A new manufacturing method of all ceramic restoration using alumina tape and presentation of clinical cases

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In an effort to facilitate fabrication procedure of all ceramic crowns, a novel preparation method for all ceramic crown using alumina tape was developed. The alumina tape having a uniform thickness was cast by using Doctor blade method. The physical properties of newly introduced alumina tape has biaxial flexure strength of 500~600 MPa. The value of toughness is 3.18~3,28 MPa.$m^{1/2}$ which corelates with facture and the linear shrinkage rate of the alumina tape is 0.44% during core production. The marginal fitness of the alumina tape all-ceramic restoration with 90¡ shoulder margin had average marginal discrepancy at 78.3§ and average marginal gap at 44.4§. At the marginal preparation of 135¡ deep chamfer, the average marginal discrepancy at 82.1§ and the average marginal gap at 40.2§ had been reported.
This fabrication procedure of all ceramic crowns with alumina tapes is easier and less technical sensitive for dental technicians.
After restoration with new all ceramic crowns we followed the patients 2 years later, there were no complications as porcelain fractures or periodontal disease. We had good esthetic clinical results with new all ceramic crowns.

Key Words :
All ceramic crown, alumina tape, flexure strength, fithess

With increase in awareness of aesthetics, use of ceramic material in dentistry has steadily widened. In the past, on introduction of metal fused ceramic restoration, it has taken a considerable proportion of all restoration and is still one of the most commonly used restoration materials. Despite the extensive application of ceramic restorations, the metal copying underneath the ceramic layer limits the translucency and excessive reflectivity produce insufficient aesthetics. To overcome these problems all-ceramic restorations have been introduced. In comparison to the metal fused ceramic restorations, these materials however lack in the strength, have complicated manufacturing procedure and often require expensive specific equipments therefore have yet to substitute

the metal fused ceramic restorations. In the recent years there have been many researches on the all-ceramic restoration materials with higher strength furthermore introductions of new manufacturing procedures and alternative materials.

Most commonly used all ceramic restoration materials includes In-Ceram System (Vita zahnfabrik, Bad Sckingen, Germany), IPS Empress System (Ivoclar, Lichtenstein), Dycor System (Dentsply International, Inc., York, PA, USA) and recently introduced Procera All Ceram Crown System (Noble Biocare, Goteburg, Sweden). Resin and ceramic have been combined to produce a ceromer such as Targis- Vectris (Ivoclar-Vivadent, Liechtenstein) has been also available for clinical use.

Ceramic that have increased the strength by dispersing leucite within the material are Optec and IPS Empress System. The later employs lost-wax technique. Wax is carved on a working die this is invested then is burnt out before cast with correlating tooth shaded ceramic ingot with heat-pressed technique. High heat pressed leucite-reinforced ceramic can reproduce accurate morphology and through staining and layering a realistic shade can be produced. The flexural strength however is 160~180 MPa, which is suitable for anterior single tooth restoration but not sufficient for fixed partial dentures. This procedure requires special heat pressure facility.[1] The recently introduced strengthened IPS Empress II (Ivoclar, Lichtenstein) is possible for usage as fixed partial dentures.

Procera Allceram increased the strength and translucency through high heat and pressure,[2,3] requires equipments for sintering and CAD-CAM for producing copying. The marginal fitness was reported as 70~100§ > which is inferior to that of In-Ceram.[4,5]

In-Ceram System has an excellent aesthetic and strength and are congruent for anterior fixed partial denture. The alumina core is manufactured using a complex slip casting technique.[6] The slip casting technique use a slip, a mixture of alumina powder and liquid, is placed on a special plaster-working die with a brush. The liquid from slip placed on the die is absorbed and core is produced. The technique is difficult and depending on the layering of the slip, onion shell layered structure can occur, weakening the strength.[6]

This therefore demands an experienced technician. To overcome these difficulties the authors introduce alumina tape that can be wrapped on a working die, newly developed in South Korea.[7-10]

Alumina tape is manufactured through Doctor Blade Casting method. This casting method mixes microscopic ceramic powder with a solvent this is dispersed with a binder that combine inorganic filler and plasticizer to increase flexibility. The mixture is placed at slurry, which disperse the material and reduce viscosity. The slurry is laid on a moving film tray at an even thickness. The solvent will evaporate leaving alumina tape.

