ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 4, Issue – 6, November - 2021, Page No. : 343 - 358

To evaluate the suitability of using Polyether ether ketone (PEEK) in fabrication of telescopic prosthesis (Double crowned retained prosthesis) in terms of resistance to load and surface wear - A Systematic Review

[1]Harsh Kasabwala, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai.

[2]Dr Deepak Nallaswamy, Director of academics, Saveetha Dental College and Hospitals, Saveetha Institute Of Medical And Technical Sciences, Saveetha University, Chennai.

Corresponding Author: Harsh Kasabwala, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai.

Citation of this Article: Harsh Kasabwala, Dr Deepak Nallaswamy, "To evaluate the suitability of using Polyether ether ketone (PEEK) in fabrication of telescopic prosthesis (Double crowned retained prosthesis) in terms of resistance to load and surface wear - A Systematic Review ", IJDSIR- November - 2021, Vol. – 4, Issue - 6, P. No. 343 – 358.

Type of Publication: Review Article

Conflicts of Interest: Nil

Abstract

The main objective of the study is to evaluate if Polyether ether ketone is a suitable material over other available materials in terms of wear resistance, retention, patient satisfaction and clinical efficacy. An electronic search was done in Pubmed, European PMC, Lilac, Google Scholar, and Cochrane Library. A total of 5 studies were included in the present study based on the Search strategy (PICO) inclusion criteria. All the studies were In- Vitro studies. Among sll the included articles found in literature till date no studies has analysed the long term effects of peek as a telescopic abutment. Although majority of the lab based non clinical studies support the use of PEEK for a telescopic denture, well-designed randomized controlled trials are required in this field to establish the clinical applicability of the material. Conclusion: Within the limits of the present study it can be concluded that there is insufficient evidence to prove that the use of PEEK is ideal in the fabrication of telescopic prosthesis. Well-designed randomized controlled trials are required in this field in order to improve the awareness of this material among the clinicians.

Keywords: Telescopic prosthesis, Double crown retained prosthesis, Polyether ether ketone, Cobalt chromium, Surface wear, Retention.

Introduction

Polyetheretherketone (PEEK) a modification of the main thermoplastic polymer group polyether aryl ketone (PEAK). [1] It is a high temperature thermoplastic polymer, consisting of an aromatic backbone molecular chain, it is interconnected by ketone and ether functional groups. [2] The melting point of this material is roughly 343 °C, the density accounts for 1.3–1.5 g/cm. [3] Apart

from its high temperature stability it also has a very high hardness and a lower water absorption and solubility Therefore, PEEK is an interesting alternative to traditionally used alloys and ceramic materials. [4] Many authors in their studies have used PEEK as implant, provisional abutment, implant supported bar, clasp material in the field of removable dental prosthesis (RPD) and for FPDs. [5-7] Various materials are currently being used in fabrication of telescopic prosthesis. PEEK is one such material that has been introduced in the dental market recently and is gaining much popularity due to its various advantages. [8,9] This systematic review explores the available literature on the use of the clinical use of peek for telescopic denture.

The lower surface energy of the PEEK material reduces the chances of surface modifications which is one of the main concerns in making a telescopic prosthesis. [10,11] Due to less wearing off of the material there is a higher chance of the prosthesis having a longer life and the snug fitting of the prosthesis will remain intact. Telescopic crowns have been used mainly in the fabrication of removable dental prostheses (RDP). They aid in connecting the denture or acrylic framework to the remaining dentition. [12] They can also be called as retainers in completely abutment or tooth -borne removable prosthesis. [10-13] The number and distribution of the telescopic crowns dictates the amount of retention and stability that can be achieved. The taper of the walls of the primary copings is also very important to achieve retention. In cases of crowns or abutments with short clinical height, the walls of the primary coping should be extremely parallel with max taper between 2-5 degrees to achieve good retention. [14] PEEK has been advised as good material for telescopic copings as they showed good retentive loads after multiple pull out tests. [15-17] PEEK material has also shown to have reduced surface changes as compared to other materials when exposed to surface wear making them ideal for telescopic copings. [8] This systematic review is done to critically analyse all the literature and studies done on telescopic prosthesis made of PEEK material.

