Implant-Retained Overdentures Using an Attachment with True-Alignment Correction: A Case Series

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Severely resorbed residual alveolar ridges in edentulous patients preclude the construction of retentive and stable complete dentures (CDs). Ill-fitting CDs can compromise oral function, thereby affecting the individual’s oral health–related quality of life (OHRQoL) and possibly causing psychosocial problems. Implant therapy is often preferred to preserve the residual ridges in the peri-implant area, improve the retention of the removable dental prosthesis (RDP), and maintain the stability of the RDP during function, thereby improving the masticatory efficiency as well as the patient’s OHRQoL. However, for implant overdenture (IOD) therapy to be successful, the number and position of implants are considered essential aspects in an ideal treatment concept. This may not always be possible in functionally compromised elderly individuals, particularly in those with severely resorbed jaws. Factors such as anatomical constraints, compromised multimorbid health statuses, economic factors, or the patient’s choice to not opt for complex surgeries in addition to implementing the geriatric treatment aspect of reducing the treatment burden could greatly influence the number of implants planned and also sometimes the alignment.
of the implants placed. In effect, inter-implant alignments may deviate from the ideal, resulting in clinical situations that may not always be easy to rehabilitate and may potentially cause frequent prosthetic complications and lead to increased maintenance needs. In such situations, the right choice of anchorage system may play a fundamental factor in achieving a successful rehabilitation. The selected attachment should not be cumbersome to process; ought to be easy to clean, repair, or remake; must not be too retentive for frail elderly individuals with low hand force and/or dexterity; and, finally, not have a high initial cost.

The CM LOC FLEX anchor (Cendres+Métaux), is an unsplinted, stud-type attachment system that is specifically designed for clinical situations where the inter-implant angulation is not parallel. The attachment system has an angular compensatory mechanism for up to 60 degrees between implants. The abutment head is designed to act as a swiveling head, which is free to rotate until the desired parallelism is achieved. A dual-curing resin cement is then injected into the abutment head, which is fixed at the desired angulation once the cement has set. The female component of this anchor comprises a housing assembly that holds a retentive insert. The retentive inserts are available in different strengths and are made from polyetherketoneketone (PEKK) (Pekkton, Cendres+Métaux). For higher retentive demands, a gold alloy (Elitor, Cendres+Métaux) insert is further available. This Elitor insert is adjustable, as the retentive force can be further increased or decreased per the patient's individual requirement. The housing itself is available in two material options: Pekkton or titanium, both of which utilize the same PEKK inserts; the Elitor insert, however, can only be used with a titanium housing. Furthermore, PEKK being a strong and durable polymer, it is versatile in its use and can be used with various different veneering materials, making it a suitable material of choice for a framework that can be utilized for both fixed and removable implant reconstructions.

Therefore, the objectives of this clinical report were to demonstrate the functionality of a novel attachment with a true-alignment correction capability in complex cases with large inter-implant angular discrepancies and to demonstrate the use of PEKK as a viable reinforcing framework material in IODs.

CASE 1: MANDIBULAR IOD RETAINED BY CM LOC FLEX ATTACHMENTS ON TWO TISSUE-LEVEL IMPLANTS

A 59-year-old man dissatisfied with his existing mandibular IOD retained by two implants opposing a conventional maxillary CD was referred to the Removable Prosthodontics Clinics for rehabilitation. His chief complaints included an unstable mandibular IOD, lack of retention, inability to eat, pain, and discomfort. The patient also reported the need for frequent maintenance visits to improve the retention of his unstable IOD. He also complained of pain in the peri-implant region around the implant on his left side. He did not have any complaints with his maxillary CD. The existing prostheses had been in situ for approximately 2 years. His medical history revealed controlled diabetes mellitus, but the patient was otherwise healthy. Extraoral examination revealed no apparent pathology, no TMJ problems, and no history of parafunctional habits. His mouth opening was normal. Intraoral and radiographic examinations revealed a severely resorbed maxilla and mandible (Figs 1a to 1c). There were two Regular Neck Tissue-Level Straumann implants (Institut Straumann) with a stud-type anchorage system (Locator, ZEST Anchors) present in the mandible in the regions corresponding to tooth positions 33 and 43 (FDI). The implants were divergent to one another, and the inter-implant angular deviation was large (estimated to be > 40 degrees) (Fig 1d). The peri-implant mucosa around implant 33 was inflamed, revealing signs of pressure and frictional trauma (Fig 2a). After careful consideration of the patient’s current complaints and his financial situation, a conservative treatment plan was decided. A decision was made to change the existing attachments to CM LOC FLEX attachments and to process the corresponding housings in the existing IOD intraorally.

