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Removal of Failed Fixed Partial Dentures-A Multifactorial Approach

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Abstract: ***For many years, fixed partial dentures (FPDs) have been the preferred method of replacing lost teeth. However, they are frequently faced with the problems of failure of the restored crown or the abutment which often results in removal of the FPD. The purpose of this review is to give an overview and describe various available systems to remove FPDs and to provide different options for each clinical condition.***

Keywords: Crown removal, crown and bridge removal, FPD, YSGG laser

Abbreviations: FPD – Fixed Partial Denture

1. Introduction

One of the most significant and popular forms of tooth replacement is fixed prosthetic therapy. Patients prefer fixed partial denture because they offer an immediate restoration option, more affordable than implants, and take shorter time to complete. Despite being widely utilized, it has its perks and downsides. Options for fixed prosthodontic therapy may offer the patient and dental professional exceptional satisfaction. It can transform an unbalanced, uneasy, and unhealthy dentition into a relaxed, healthy occlusion that will work more effectively for many years and look significantly better. Fixed prosthodontic failures are stressful and difficult to recognize and treat, and they can occur at any time [1].

Fixed partial denture failure may occur due to the periodontal health issues or damage of cores of the abutment teeth [2]. In that cases it may require for the removal of the fixed partial denture. The literature describes a variety of approaches for the effective removal of a fixed partial denture (FPD) [3].

The aim of this article is to present different approaches in the removal of a fixed dental prosthesis, its construction based on various literature overview and to conclude which approach is generally preferred by the practitioners. In addition to the traditional cutting technique, conservative, semiconservative and combined procedures are discussed in this article, that is effective in the preservation of the FPD while removing it [4].

Classification of different techniques and methods of FPD removal:

There are numerous systems and strategies for removing failed FPDs, but little information has been published regarding their classification, which could aid the dentist in selecting the best one based on the clinical circumstances**.** A classification into five systems and techniques is provided as follows as a consequence of the combination of various authors with some modifications. (Figure 1)

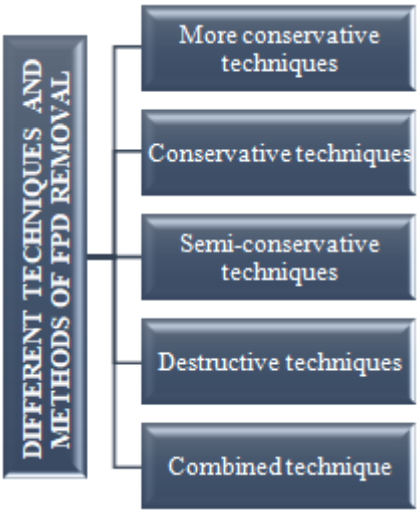

Figure 1: Graphic presentation of Different techniques and methods of FPD removal

2. More Conservative Techniques

The safest method, involves fracturing the luting cement to loosen the restoration, allowing it to be effectively removed and re-cemented. This comprises of the following methods,

2.1 Ultrasonic

The method involves utilizing specialized scalar tips to remove prosthetic restorations (Piezon Ultrasonic, EMS)

(FIG 2A). The approach may be used independently or in conjunction with other techniques. It effectively removes the luting cement layers without damaging the restoration [4]. In this method #5 vibrator tip is usually placed on the metal aspect of the casting and a power setting of the unit is placed between 5 and 10 and is left in place for 5 minutes approximately. Using ultrasonic energy prior to using a Richwilcrown and bridge remover can help achieve the easy removal of a crown or fixed partial denture. Parreira et al. concluded that the technique is successful in 60% of the cases [5]. The heat generated may cause damage to the pulp, in case of vital tooth, so copious water spray is recommended. According to Melo Filho et al., applying ultrasound vibration at the gingival margin for 15 minutes reduces bond strength, which causes the cement layer to break down [6].