In their private practice many dentists have started using PEEK for the fabrication of different prosthesis (mainly FPDs and hybrid denture frameworks). [9] There is very little evidence that shows the clinical efficacy, survival rates, biocompatibility and stability of PEEK double crown systems. In this context it is also unknown whether the fabrication method of PEEK double crowns has an impact on the stability, clinical efficacy and patient satisfaction. Hence, this systematic review aims at collecting all the evidence that aids us in making a conclusion about the applicability of PEEK in fabrication of telescopic prosthesis.

Materials and Methodology:

Structured Question

In cases requiring telescopic prosthesis is Polyether ether ketone a suitable material over other available materials in terms of wear resistance, retention, patient satisfaction and clinical efficacy?

The searched electronic databases included, National Library of Medicine (PubMed), Google Scholar, Science Direct, Cochrane database of systematic reviews. No limitation regarding publication type and publication date was set.

Search strategy:

(telescopic prosthesis) OR telescopic dentures) OR double crown retained prosthesis) OR telescopic copings) OR primary copings) OR secondary copings) OR telescopic overdenture) OR partially edentulous space) OR few remaining teeth)) AND (((poly ether ether ketone) OR peek) OR pectone)) AND (cobalt chromium) OR nickel chromium) OR phonetics) OR

ease of cleaning) OR retention) OR wear resistance) OR masticatory efficiency) AND (patient satisfaction) OR phonetics) OR ease of cleaning) OR retention) OR wear resistance) OR masticatory efficiency) (Table 2)

The search strategy was based on the PICO criteria

Inclusion Criteria (Articles fulfilling any 2 of the following)- Articles describing telescopic prosthesis fabricated using PEEK, studies comparing PEEK telescopic prosthesis with other materials, In-vitro studies, prospective studies, retrospective studies, RCTs, case-series, clinical trials.

Exclusion criteria: Studies involving removable prosthesis other that double crowned prosthesis, Studies comparing outcomes other than the outcome measures decided for the systematic review.

Results

PEEK showed promising results in terms of retention loads when used as telescopic copings. [15] The fabrication method of PEEK telescoping copings did not have a significant effect on the retention loads. The degree of taper of primary copings did not affect the retention load when PEEK was used as a material for secondary coping over zirconia primary copings. [16,18] The processing of PEEK telescopic copings was much more convenient as compared to conventionally used materials (cobalt chromium). The adaptability and flexibility of PEEK telescopic copings was found to be much superior as compared to its conventional counterparts. The ability to polish PEEK copings on the other had been much more difficult than metal copings. [18] Telescopic attachments fabricated using Zircon-PEEK material transmitted the least amount of stresses in comparison to all PEEK, and all zircon ones. On the other hand the greatest wear was shown with the Zircon-PEEK group. [8] All PEEK attachments were found to be good alternatives for telescopic copings.

Discussion

Choosing the ideal/correct material is a major step in the fabrication of telescopic removable partial denture and in the success of the treatment. Various aspects that have to be taken into consideration in choosing the material are as follows- Retention, aesthetics and load distribution. The friction between the primary and secondary crowns governs the amount of retention that can be achieved in the prosthesis enabling it to function for the longest time possible. Aesthetic dictates the choice of the treatment as the patients generally tend to prefer a metal free prosthesis. [19] The distribution of load should be equalised and should transmit the force uniformly and in a favourable manner. The double crown prosthesis effectively transmits the occlusal forces along the direction of the long axis of abutments this provides better resistance and stability to the prosthesis. Apart from that, they also provide guidance, support and protection from movements that might dislodge the removable partial dentures. [20]

PEEK is a soft and ductile material. It has good adaptive quality and fitting. [15] Owing to these qualities PEEK showed satisfactory retention load values when they were used as primary telescopic copings. [15] This suggests that PEEK could be a good alternative and a suitable option as a primary coping material when compared to conventionally used materials like cobalt chromium or titanium.

