Review Article

Applications of Ultrahigh Molecular Weight Polyethylene Fibres in Dentistry: A Review Article

Megha Agrawal, Private practitioner, Vadodara

Corresponding Author

Dr. Megha Agrawal

Private practicioner,

Vadodara

Email: drmeghaa4u@gmail.com

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Abstract

Ultra High Molecular Weight Polyethylene Fibre (UHMWPE) is one of the most versatile materials that have been introduced in dentistry.They are thin, strong, aesthetic, easy to manipulate and exhibit excellent bonding with composite resin. The aim of this article is to review the current applications of ultrahigh molecular weight polyethylene fibre is various discilplines of dentistry.

Keywords: Ultra High Molecular Weight Polyethylene Fibre, Fibre reinforced composites

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Introduction:

Ultra High Molecular Weight Polyethylene Fibre (UHMWPE) is one of the most versatile materials that have been introduced in dentistry. It proves to be a boon to the clinicians on accord of its valuable and multifarious applications pertaining to every field of dentistry such as prosthodontics, restorative dentistry, endodontics, paedodontics, orthodontics as well as periodontics. It has earned the designation of miscellaneousness because it possess extraordinary set of physical properties as it is highly aesthetic compared to cast metal or metal mesh as it is tooth colored secondly, it has high flexibility, is thin as well as strong and is being used to strengthen dental composite in large restorations.

Previously the materials that were used such as cast metal or metal mesh had the disadvantage of being unesthetic and unhygenic.Whereas the bonding ability between resin and reinforcing fibre is superior to that between resin and casting metal and hence is used diversely. In the present review, the varied clinical applications of UHMWPE are comprehensively stated and discussed.

Applications:

Prosthodontics

UHMWPE ribbons have been used to restore single anterior edentulous space. Cases have been reported where the recently extracted natural tooth was used as a pontic which was bonded to the teeth adjacent to either side of the space using Ribbond ribbon and composite resin.[1-5] In some cases, acrylic or composite resin pontic have been used instead of natural tooth and bonded to the teeth on the either side with fiber reinforcement ribbon and composite resin.

In the past, cast metal frameworks, metal mesh, nylon, wires have been used to bond these pontics to adjacent teeth with composite resin. Due to their inability to get chemically incorporated in composite resins, failures of such bridges were common. In addition to this, the bulk of composite resin required to support the wires and mesh grids led to plaque and

food accumulation making it more difficult to clean and maintain good oral hygiene. On the contrary, Ribbond fibres are thin, strong, aesthetic and can be easily manipulated. Also, the bonding ability between resin and reinforcing fibre is superior to that between resin and casting metal. Some reports show that such bridges retain satisfactory aesthetics and function for about a year. In a long term clinical evaluation of splinting using the original Ribbond Reinforcement Ribbon including single visit bridges, it has been reported that over a period of 42-96 months (mean=68.6 months), fiber reinforced composite resins are highly successful.[2]

Restorative Dentistry

Ribbond fibre bands have been used to reinforce composite resin restorations in wide MOD preparations. Cases have been reported in which after priming and bonding procedures, the cavity was lined with flowable composite material and then fibre ribbon is embedded in flowable composite bed in buccal to lingual direction and cured after which the entire cavity was restored with composite resin. Another technique reported was the placement of ribbond fibre on the occlusal third of the restoration. Belli et al reported a case in which they prepared a groove on the occlusal surface of the finished restoration and inserted the Ribbond fibre ribbon in combination with flowable resin in the groove in buccal to lingual direction, cured it and then covered it with composite resin. Studies show that such procedures significantly increase the fracture strength. Placement of the fibre in the occlusal third of the restoration showed even higher fracture resistance.[6,7] Some authors say that use of a Leno Woven Ultra High Molecular Weight (LWUHMW) polyethylene fibre ribbon in combination with bonding agent and flowable composite under composite restoration may act as a stress absorber because of its lower elastic modulus thereby increasing fracture resistance. Another reason for the increased fracture resistance might be the bonding ability of the LWUHMW polyethylene fibre because of which the cusps might have bonded together.

Also, the use of flowable composite in combination with polyethylene or glass fibers helps reduce occlusal leakage in Class II adhesive cavities with enamel margins.There is a great deal of stress at the dentin-composite interface and modifications in that would reduce or eliminate the interfacial stress concentrations may reduce gap formation and microleakage. A higher modulus of elasticity and lower flexural modulus of the polyethylene fiber were reported to have a modifying effect on the interfacial stresses developed along the etched enamel-resin boundary.