2.2Richwil FPD remover

It is a water-soluble thermoplastic resin that might develop a strong temporary adhesive property under increased temperature (Fig 2 B) [7]. It is a water-soluble resin tablet that softens at 145°F for 2 to 3 minutes and is then inserted into the incisal or occlusal surfaces of the prosthesis that needs to be removed. The incisal or occlusal surface of the prosthesis to be removed is coated with softened resin. The patient is told to occlude the area and compress it to a size that is two-thirds of its original size. The abrupt opening motion after 10 seconds will dislodge the crown after it has cooled since the cement seal has broken and the restoration gets fixed on the opposing teeth along with the resin. If there is a nonsecure restoration in the opposing arch, their use is limited. This method is referred to as the most efficient method for removing cast restorations [8]. But the limitations of the Richwil FPD remover is, it can be used primarily only in debonding ofall-ceramic restorations. According to Olivia et al, this approach has a 100% success rate for removing temporarily cemented restorations and a 60% success rate for removing cast restorations that are permanently cemented when combined with ultrasonic [9], [10].

2.3 Trial crown tractors and remover

They are known as grasping forceps (Hu-Friedy Co., Chicago) (fig 2 C) because they dislodge the restoration without harming the ceramic borders by maintaining a firm grip over the FPDs with the help of rubber or soft grips and powder. These tools, which resemble forceps, operate by pushing inward on two opposing handles. They work best when removing temporary restorations. To prevent the crown from being crushed, some of them have turn screws. Some commercially available grasping instruments include the Wynmann Crown Gripper (Miltex Instrument Company, Lake Success, New York, PA) K. Y. Pliers (G C America, Alsip, IL), CK pliers (C-K Dental, San Diego, CA), Nordent crown adaptor pliers (Nordent Manufacturing, IL, United States), Trial Crown Remover (Hu-Friedy Co., Chicago), Trident Crown Placer or Remover (C-K Dental, San Diego, CA), TempOff crown removers (David Fyffe, DDS, Dallas, US) [3], [9].

2.4 Lasers

Generally, Laser being the non-invasive method, favours both the dentist and the patient. Er, Cr: YSGG (erbium, chromium: yttrium, scandium, gallium garnet) (fig 2 D) lasers at 2780 nm are used to quickly and safely remove all ceramic restorations without endangering the underlying tooth structure. The wavelength of the laser is not absorbed by the porcelain structure through which it passes, but by the water in the luting cement [4]. According to studies, the components of resin cements (water molecules or leftover monomers) are vaporised by laser radiation as it passes through the ceramic, according to a process known as thermal ablation [10]. Three different processes—thermal softening, thermal ablation, and photoablation—contribute to the disintegration of adhesive by laser irradiation. The first method depends only on heat, but ablation is related to resin vaporisation by rapid heating, and photoablation happens as a result of a chemical reaction between light and the resin atoms [11].

To avoid overheating and damaging the vital tooth, it's crucial to limit temperature increases during irradiation. The Er: YAG (erbium, yttrium, aluminium-garnet) laser with air/water coolant did not raise the pulpal temperatures of any of the teeth, according to research by Fife et al. Instead, it actually lowered the pulp chamber temperature by as much as 5 degree [12].

Morford et al**.** used an Er-YAG laser with a 2940 nm wavelength, 133 mJ output, and a fibre tip positioned 3-6 mm from the restoration's surface to debond all ceramic restorations for a period of 31-290s [13].

According to Oztoprak et al, Er YAG laser with a wavelength of 2940nm applied for 3 to 9s with 2mm distance on the labial surface in horizontal strokes caused a 9-fold reduction in bond strength of luting composite to enamel [14], [15].

Advantages include, lasers are highly time saving and the removed prosthesis is not damaged and can be reused.

Disadvantages include, they are indicated only for all ceramic restoration and are dangerous if the beam is not directed properly [4].

Figure 2: Ultrasonic (A) Richwil resin (B) Crowntractors (C) Laser (D)

2.5 Conservative Techniques

These systems function by breaking down the layer by giving a traction or percussive force to the luting agent. The restoration is still intact and can be reinforced.

2.5.1 Removal with a chisel and a sliding hammer:

A appropriate tip is chosen to engage the crown margin, and the restoration is then loosened by sliding a weight along the shaft in a series of brief, quick taps. There are numerous designs on the market. Patients find them uncomfortable, and they are no longer used nowadays. It is not advised to use with periodontally compromised teeth because it could damage the porcelain margins [16] (figure 3 E).