PEEK has a low flexural modulus which is only up to 4 GP. [2] This could be a possible explanation for the fact that the fabrication method and degree of taper of primary copings did not affect the retention load when PEEK was used as a material for secondary coping over zirconia primary copings. [16-18] This is in contrast with the general idea that the retention load decreases with the increase in the taper of the primary copings. [21-22] The

pressed form of PEEK showed slightly better retention load values as compared to its other forms. Taper had no effect on the pressed form of PEEK secondary crowns. [16] PEEK is much easier to process, and shows better adaptability and was found to be more flexible than metal. But the ability to polish PEEK is much more difficult than metal. [18]

Low modulus of elasticity (4 GPa) of PEEK as compared to other conventional materials aids it in absorption of occlusal loads and also reduces surface wear. The surface topography of all PEEK, all zircon and Zircon-PEEK telescopic attachments after six months of overdenture use was assessed. Telescopic attachments fabricated using zircon-PEEK material transmitted the least amount of stresses in comparison to all PEEK, and all zircon ones. On the other hand the greatest wear was shown with Zircon-PEEK group which is of the same kind as that of natural teeth. [8] All PEEK telescopic attachments could be suggested as good options for telescopic prosthesis copings.

Till date cobalt chromium was supposed to be the most suitable material for fabrication of cast partial dentures. With time there will always be a continued improvement of materials and techniques used in dentistry which could become potential alternatives to traditional materials used in the field of prosthodontics. PEEK is one such innovative material that has shown promising results in different branches. But there is a lack of studies on the long term survival rates, patient satisfaction, plaque accumulation, stability and fracture resistance associated with the prosthesis. Hence, long term studies monitoring the prognosis of various telescopic attachment materials and its properties should be encouraged.

The limitations of the present study include : articles with literature only pertaining to In-Vivo study without any randomized controlled trial done on the topic of interest. The level of evidence of this systematic review is not very high due to lack of studies. There are only 2 outcome measures that could be evaluated in the studies included in this review (resistance to load and surface wear resistance). None of the articles mention stability, patient satisfaction, clinical efficacy and plaque accumulation associated with the PEEK Telescopic prosthesis. None of the articles included in the review were homogeneous as there are no articles with the same outcome measures that involve PEEK fabricated telescopic prosthesis. Another shortcoming of the systematic review is that none of the articles mentioned the influence of thermo mechanical stress occurring on the prosthesis during daily wear. This review cannot come to a conclusion as there is a severe lack of evidence on using PEEK as a material for fabrication of telescopic prosthesis. Further research is needed in this particular field.

PEEK is an innovative material that has shown promising results in different branches. Many clinicians have started using PEEK in fabrication of various dental prostheses. Due to the lack of awareness and availability, the material is currently not very popular among dental clinicians. By studying the materials physical properties and advantages the material does seem to be quite promising and has a good future in fabrication of not only telescopic prosthesis but also other dental prosthesis.

Conclusion

There is insufficient evidence to prove that the use of PEEK is ideal in the fabrication of telescopic prosthesis. Well-designed randomized controlled trials are required in this field in order to improve the awareness of this material among the clinicians.

