.

A good design, tooth preparation and choice of material and adhesives increases the fracture resistance of a prosthesis.

The digital oral scans provide the laboratory with precise margins, helping them prepare an immaculate IRFDP margin. With scans, there are either no or significantly reduced risk of distortions in preparation of margins (unlike impression materials which have the susceptibility for shrinkage or anomalies because of ill-fitting trays, or accumulation of saliva).

Even though there has been some research on IRFDP, we still need further clinical studies with greater sample sizes and a longer period to evidence the effectiveness and survival rates of IRFDP.