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Case Report

Lithium Disilicate Restorations: Overview and A Case Report

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Abstract

To avoid the shortcoming of conventional metal-based materials and to provide natural-appearing dental restorations, manufacturers introduce different all-Ceram materials to the market, starting with feldspathic porcelain, Dicor material, pressable leucite-reinforced glass ceramic materials and ended with variable generations of zirconium and lithium disilicate. The multifunctional use of lithium disilicate, its translucent optical properties, and its availability as a mono-block, make it as a trending topic in dentistry.

In this overview article, *in-vitro* and clinical studies regarding lithium disilicate are discussed and one case of implant supported lithium disilicate crown manufactured by CAD/CAM technique is presented.

Keywords: Lithium disilicate; Press; CAD/CAM; Monolithic

Abbreviations

FDPs: Fixed Dental Prosthesis; CAD/CAM: Computer- Aided Design and Computer- Assisted Manufacturing; USPHS: United States Public Health Service; AIOP: Italian Academy of Prosthetic Dentistry

Introduction

The recent innovations in ceramic materials and CAD/CAM technologies are developed in order to enable the accomplishment of high aesthetic demands and to limit the shortcoming of conventional materials and methods; i.e., low tensile strength, sintering shrinkage, excessive brittleness, wear of antagonist, crack propagation [1] and marginal gaps [2].

Recently, lithium disilicate material had been widely marketed, because of the adhesive properties of this material [3] and its preservation of tooth structure [4]. Lithium disilicate restorations are manufactured by heat press-lost wax technique (IPS e.max Press) or by CAD/CAM technique (IPS e.max CAD). The former has a high survival rate based on short [5] and long term [6] survival evidence for each single crown restoration and 3-unit FDP. The latter (IPS e.max CAD) techniques, which produce different crystal characterization, lack enough clinical evaluations and trials thus are still not indicated for multiple units FDP [7,8]. The manufacturer (Ivoclar Vivadent) starting use lithium disilicate as a frame work to increase the strength of veneer such as IPS Empress2, where the veneer material was fluorapatite-based porcelain [9,10]. After that the monolithic blocks of lithium disilicate (IPS e.max CAD, IPS e.max Press) are presented. The second generation of these blocks is used for zirconium core veneering (Vita Suprinity; Vita Zahnfabrick, Bad Säckingen, Germany), while the third generation is used for implant-supported prosthesis due to its ability to be bonded with the titanium base and also to its presence in various shade blocks [7].

Recent literatures spotlight the properties of machinable lithium disilicate (IPS e.max CAD, Ivoclar Vivadent). This product, which is marketed as blue blocks, contains 40% of partially crystallized Lithium metasilicate, which transformed to lithium disilicate crystal after CAD-CAM milling and tempering. After this process, all crystal particles increased in size; so the flexural strength of material increased. The blue color of lithium disilicate blocks change to the tooth color during the oxidation phase in the tempering process [2,7,10]. Although the shrinkage of Lithium Disilicate during the crystallization process does not affect the margin fit [2], this kind of restoration is still not suggested for multi-unit FDP as conducted in AIOP closed meeting in 2013, due to the lower mechanical properties (fracture resistance and flexure strength) when compared with IPS e.max Press [8]. The lithium disilicate restorations cannot be applicable for all type of prosthesis; Table 1 represents the possible clinical uses of lithium disilicate restorations as conducted in AIOP closed meeting [11].

In-vitro studies

The mechanical properties of lithium disilicate restorations depend on the component of the block [12] and on the manufacturing process [7,13].

The zirconia reinforced lithium disilicate (Vita Suprinity; Vita Zahnfabrick, Bad Säckingen, Germany) that is manufactured by CAD-CAM has higher mechanical properties than machinable lithium disilicate (IPS e.max CAD) in terms of fracture toughness, flexure strength, hardness and elastic modulus. On the contrary, lithium disilicate glass ceramic (IPS e.max CAD) crown exhibits higher fatigue load to reach the failure value than the zirconium oxide crown (Y-TZP) [14]. In another study, which also compared the fatigue behavior of monolithic lithium disilicate versus veneered Y-TZP crown (IPS e.max ZirCAD), early veneer failure of IPS e.max ZirCAD was observed [15]. One of the most frequent failure cause of zirconium restoration; is chipping or fracturing of the veneering ceramic [16]. On the other hand, the lithium disilicate restoration may be fabricated as a single unit (monolithic) without a ceramic veneering need.

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Table 1: Possible clinical use of lithium disilicate material (from an AIOP closed meeting 2013).