References

1. Panayotov IV, Orti V, Cuisinier F, Yachouh J. Polyetheretherketone (PEEK) for medical applications [Internet]. Vol. 27, Journal of Materials Science: Materials in Medicine. 2016. Available from: http://dx.doi.org/10.1007/s10856-016-5731-4
2. Kurtz SM, Devine JN. PEEK biomaterials in trauma, orthopedic, and spinal implants. Biomaterials. 2007 Nov;28(32):4845–69.
3. Chen H-L, Porter RS. Melting behavior of poly(ether ether ketone) in its blends with poly(ether imide) [Internet]. Vol. 31, Journal of Polymer Science Part B: Polymer Physics. 1993. p. 1845–50. Available from: http://dx.doi.org/10.1002/polb.1993.090311217
4. Liebermann A, Wimmer T, Schmidlin PR, Scherer H, Löffler P, Roos M, et al. Physicomechanical characterization of polyetheretherketone and current esthetic dental CAD/CAM polymers after aging in different storage media [Internet]. Vol. 115, The Journal of Prosthetic Dentistry. 2016. p. 321–8.e2. Available from: http://dx.doi.org/10.1016/j.prosdent.2015.09.004
5. Santing HJ, Meijer HJA, Raghoebar GM, Özcan M. Fracture Strength and Failure Mode of Maxillary Implant-Supported Provisional Single Crowns: A Comparison of Composite Resin Crowns Fabricated Directly Over PEEK Abutments and Solid Titanium Abutments [Internet]. Vol. 14, Clinical Implant Dentistry and Related Research. 2012. p. 882–9. Available from: http://dx.doi.org/10.1111/j.1708-8208.2010.00322.x
6. Bayer S, Komor N, Kramer A, Albrecht D, Mericske-Stern R, Enkling N. Retention force of plastic clips on implant bars: a randomized controlled trial [Internet]. Vol. 23, Clinical Oral Implants Research. 2012. p. 1377–84. Available from: http://dx.doi.org/10.1111/j.1600-0501.2011.02312.x
7. Tannous F, Steiner M, Shahin R, Kern M. Retentive forces and fatigue resistance of thermoplastic resin clasps [Internet]. Vol. 28, Dental Materials. 2012. p. 273–8. Available from: http://dx.doi.org/10.1016/j.dental.2011.10.016
8. Emera RK, Altonbary G, Elbashir S. Comparison between all zirconia, all PEEK, and zirconia-PEEK telescopic attachments for two implants retained mandibular complete overdentures: In vitro stress analysis study [Internet]. Vol. 9, Journal of Dental Implants. 2019. p. 24. Available from: http://dx.doi.org/10.4103/jdi.jdi_6_19
9. Najeeb S, Zafar MS, Khurshid Z, Siddiqui F. Applications of polyetheretherketone (PEEK) in oral implantology and prosthodontics. J Prosthodont Res. 2016 Jan;60(1):12–9.
10. Noiset O, Schneider Y-J, Marchand-Brynaert J. Adhesion and growth of CaCo2 cells on surface-modified PEEK substrata [Internet]. Vol. 11, Journal of Biomaterials Science, Polymer Edition. 2000. p. 767–86. Available from: http://dx.doi.org/10.1163/156856200744002
11. Ohl A, Schröder K, Keller D, Meyer-Plath A, Bienert H, Husen B, et al. Chemical micropatterning of polymeric cell culture substrates using low-pressure hydrogen gas discharge plasmas. J Mater Sci Mater Med. 1999 Dec;10(12):747–54.
12. Langer A. Telescope retainers and their clinical application [Internet]. Vol. 44, The Journal of Prosthetic Dentistry. 1980. p. 516–22. Available