Paedodontics

Reports have shown the use of UHMWPE as posts along with extensive composite restoration in primary anterior teeth after trauma. Such restoration showed excellent clinical performance after 2.5 years in primary anterior teeth after pulp therapy. The advantages of Ribbond fibre are its greater strength and increased flexural characteristics of the composite resin, which provide high fatigue resistance, preserve the architectural shape, and maintain fibre orientation during application. In addition to this, the tooth integrity can also be maintained as it does not require additional dentinal preparation for its placement.[8]

Ribbond fibres can be potentially used to make space maintainers. Studies have shown that ribbond space maintainers have similar strength as that of conventional stainless steel band and loop space maintainers.[9]

Orthodontics

UHMWPE ribbon reinforced composites have also been used as lingual retainers. These were introduced to overcome the problems associated with the conventional stainless steel wire retainers. The most

frequent problems of metal retainers are failure of the wire-composite interface, breakage of the wire, and detachment of the resin pads at the composite-enamel interface. Since fibre reinforced composites allowed chemical adhesion of the retainer to the bonding agent, they were expected to reinforce the resistance of the bonding agent by transferring the loads acting on the retainer complex to the fibres.Nevertheless, retainer failures still occurred and clinical survival studies did not reveal significant results. A 6-year clinical follow-up study showed no significant differences between FRC and multistranded wire retainers; the results indicated that FRC retainers could be a viable alternative to multistranded wire retainers. Two recent cinical studies showed a 37.9% failure rate in a 6-month period with multistranded wire retainers and a 94.8% survival rate in a 4.5-year period with FRC retainers. However, some reports suggested that multistranded wire retainers were significantly superior to UHMWPEribbon-reinforced retainers and discouraged their use due to higher failure rate.[10]

Periodontics

Polyethylene fibre reinforced composites have been for splinting teeth that have become mobile due to acute periodontal lesions following trauma. The fibre segment of corresponding length can be cut, wetted with adhesive resin and can be applied to the middle third of the buccal surfaces of teeth which are covered with a thin layer of flowable composite and then light cured. Ribbond is biocompatible, esthetic, easy to adapt and manipulate and no laboratory work is needed thereby reducing chairside time. It also has acceptable strength because of good integration of fibers with the composite resin; this leads to good clinical longevity. In addition to this, Ribbond polyethylene fibre reinforced splints have flexibility that allow mild tooth movement would exert mechanical stimulus which would in turn favour the revascularization process, prevent ankylosis and maintain the Hertwig's epithelial root sheath , which is vital in the event of the developing roots. Several materials can be used for splinting but it has been observed that teeth stabilized with high- flexibility splints are less likely to undergo root resorption and show a better reorganization of the periodontal fibres compared with teeth splinted by means of rigid contention devices which cause excessive compression of periodontal ligament and hinders healing by interfering with fibroblast metabolism because of the lack of mechanical stimuli.[11,12]

Endodontics

In recent times, Ultra High Molecular Weight Polyethylene (UHMWPE) fiber reinforcement systems have been used widely as endodontic posts. They offer several advantages over the conventional metallic posts. They help to conserve the remaining sound dental structure as there is no need to enlarge the root canal space which in turn reduces the risk of root canal perforation. The elastic modulus of these posts is similar to that of dentin and can be bonded to both dentin and core material creating a monoblock dentin-post-core system which improves the distribution of forces along tooth roots which further contributes to the tooth-restoration reinforcement.[13] Moreover, these tooth colored posts allow light transmission through them which was impeded in conventional metallic post, thus providing better esthetics. Other advantages include ease of manipulation and reduction in microleakage due to better bonding capacity.[14] A study showed that customized fibre post systems EverStick Post or Ribbond showed mostly repairable fracture pattern after loading and therefore seem to be preferable for the rehabilitation of the roots with vertical fracture and re-attached fragments.[15] Another study showed that Ribbond post-core system saved the remaining root structure 100% in

the sound roots and therefore can be considered as an appropriate material for the restoration of the weak roots.[15] One study showed that the effect of cyclic loading on loss of retention was significantly lesser in custom fabricated Ribbond posts than compared to metal and glass fibre posts.[16] Various case reports showing use of Ribbond fibre posts have shown good clinical performance.

Conclusion

Ribbond polyethylene fibre bands are thin, strong, aesthetic, easy to manipulate and exhibit excellent bonding with composite resin. These fibre bands have been successfully used in varied disciplines of dentistry for numerous purposes. They can be used to give interim prosthesis, reinforce large bulky composite restorations, splinting of traumatized teeth, as lingual retainers and endodontic posts. However, these studies show short term clinical results only. Further clinical trials with long term results are required to validate the credibility of this material on a long term basis and understand its efficacy.

Applications of Ribbond Fibres

Applications of Ribbond Fibres

- For making FPDs for single anterior edentulous space using natural or acrylic tooth as a pontic
- For reinforcement of wide MOD restorations
- As posts in primary teeth
- For making space maintainers
- As lingual retainers
- For splinting teeth after trauma
- As endodontic posts in structurally weakened teeth

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