Type of prosthesis	Monolithic Disilicate
Single anterior/ posterior crown	Applicable
Single anterior/ posterior implant crown	Applicable
Anterior FDP 4 unit	Possible but requires further clinical and scientific validation
Anterior implant FDP 4 unit	Possible but requires further clinical and scientific validation
Posterior FDP 4 units	Not applicable
Posterior implant FDP 4 units	Not applicable
Full arch on teeth or on implant	Not applicable

Table 2: Evidence-based literature on lithium disilicate restoration.

Author -date	Type of prosthesis	Lithium Disilicate Material	Years of follow up	Survival rate
Fasbinder, Dennison et al. [10]	Single posterior crown	IPS e.max CAD but fluorapatite veneering material was used	2 years	Well clinical performance
Etman and Woolford [5]	Single posterior crown	IPS e.max Press	3 years	Well clinical performance
Reich, Fischer et al. [30]	Single posterior crown	Chair-side IPS e.max CAD	2 years	Well clinical performance
Guess, Selz et al. [26]	Posterior single crown	IPS e.max Press	7 years prospective study	100% 97%
Sola-Ruiz, Lagos-Flores et al. [4]	3 unit FDP	Lithium disilicate as framework	10 years prospective study	71.40%
Kern, Sasse et al. [6]	3 unit FDP	IPS e.max Press	10 years prospective study	87.90%
Wolfart, Eschbach et al.[27]	3 unit FDP	IPS e.max Press	8 years prospective study	93%
Valenti and Valenti [28]	Anterior and posterior single crown	Lithium disilicate crowns	9 years retrospective	96.10%
Gehrt, Wolfart et al. [29]	Anterior and posterior single crown	IPS e.max Press	5 years 8 years	97.4% 94.8%

Alkadi and Ruse et al. compared the fracture toughness of IPS e.max CAD and IPS e.max Press according to the type of manufacturing process. The result was that the lithium disilicate which is manufactured by Press technique has significantly higher mechanical properties, which means that the CAD-CAM technique reduces crystal size and crystal phase of lithium disilicate as investigated by SEM images of fractured specimens [7].

The conservative feature of lithium disilicate is also considered, its fracture resistance which is not affected by the type of finish line of preparation [17] and its fabrication in minimal thickness of less than 1.00mm [18], make it a non-invasive restorative material. Sripetchdanond and Leevailoj showed that wear of the lithium disilicate is similar to that of human enamel; however lithium disilicate caused significantly more wear depth of enamel surface of the antagonist when compared with monolithic zirconia and composite resin materials [19].

The optical properties of lithium disilicate are also discussed. In an *in-vitro* study, Harada et al. has reported that the lithium disilicate is more translucent than zirconia, which means the superior aesthetic property of monolithic lithium disilicate [20]. The monolithic zirconia is usually veneered with porcelain to give appropriate characterization [18,20,21]. The presence of polyvalent ions in lithium disilicate blocks the color and prevent the imperfection so full characterization can be achieved [20,21].

The accuracy of lithium disilicate prosthesis and its marginal fit are also tested and investigated. Each of IPS e.max CAD are within the clinically acceptable range in terms of marginal and internal fit measurements; Kim et al. measured the internal and marginal gaps of a lithium disilicate CAD/CAM crown using a digital microscope, this study approved that the 0.2% of material shrinkage that occurred during crystallization process using Cerec CAD/CAM technique does not affect the fit of the final prosthesis [2]. The marginal discrepancy between two types (IPS e.max press and CAD) of lithium disilicate was compared and evaluated by multiple studies [22-24]. Kim et al. showed no significant differences between IPS e.max Press and IPS e.max CAD regarding to the marginal adaptation when extra oral digital impression used, only significant differences were founded when two different intraoral digital impression techniques were used for IPS e.max CAD fabrication [24]. In another study [23], the marginal fit of restoration fabricated by CAD/CAM technique was better than those fabricated by press lost wax technique. A different result was reported by Anadioti et al. [22], the marginal discrepancy of IPS e.max Press better than IPS e.max CAD, and no differences observed when using traditional or intraoral digital impression technique.

Clinical studies

Lithium disilicate based restorations have high survival rate as reported in 2008 by Della Bona et al. [25]. As regards to the monolithic lithium disilicate restoration, the evidence-based clinical studies of this material are limited, presented in Table 2. IPS e.max CAD showed the perfect clinical performance, with no fracture, chipping or sensitivity during two years of evaluation [10]. In another short-term study data showed the clinical changes of IPS e.max Press and metal ceramic restorations was less than changes occur in all Ceram according to USPHS criteria i.e. secondary caries,

Figure 1: Clinical view.

Figure 2: Initial panoramic radiograph.