from: http://dx.doi.org/10.1016/0022-3913(80)90070-0

13. Langer A. Tooth-supported telescope restorations [Internet]. Vol. 45, The Journal of Prosthetic Dentistry. 1981. p. 515–20. Available from: http://dx.doi.org/10.1016/0022-3913(81)90037-8
14. Sakai Y, Takahashi H, Iwasaki N, Igarashi Y. Effects of surface roughness and tapered angle of cone crown telescopic system on retentive force. Dent Mater J. 2011 Sep 23;30(5):635–41.
15. Stock V, Schmidlin P, Merk S, Wagner C, Roos M, Eichberger M, et al. PEEK Primary Crowns with Cobalt-Chromium, Zirconia and Galvanic Secondary Crowns with Different Tapers—A Comparison of Retention Forces [Internet]. Vol. 9, Materials. 2016. p. 187. Available from: http://dx.doi.org/10.3390/ma9030187
16. Merk S, Wagner C, Stock V, Eichberger M, Schmidlin P, Roos M, et al. Suitability of Secondary PEEK Telescopic Crowns on Zirconia Primary Crowns: The Influence of Fabrication Method and Taper [Internet]. Vol. 9, Materials. 2016. p. 908. Available from: http://dx.doi.org/10.3390/ma9110908
17. Wagner C, Stock V, Merk S, Schmidlin PR, Roos M, Eichberger M, et al. Retention Load of Telescopic Crowns with Different Taper Angles between Cobalt-Chromium and Polyetheretherketone Made with Three Different Manufacturing Processes Examined by Pull-Off Test. J Prosthodont. 2018 Feb;27(2):162–8.
18. Stock V, Wagner C, Merk S, Roos M, Schmidlin PR, Eichberger M, et al. Retention force of differently fabricated telescopic PEEK crowns with different tapers. Dent Mater J. 2016;35(4):594–600.
19. Zarone F, Russo S, Sorrentino R. From porcelain-fused-to-metal to zirconia: clinical and experimental considerations. Dent Mater. 2011 Jan;27(1):83–96.
20. Langer A. Telescope retainers for removable partial dentures. J Prosthet Dent. 1981 Jan;45(1):37–43.
21. Turp I, Bozdağ E, Sünbüloğlu E, Kahruman C, Yusufoğlu I, Bayraktar G. Retention and surface changes of zirconia primary crowns with secondary crowns of different materials. Clin Oral Investig. 2014 Nov;18(8):2023–35.
22. Ohkawa S, Okane H, Nagasawa T, Tsuru H. Changes in retention of various telescope crown assemblies over long-term use [Internet]. Vol. 64, The Journal of Prosthetic Dentistry. 1990. p. 153–8. Available from: http://dx.doi.org/10.1016/0022-3913(90)90170-h

Legend Tables

Sn.	Author & Year	Study Design	Reason For Exclusion
1	Schwindling et al. 2017	Rct	Difference in the intervention group and outcome parameters
2	Salvi et al. 2007	Rct	Difference in the intervention group and outcome parameters
3	Verma et al.	Systematic review	Difference in the intervention group .
4	Schwindling and Deisenhofer et al. 2017	Rct	Difference in the intervention group

Table 1: Table illustration depicting the list of studies that were excluded from the systematic review where the prime reason for exclusion was heterogeneity among group.

P	(telescopic prosthesis) OR telescopic dentures) OR double crown retained prosthesis) OR telescopic copings) OR primary copings) OR secondary copings) OR telescopic overdenture) OR partially edentulous space) OR few remaining teeth))
I	(poly ether ether ketone) OR peek) OR pectone))
C	(cobalt chromium) OR nickel chromium) OR phonetics) OR ease of cleaning) OR retention) OR wear resistance) OR masticatory efficiency))
O	(patient satisfaction) OR phonetics) OR ease of cleaning) OR retention) OR wear resistance) OR masticatory efficiency)

Table 2: illustration depicting the population, intervention, comparison and outcome (PICO) that has been evaluated in this study.

Sn.	Title	Author and Year	Study Design	Intervention	Groups	Sample Size	Type of Statistics Used	Outcome	Conclusion
1	Suitability of Secondary PEEK Telescopic Crowns on Zirconia Primary Crowns: The Influence of Fabrication Method and Taper	Susanne et al. 2016	In vitro study	Secondary PEEK Telescopic Crowns	GROUP 1- PEEK milled secondary copings GROUP 2- PEEK pressed pellets secondary copings	Total sample size 90 secondary crowns Group 1 - 30 secondary crowns Sub groups (0 degree, 1	Kolmogorov–Smirnov test, 2way and 1-way ANOVA test, Scheffé's post-hoc test.	RETENTION LOAD GROUP 1 (Zero degree taper) Mean and standard deviation- 13.83 ± 7.82	In assessing retention load, PEEK may be a suitable material for removable prosthesis and a telescopic crown technique when used on zirconia crowns. However, long-term investigations and the advancement of PEEK CAD/CAM processing are still necessary