The above manufactured alumina tape have been successively used in all ceramic restoration. This article is to report the properties of this material and the clinical cases.

PHYSICAL PROPERTIES

This newly introduced alumina tape has biaxial flexure strength of 500~600 MPa[7,11] which is in comparison with In-ceram at 450~600 MPa. However it shows much higher strength value to Empress at 160~180 MPa[1] and 90~124 MPa of Dycor[12] and is possible to use as anterior fixed partial denture.

The value of toughness is 3.18~3,28 MPa.m$^{\circ}$ which corelates with facture and in-ceram has value of 3 MPa.m$^{\circ}$.[7,11] The linear shrinkage rate of the alumina tape is 0.44 % during core production, which is compensated with the expansion of the special plaster die.[7,11]

The marginal fitness of the alumina tape all-

ceramic restoration with 90¡shoulder margin had average marginal discrepancy at 78.3§> and average marginal gap at 44.4§>. At the marginal preparation of 135¡deep chamfer the average marginal discrepancy at 82.1§> and the average marginal gap at 40.2§> had been reported.[10]

MANUFACTURING METHOD

When Treatment plan has been made a tooth is prepared and impression is taken, the preparation is done in a same manner as a tooth preparation for In-Ceram System. The occlusal reduction of 1.5 ~2 mm, labial reduction of 1.2~1.5 mm, palatal reduction of 0.7~1.0 mm should be done and the marginal finish line should be either round shoulder or deep chamfer. A standard method of gingival tissue retraction, haemostatic and moisture control is carried out followed by impression taken either with additional silicon or polyether impression material. A master die and a working die are fabricated with type IV dental improved stone and a second working die is fabricated with special plaster for sintering (Fig. 1). For In-Ceram the second die made of special plaster is duplicated with silicon impression material from the working die. In alumina tape the second working die can be fabricated in a same manner as the In-Ceram or the final impression of the tooth preparation can be reused after fabrication of the master die, which simplify this stage of the procedure.

An appropriate sized alumina tape is cut and is rapped around moisture free second working die. The excess are removed with scissors or a knife (Fig. 2). This die is then further rapped with plastic sheet to remove trapped air and placed in a Warm Isostatic Presser for 10 minutes at 80¡ followed by Warm Isostatic Pressure(WIP) at 15MP for 5minutes to closely adapt the alumina tape to the die (Fig. 3). The adapted alumina tape has some plasticity and is appropriate for marginal trimming using carving instruments. The instrument can be warmed in a alcohol lamp as necessary.

The sintering is similar to the method used in In-ceram. For the sintering the alumina tape on the die is heated at rate of 1 ¡ per minute up to 600 ¡ and is maintained for one hour followed by raise of temperature to 1,120 ¡ at rate of 9 ¡ per minute which is maintained for another two hours then cooled. The sintered core is placed on the working die and the shape is modified with diamond point (Fig. 4). The glass infiltration is also

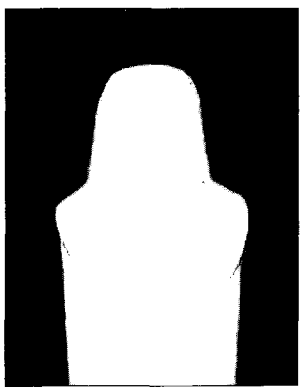

Fig. 1. After master cast and working die were fabricated, duplicate the working die with special plaster.

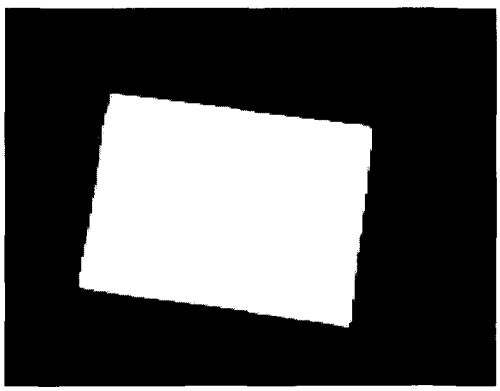

Fig. 2. Alumina Tape was prepared to wrap around the plaster die.