2.5.2 Manual back action remover:

These instrument sets have a tip that is connected to a shaft and engages the margins (figure 3 F). The shaft has a sliding weight and a impact force is produced by manually activating the weight. It is mostly used to remove a prosthesis that has been temporarily cemented. The rod may readily deviate from the desired removal axis upon activation of the load. The Morrell crown remover (Henry Schein, Port Washington, NY), the Miltex crown remover (Integra York PA Inc., Davies Drive, York, PA), the Pulpdent Crown and Bridge Remover (Pulpdent Corporation, Watertown, USA), the Osung Crown Remover (Osung MND Co., Ltd, Kimpo, KS), the Shen crown remover, etc. are among the instruments in this category. These traction-based devices may cause considerable trauma to the patients and luxation of the ligament [3], [16], [17].

2.5.3 Spring loaded back-action remover

These are back action spring-loaded hammers. The spring is manually compressed and then released to generate the impact force. These instruments include the Kohler spring-loaded device and the KentzlerKaschner Dental Type C crown removal (Pearson Dental) [3] Limitations with this technique include, the rod might easily drift away from the tooth's long axis [4].

2.5.4 Spring loaded Semi-automatic remover

The remover tip can be held at the crown margin with one hand while being readily operated with the other. They have better control over the directional force they use. The outer cylinder is slid over the inner one to compress the spring (figure 3 G). When the button is pressed, force is exerted through a back action mechanism. Each time these devices are used, they should be removed and then reactivated. (2, 3) One of the limitations is that the tip of the instrument can easily deviate/slip from the crown margin and the long axis of the tooth which can be highly hazardous to the underlying substructures [4].

2.5.5 Pneumatic automatic back-action remover

It is an air driven instrument (figure 3 H). To break the cement seal, this series of tools uses pressurised air in the dental unit. The restoration's margin serves as the purchase point, and short, repeated, low impact force is applied there. Because of the compressed air flowing through the device, reactivation happens automatically. Force applied up to 20 micro-hits per second which is well tolerated by the patients. A study conducted by Cristina Bignardi, stated that the manual tools produce sharp forces with lesser impact hence air driven instruments are more reliable than the manual instruments [18], [19]. The procedure is time-consuming, difficult to determine the precise draw direction, and could be uncomfortable for the patient [4].

2.5.6 ATD automatic FPDs remover

Oruç demonstrated the removal of FPDs by attaching a cone to a horizontal bar on which the impact could be transmitted via ligature wires that passed through the embrasures of the bridge. (20) On the buccal and lingual surfaces of the bridge, Verrett and Mansueto used a two-piece matrix that was connected to one another with a nut and bolt. If tapping force is applied through the resin matrix, the FPD may be safely removed (figure 3 I). (21, 22)

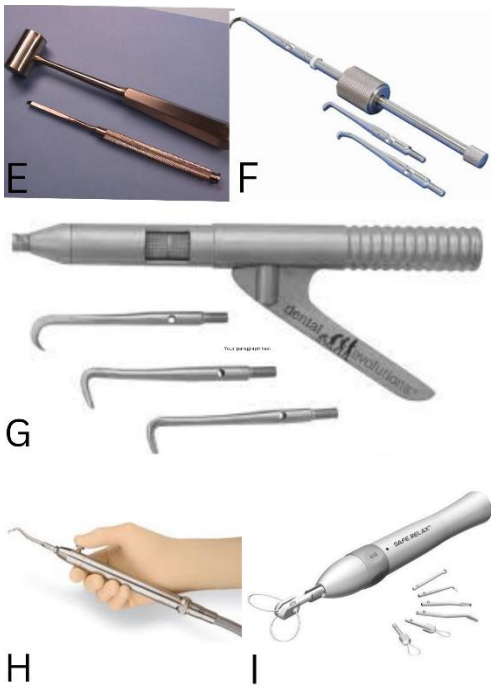

Figure 3: Chisel and a sliding hammer (E) Manual back action remover (F) Spring loaded Semi-automatic remover (G) Pneumatic automatic back-action remover (H) ATD automatic FPDs remover (I)

3. Semi Conservative Methods

Through the use of a tiny access hole drilled through the restorations, these procedures actively engage the FPDs to support the abutment as the lifting force is applied to the prosthesis. Their benefits include quicker recovery, greater patient comfort, the ability to safely separate from one another, and less traumatic use of force to remove the FPDs.