					GROUP 3- PEEK pressed granular secondary crowns	degree, 2degree taper) Group 2 - 30 secondary crowns Sub groups (0 degree, 1 degree, 2degree taper) Group 3- 30 secondary crowns Sub groups (0 degree, 1 degree, 2degree taper)		(1degree taper) Mean and standard deviation- 6.07 ± 3.01 (2 degree taper) Mean and standard deviation- 14.10 ± 8.19 GROUP 2 (Zero degree taper) Mean and standard deviation- 22.83 ± 5.94 (1degree taper) Mean and standard deviation- 21.06 ± 8.60 (2 degree taper) Mean and standard deviation- 19.84 ± 7.13 GROUP 3 (Zero degree taper) Mean and standard deviation- 15.87 ± 2.58	

								(1degree taper) Mean and standard deviation- 27.00 ± 10.05 (2 degree taper) Mean and standard deviation- 19.05 ± 8.25	
2	Retention force of differently fabricated telescopic PEEK crowns with different tapers	STOCK et al. 2016	In vitro study	Secondary PEEK Telescopic crowns	GROUP 1- PEEK milled secondary copings GROUP 2-PEEK pressed pellets secondary copings GROUP 3-PEEK pressed granular secondary crowns	Total sample size 90 secondary crowns Group 1 - 30 secondary crowns Sub groups (0 degree, 1 degree, 2degree taper) Group 2 - 30 secondary crowns Sub groups (0 degree, 1 degree, 2degree taper) Group 3- 30 secondary crowns Sub groups (0 degree, 1 degree, 2degree taper)	Kolmogorov–Smirnov test, 2way and 1-way ANOVA test, Scheffé's post-hoc test	RETENTION LOAD GROUP 1 (Zero degree taper) Mean and standard deviation- 4.29 ± 1.48 (1degree taper) Mean and standard deviation- 21.12 ± 9.17 (2 degree taper) Mean and standard deviation- 29.06 ± 9.37 GROUP 2 (Zero degree taper) Mean and standard deviation-	Milled PEEK crowns with a 0° taper showed the lowest retention force values, whereas milled PEEK crowns with a 2° taper showed the highest retention force values. For pressed PEEK crowns the taper angle had no impact on retention force. However, insights based on long-term studies are still necessary.

								14.9 ± 7.62 (1degree taper) Mean and standard deviation- 17.46 ± 7.13 (2 degree taper) Mean and standard deviation- 19.73 ± 4.21 GROUP 3 (Zero degree taper) Mean and standard deviation- 11.64 ± 5.74 (1degree taper) Mean and standard deviation- 15.11 ± 8.05 (2 degree taper) Mean and standard deviation- 17.08 ± 9.29	
3	PEEK Primary Crowns with Cobalt-Chromium, Zirconia and Galvanic Secondary Crowns with Different Tapers—A Comparison of Retention Forces	STOCK AND SCHMIDLIN et al.	In vitro study	PEEK Primary crowns	Group 1 - PEEK primary copings with CoCr secondary copings	Total sample size 90 PEEK Primary copings 90 secondary copings	Kolmogorov–Smirnov test, 2way and 1-way ANOVA test,	GROUP 1 (Zero degree taper) Mean and standard deviation- 15.00 ± 11.16	Satisfactory high retention force values were achieved, which shows that PEEK, in combination with cobalt-chromium, zirconia, as well as with galvanic secondary crowns, is suitable as a primary crown for removable

					Group 2 PEEK primary copings with zirconia secondary copings PEEK primary crowns with Galvanic secondary copings	Grouping of secondary crowns Group 1 - 30 cobalt chromium secondary crowns Sub groups (0 degree, 1 degree, 2 degree taper) Group 2 - 30 zirconia secondary crowns Sub groups (0 degree, 1 degree, 2degree taper) Group 3- 30 galvanic secondary crowns Sub groups (0 degree, 1 degree, 2degree taper)	Scheffé's post-hoc test	(1degree taper) Mean and standard deviation- 21.40 ± 8.11 (2 degree taper) Mean and standard deviation- 31.20 ± 11.27 GROUP 2 (Zero degree taper) Mean and standard deviation- 16.90 ± 4.15 (1degree taper) Mean and standard deviation- 22.80 ± 7.15 (2 degree taper) Mean and standard deviation- 38.20 ± 2.39 GROUP 3 (Zero degree taper) Mean and standard deviation- 26.10 ± 15.14 (1degree taper)	partial dentures. In the 1″ and 2″ tapers, CoCr and ZrO2 presented higher retention force values than GAL, whereas in the 0″ taper no difference was found.