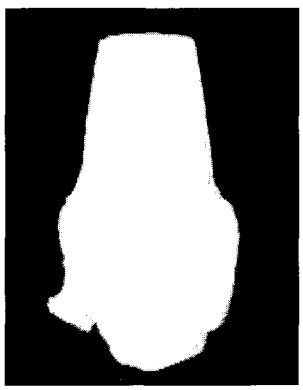

Fig. 3. Alumina Tape was pressed on the plaster die with WIP at 80¡ .

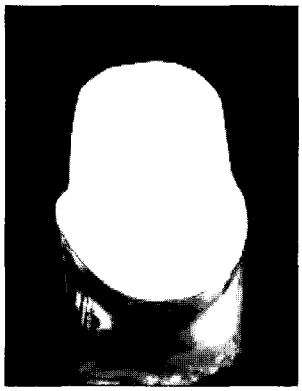

Fig. 4. Sintered ceramic core was shown.

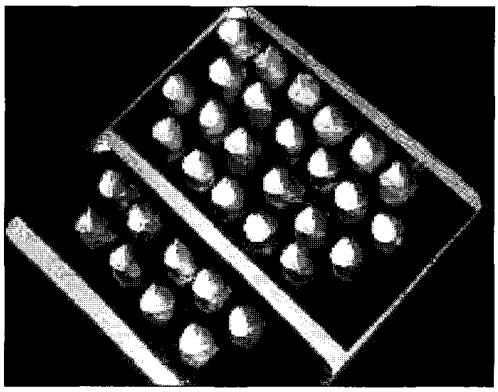

Fig. 5. Glass powder on the sintered alumina core.

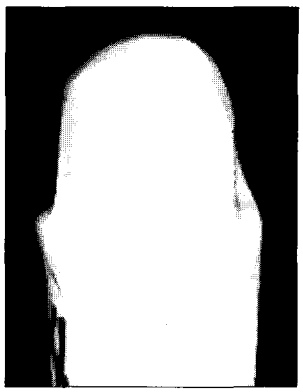

Fig. 6. After glass infiltration, excess glass was blasted with 50 ¥m Al2O3.

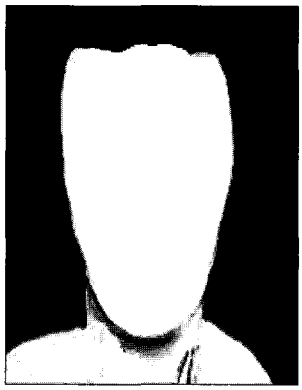

Fig. 7. It shows completed all ceramic crown with alumina tape.

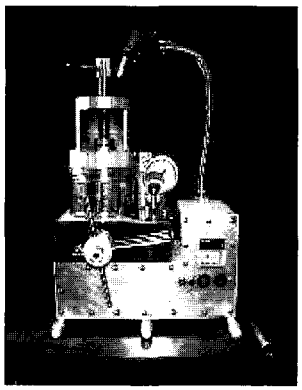

Fig. 8. It shows warm isostatic presser(WIP).

analogous to In-ceram (Fig. 5). The excess glass after the glass infiltration is sand blasted with Al_2O_3 diameter at 50§ > (Fig. 6). The remaining coronal portion of the restoration is constructed with Vitadur~a in a generally used method (Fig. 7).

CLINICAL CASES

Case 1

A 25years old female patient attended a dental clinic with traumatized Maxillary left central incisor. The tooth had exposing pulp tissue, no mobility was observed but had positive response to percussion. There were negative response to percussion and no mobility on the adjacent and opposing dentition. There was no trauma to the soft tissue and other symptoms were revealed (Fig. 9).

Diagnose of class III coronal fracture was made and it was to be restored with all-ceramic crown after root canal treatment. The tooth was root canal treated with common routine method. Using Parapost Sysytem a post was made and cemented with zinc phosphate cement. The core was built afterward using light cured core resin.

The tooth was prepared with diamond point bur on a high speed frictional grip hand piece with copious water. After gingival was retracted additional silicon impression was made. A working die

Fig. 9. The maxillary central incisor was fractured and the pulp tissue was exposed without tooth mobility.