3.1 The classic system-Mtalift Baton Rouge, LA

The mtalift system is based on a principle called ‘Jack-screw’ principle (figure 4 J) A precision hole is drilled with a diamond bur into the occlusal surface of an FPDs. The area surrounding the hole's perimeter is then undermined before a threaded screw is inserted into the opening. When the

instrument stops advancing by contacting the underlying core as a result of prolonged rotation, the crown displaces from the tooth structure. To reduce any risks of fracture, enough ceramic veneering should be removed surrounding the opening. The approximate thickness of the metal must be around 0.5mm for this method. In case of re-cementation of the crown, the hole can be repaired using plastic filling material. Additionally, a complete kit with precision attachments is provided with the instrument set [2], [3], [9], [17].

3.2. The Higa system

The method involves threading a brass wire through the bridge embrasures to create a loop upon which a force can be exerted in order to remove the bridge [17]. (Figure 4 K) A precision hole is drilled into the occlusal surface of the crown and a support pin is inserted into the hole. Tightening of the wire lifts the restoration by applying pressure in an upward manner while the pin supports the underlying tooth structure [2], [3], [17].

3.3 The Wamkey system

It is a basic narrow-shanked cam device that uses oval-shaped keys with diameters ranging from 2.5 to 5 mm2 on any surface of the crown. It is available in three sizes. (Figure4 L) A Wamkey is rotated after being placed into the tunnel created between the preparation's occlusal surface and the crown's intaglio surface. The crown rises from the preparation by taking the path of least resistance. The force exerted should be in the path of insertion of the FPDs which can be is easily dislodged. Before extending the channel over the occlusal surface in this method, the cement layer should be identified [23].

3.4The Kline System (Brasseler USA)

The kline crown remover (figure 4 M) is basically made to remove posterior crowns with minimal damage to the crown and the tooth. The instrument consists of an adjustable swivel pin. Stainless steel plier like instrument is used with one end having a pin 6 mm long and 1.6 mm in diameter, which engages a hole drilled on the cusp tip, and the other end having a flat and pointed tip, that engages a notch created above the gingival margin in the metal. When squeezing the handle, the pressure is produced, which breaks the cement layer. The pressure of the pin is applied along the long axis of the tooth. This system resembles Karnoff's technique with orthodontic pliers [3].

3.5 Bucco-Lingual 'Dimple' Technique

A small round bur is inserted into the gingival third of the fixed prosthesis' buccal and lingual surfaces to create dimples that will prevent pliers from slipping off of smooth porcelain or metal surfaces. Baade's pliers, which come in straight and angled varieties, are employed for this procedure. The operator tries to break the cement seal and remove the FPD after creating the dimples and setting the Baade pliers in place by twisting their hand and wrist. It is contraindicated in patients with periodontally compromised dentition, an unfavourable crown-to-root ratio, or very mobile teeth. It works well on over-tapered prepared teeth and short clinical abutments [1], [3], [24]

3.6 Orthodontic removal

Karnoff described how to remove a restoration with pliers using a conventional orthodontic technique. One of the pliers' beaks is inserted into the hole that has been created, and the other beak is placed at the edge of the crown. When pressure is applied, the crown is knocked off [25].

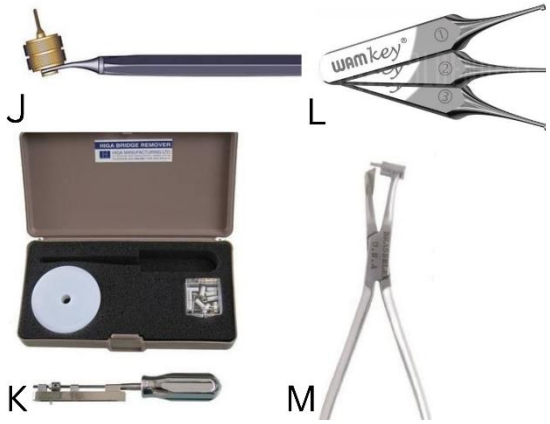

Figure 4: Mtalift system (J) Higa system (k) Wamkey system (L) Kline system (M)