								Mean and standard deviation- 9.60 ± 9.08 (2 degree taper) Mean and standard deviation- 14.80 ± 8.00	
4	Retention Load of Telescopic Crowns with Different Taper Angles between Cobalt-Chromium and Polyetheretherketone Made with Three Different Manufacturing Processes Examined by Pull-Off Test	Wagner et al. 2016	In vitro study	PEEK secondary crowns	GROUP 1- PEEK milled secondary copings GROUP 2-PEEK pressed pellets secondary copings GROUP 3-PEEK pressed granular secondary crowns	Total sample size 90 secondary crowns Group 1 - 30 secondary crowns Sub groups (0 degree, 1 degree, 2degree taper) Group 2 - 30 secondary crowns Sub groups (0 degree, 1 degree, 2degree taper) Group 3- 30 secondary crowns Sub groups (0 degree, 1 degree, 2degree taper)	Kolmogorov-Smirnov test Shapiro-Wilk tests. Kruskal-Wallis Test Mann-Whitney U-test	GROUP 1- (Zero degree taper) Minimum and maximum retention load values 1.3 and 19.1 respectively (1degree taper) Minimum and maximum retention load values 6.6 and 35.6 respectively (2 degree taper) Minimum and maximum retention load values 10.8 and 27.7 respectively GROUP 2- (Zero degree taper) Minimum and maximum retention load values 5.2 and 27.3 respectively	Telescopic crowns made by polyether ether ketone seem to have stable retention load values for each test sequence. However, further data is still required.

								(1degree taper) Minimum and maximum retention load values 3.7 and 16.2 respectively (2 degree taper) Minimum and maximum retention load values 6.0 and 18.8respectively GROUP 3- (Zero degree taper) Minimum and maximum retention load values 5.9 and 24.5 respectively (1degree taper) Minimum and maximum retention load values 5.7 and 34.8 respectively (2 degree taper) Minimum and maximum retention load values 5.5 and 24.9 respectively	

5	Surface wear of All Zirconia, All PEEK and Zirconia-Peek Telescopic Attachments for Two Implants Retained Mandibular Complete Overdentures. In -Vitro study using scanning electron microscope.	Radwa et al.	In vitro study	Surface wear of PEEK telescopic copings primary and secondary	Group 1 All Peek telescopic group Group 2 All Zirconia telescopic group Group 3 Zirconia Peek telescopic group	Total samples=3 The surface topography for all the 3 groups was evaluated at 0 and 6 months respectively	Shapiro-wilks test. Student's t-test One way ANOVA test Post-hoc tukey test	Group 1 a)Top surface wear(primary coping) mean and standard deviation value 7.727 ± 1.288 b)Primary coping(wall surface wear) mean and standard deviation value- 1.565 ± 0.2608 c)Secondary coping wear mean and standard deviation value- 2.914 ± 0.4856 Group 2 a)Top surface wear(primary coping) mean and standard deviation value 2.842 ± 0.437 b)Primary coping(wall surface wear) mean and standard deviation value- 0.25 ± 0.0417 c)Secondary coping wear mean and standard deviation value- 2.676 ± 04896.	Combining PEEK and zirconia for telescopic attachment construction may be associated with changes in surface topography in contrast to all PEEK or all Zirconia telescopic attachments.

								Group 3 a)Top surface wear(primary coping) mean and standard deviation value 2.89 ± 0.482 b)Primary coping(wall surface wear) mean and standard deviation value- 2.62 ± 0.467 c)Secondary coping wear mean and standard deviation value- 22.88 ± 3.813	

Table 3: This table shows the general information of all the 5 included articles in this systematic review and the outcome measures used in those studies.