Figure 3: Simple surgical guide.

marginal adaptation, discoloration, surface roughness, color match and anatomical form, [5]. Prospective study for IPS e.max Press result was 100% survival rate after 7- year follow-up based on Kaplan-Meier analysis, where no secondary caries and fractures were observed, just minimal color change due to the chemical degradation of glazing layer [26]. Another prospective study evaluated the survival rate of lithium disilicate based-Ceram in 3-unit FPD for ten years: 71.4% survival rate and 28.6% fracture rate were reported [4]. While other authors reported higher survival rate [100% after five years, 87.9% after 10 years [6] and 93% for eight years follow up [27]], these variant results may be due to the crystal size and developed feature of press lithium disilicate. A retrospective study for 110 lithium disilicate crowns showed a favorable clinical performance in term of marginal and structural integrity after nine years with 96.1% survival rate and 1.8% failure rate, while knife-edge preparation design for all anterior and /or posterior crowns was done [28]. The high survival rate for the single anterior and posterior lithium disilicate crown manufactured by press technique and cemented to the tooth preparation with shoulder and/or chamfer finish line was also observed in another long-term retrospective study, although veneering material was used [29]. Chair-side IPS e.max CAD restorations were evaluated clinically for two years and satisfied results were obtained [30].

Although discussed studies show a high clinical performance of lithium disilicate restorations, still more studies are needed to clarify the effect of preparation design on the success rate, and to manifest

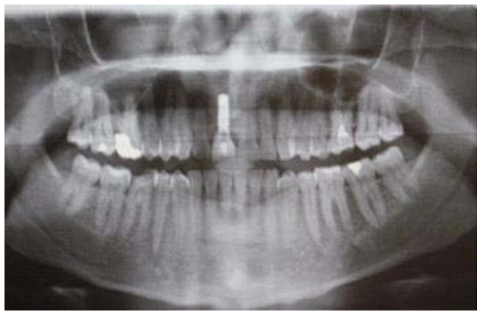

Figure 4: Panoramic radiograph immediately after screw-retained IPS e.max CAD crown positioning.

Figure 5: Final clinical view.

Figure 6: periapical radiograph after 7 months.

if there are advantages of lithium disilicate fabricated by CAD-CAM over pressed technique and when it is indicated.

Implant supported lithium disilicate prosthesis

Alessandro Agnini and Andrea Aginini presented one case of single-implant supported lithium disilicate crown in their book (Digital Dental Revolution) [11]; in this case, a screw-retained crown was used. Four- year follow-up noted a radiographic marginal bone stability and clinical perfect esthetic results.

Case Presentation

A 35-years-old male patient was admitted to the clinic of the Oral Implantology department of Istanbul University complaining of lost upper-right central incisor. The patient did not report any systemic diseases. During clinical examination, the good oral hygiene, deep bite and low smile line were observed (Figure 1). Initial intra-oral radiograph (Figure 2) and primary study- model impression were taken. Next, a simple surgical guide was fabricated (Figure 3) to define the future tooth position and angulation. At operative stage, infiltrated anesthesia was applied, followed by enveloped flap elevation. Following reposition of a surgical guide, a bone-level dental implant (Institute Straumann, SLA surface, Walden- burg, Switzerland) was placed according to the manufacture instructions. Four months later, definite traditional impression, color shade and peri-oral photograph were taken and sent to the manufacturing center. Due to the patients deep bite occlusion, the decision to use a screw-retained prosthesis was made. Furthermore lithium disilicate material (IPS e.max CAD) was prioritized in order to avoid the problems of zirconium restoration which discussed previously. Two days later, the screw-retained IPS e.max CAD was inserted, and the treatment was completed. Final radiograph revealed the perfect adaptation and precision of the prosthesis (Figure 4) and clinically acceptable esthetic was achieved (Figure 5). Seven months later patient came for control, no radio-graphical and clinical problems was noticed (Figure 6).

Conclusion

The growing of materials and technologies does not mean the well-established traditional techniques are not working anymore. It does present the ease of retrieving and providing an accurate and precise prosthesis that was previously difficult to obtain. The evolution of lithium disilicate dental restorations give many advantages for veneering, inlay, onlay and single crown restorations. For implant supported prosthesis, lithium disilicate is still infrequently applied. Three-unit FDP had a high survival rate when pressed lithium disilicate used, but one-implant placement with single lithium disilicate crown is preferable to avoid FDP and its complications. As discussed in this review; *In-vitro* studies conclude that the lithium disilicate with different manufacture process present differential mechanical properties; and in clinical studies, lithium disilicate also showed perfect performance with no fracture, chipping or sensitivity. These results give a lot of advantages for natural teeth restorations

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