4. Destructive Techniques

Destructive techniques are considered as one of the most commonly used techniques widely used by practitioners. In this method the restorations are sectioned with the help of a diamond or tungsten carbide bur. The luting cement present may interrupt this procedure, which can be avoided by combining with an ultrasound instrument. All ceramic restorations being considered as one of the most difficult to be removed, the procedure can be proceeded by cutting through the lingual surface. In addition to this, while utilizing rotational movements to split using a crown spreader/lever or the specific Mitchell's trimmers in the groove produced on the surface of the repair, the rod may easily slide away from the long axis leading to cement breakdown. While using levers and trimmers, tension on the tooth core reduces when the crown is evenly spread. For this purpose, widening pliers are used. The beaks of the plier can be separated by squeezing the handle. This engages the prepared slot; the crown will be deformed and split. The conventional ceramic restorations are cut by diamond burs, but in case of the contemporary ceramics, the diamond coating is of limited use. Zirconium and other highly elastic ceramic materials are used for contemporary reinforced ceramic materials. Jackie 4ZRS is an alternative method used for distal and frontal restorations, this had a short (4mm) with a pointed end. After sectioning of a tooth, a technique called Brasseler crown removal system can be used. It is kept in the cutting-edge area, where it is rotated to split the crown into half. In order to release the metal substructure from the tooth, spreaders are being used. While considering multiunit joined crowns, sectioning of each crown unit separately is advisable. The indications of this mode of technique includes mobile teeth, root canal treated teeth, teeth cemented with resins and in case of esthetic and periodontal failures. [2]-[4] (Figure 5)

Figure 5: Showing destructive technique by sectioningthe metal ceramic crown

Combined Techniques

As the name suggests, it comprises of the above-mentioned techniques. At presently, technique comprising of special ultrasound scaler tips and destructive techniques are used for removal of resins [2]-[4].

5. Discussion

According to a study conducted by Ahtasham Anwarmds et al, the majority of respondents (56%) utilise conservative removal techniques, while 27% use semi-conservative techniques and the remaining use destructive techniques to minimise patient trauma. When it comes to the most common instruments, they used to remove failed FPDs, the majority of them (48%) used spring loaded back action removers, which are slightly traumatising to the patient but more tolerable than back action and chisel and hammer type removers. Only (17.8%) used semi-automatic spring-loaded removers, and only (9%) used automatic removers. Only (11%) of those who have used alternative crown remover systems are aware that lasers can also be used to remove FPDs and 17% have heard of the Richwill technique [26].

In another study, Pravinkumar G Patil suggested a new atraumatic method of crown removal where the facial surface of the crown along the long axis is sectioned with a high-speed handpiece with water spray with a round-end-taper diamond bur in to cut through ceramic and/or metal, just to expose the underlying cement layer. The crown is then removed by using force while maintaining the universal orthodontic plier's round head parallel to the groove on the facial surface and its rectangular head lingually. The methods that involve vibratory tools or adhesive resin tablets may require more time to remove and are less efficient. Techniques that use tools with jerky removal force could harm the underlying tooth structure or gingival/periodontal tissues. The best course of action in these situations is commonly to section the crown rather than try to remove it whole [27].

The ‘more conservative procedures’ for removing cemented prosthetic construction work 100% of the time, but only for prostheses that are only temporarily fixed. Parreira et al. reported that these techniques are 60% successful in cases of permanently cemented restorations [28].

‘Semi-conservative methods’ require expensive restoration materials. Patients with poor periodontal health, adverse crown-to-root ratios, and highly movable teeth are highly contraindicated. Practitioners can remove the restoration using ‘destructive techniques’ without concern about damaging the periodontium or the hard tissues of the teeth. Unfortunately, they take a lot of time and are uncomfortable for the patients [4].

All of the systems listed here are not applicable universally. Therefore, it is crucial to adopt a flexible strategy, meaning that other techniques should be attempted when one system fails to remove the crown and bridge.

6. Conclusion

Many factors must be taken into account while removing cemented FPD prostheses, including the type of cement used, the state of the underlying abutments and related tissues, and the condition of the prosthesis both before and after removal. Temporary FPD removal is typically simple, but removing a permanent FPD has always been a challenging task for both the dentist and the patient. It is also important that patient education regarding the benefits, drawbacks, and risks of removing a permanently cemented restoration is crucial. Thus, it is challenging to suggest a general system for coronal disassembly given the variety of systems and methods covered in this article. Depending on the specific clinical circumstance, the best crown removal system must be chosen. Practitioners must have a thorough understanding of the procedures in order to preserve the construction and prevent any risks associated with the clinical scenario.

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