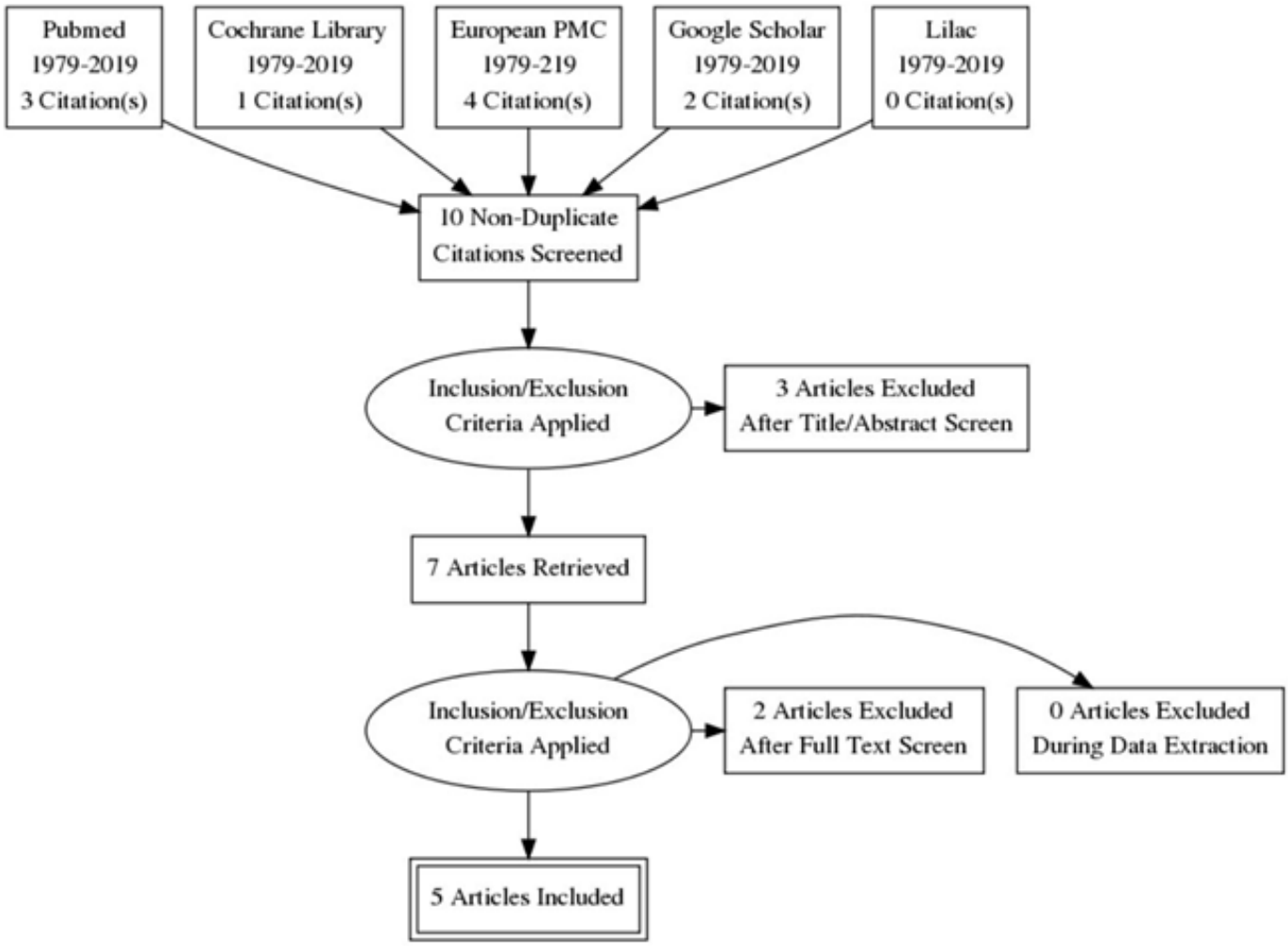

Figure 1: This flowchart depicts the search methodology and the inclusion and exclusion of the articles according to the required criteria