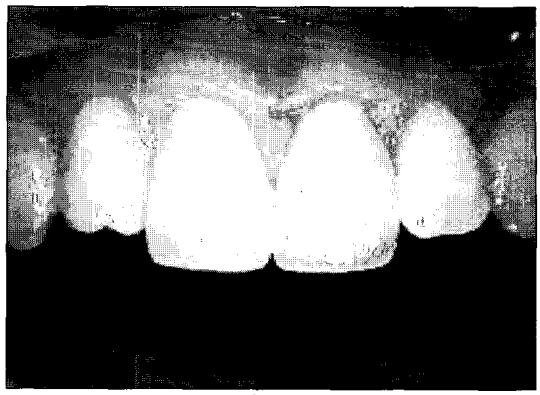

Fig. 10. Post-operation photograph of restored tooth, which was cemented with all ceramic crown fabricated from alumina tapes.

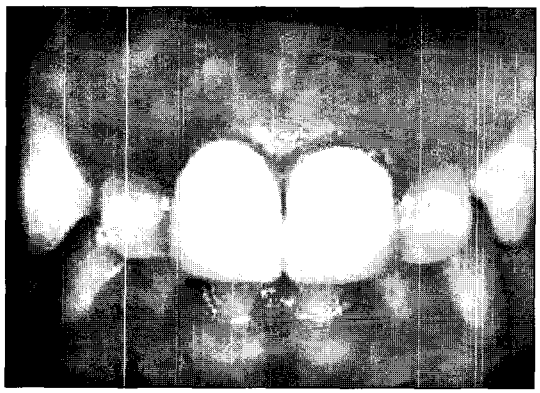

Fig. 11. Maxillary central incisors showed marginal gingivitis, poor color matches and surface caries on maxillary lateral incisors.

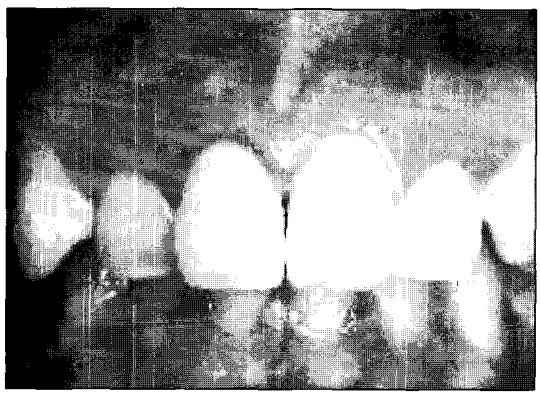

Fig. 12. Porcelain laminate veneer crown were set on lateral incisors and all ceramic crowns fabricated from alumina tapes were set on central incisors.

and a duplicated special plaster model were fabricated and an all-ceramic crown was manufacture with Alumina tape as described earlier. The constructed restoration was tried in the tooth. Marginal fit, contact points and the occlusion were checked and adjusted as necessary. It was then cemented with a resin-based cement (Fig. 10).

Satisfactory clinical observations were made with no complications following two years after the placement of the all-ceramic crown made with Alumina tape.

Case 2

A 24 years old female patient visited the clinic with aesthetically unsatisfactory maxillary anterior restorations. On oral examination her both central teeth had unaesthetic, ill fitting restorations exposing metal margins with gingivitis and gingival recession. The both lateral incisors had caries and decalcification on the cervical regions (Fig. 11). The restorations were removed. All incisors were curetted for removal of calculus with ultrasonic scaler. The lateral incisors were restored with laminate veneers and the central incisors were restored with all-ceramic restoration using alumina tape (Fig. 12).

The manufacturing procedure was as described on the first clinical case. On the recall appointment following two years, presented aesthetically satisfactory restorations with no complication.

CONCLUSION

As the aesthetic takes a large proportion of consideration more teeth are now restored with all-ceramic material and many different types are available with varying their properties. Alumina tape that is being introduced in this article has excellent biaxilar flexure strength of 500 ~600 MPa and toughness of 3.18~3.28 MPa.m, and a linear shrinkage of 0.44 % which is analog to the value of In-ceram. The all-ceramic crown made with alumina tape with 90 shoulder margin has marginal gap of 44.4m and 135 deep chamfer margin has marginal gap of 40.2m. These values indicate an acceptable standard for clinical use.

A clinical trial on all-ceramic restoration with Alumina had good aesthetic result and with no fractures or complications were noted within the two year follow up.

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