The Locator abutments were first unscrewed from the implants. The case guidelines (Cendres+Métaux) were then mounted on the implants to check the height of the gingival cuff for choosing the correct FLEX abutments (Fig 2b). The gingival cuff height was measured as 1 mm and 2 mm on implants 43 and 33, respectively. The appropriate CM LOC FLEX attachments were selected (Figs 2c and 2d). The abutments were first hand tightened on the implants (Fig 3a), then subsequently tightened to 35 Ncm using a ratchet and torque control device (Cendres+Métaux) per the manufacturer’s recommendations (Fig 3b). As a next step, for aligning the abutments, a separating medium (Vaseline, Unilever) was first applied on the abutment head to help easily remove the excess cement. The abutment aligners (Cendres+Métaux) were then seated on the abutments (Fig 3c). Extreme care was exercised to ensure that the filling funnel of the aligner was properly seated onto the central filling hole on the abutment head (Fig 3d). For aligning the abutments, a dual-curing resin cement (Rely X, 3M ESPE) was injected into the aligner in order to fill the abutment’s cement chamber (Fig 4a). The excess cement flow was confirmed through the lateral escape outlets present adjacent to the central filling hole (Fig 4b). The abutments were then tipped manually until the desired parallelism was achieved (Figs 4c and 4d).
Fig 1  (a) Orthopantomogram showing initial situation. (b) Intraoral occlusal view of edentulous maxilla. (c) Occlusal view of mandible with two tissue-level implants. (d) Planners in place illustrating inter-implant angular discrepancy. Note: The discrepancy between the implant positions in (a) and (d) is due to the poor three-dimensional positioning of the implants.

Fig 2  (a) Evidence of peri-implant inflammation. (b) Abutment height selection. (c) Selected CM LOC FLEX abutment (GH1). (d) Positioning of abutment.
The alignment was performed within the cement’s specified setting time. The aligners were then left undisturbed until the final setting of the cement was completed (Figs 4c and 4d). Subsequently, the aligners were removed, and the abutment heads were cleared of the excess cement (Figs 5a and 5b). The former denture caps were removed from the IOD using a housing extractor (Cendres+Métaux) (Figs 5c and 5d). The Pekkton housings (Figs 6a and 6b) were subsequently snapped on the aligned abutments (Fig 6c). The available space in the IOD was then verified using a silicone material (Fit Checker Advanced, GC) (Fig 6d). Exposed denture intaglio surfaces were marked and trimmed until the required clearance was obtained. After a final check, the IOD was cleaned and prepared for the intraoral processing of the housings. Petroleum jelly (Vaseline, Unilever) was applied on the mucosa of the edentulous ridge adjacent to the implants and on the lips of the patient to prevent any possible irritation from the autopolymerizing polymethylmethacrylate (PMMA) resin. The housings were removed from the attachments in order to place the block-out spacers (Cendres+Métaux) onto the abutments, and the housings were subsequently snapped back onto the abutments (Figs 7a and 7b). Care was taken not to contaminate the housing surfaces with the petroleum jelly, as this could interfere with the mechanical locking of the resin to the housing. The PMMA resin (Unifast, GC EUROPE) was mixed and applied with a disposable microbrush (3M ESPE) on top of the housing and then into the housing spaces of the IOD using a regular cement spatula (Fig 7c). The IOD was then carefully seated, and the patient was requested to close into centric occlusion and maintain the bite until the PMMA resin polymerization was complete (Fig 7d). The IOD was then removed and inspected. Excess resin around the housings was trimmed, finished, and then polished (Fig 8a). The white processing inserts were then removed using the multi-tool (Cendres+Métaux) with the side marked “OUT” (Figs 8b to 8d), and then replaced with green (medium-strength) inserts with the same multi-tool but with the side marked “IN” (Figs 9a to 9c). The multi-tool used in this case history has currently been replaced with a multi-tool with a central slot to facilitate easier placement of the retentive insert. Final checks were then performed, and the patient was given postinsertion and denture hygiene instructions (Fig 9d).
Fig 4  (a) Injection of dual-curing resin cement. (b) Verification of excess cement flow. (c) Abutments tipped to correct parallelism. (d) Occlusal view of aligned abutments.

Fig 5  (a) Removal of abutment aligners and excess cement. (b) Occlusal view of aligned abutments. (c, d) Removal of former denture caps using housing extractor.
Fig 6  (a) Basic Pekkton set. (b) Pekkton housings with white processing inserts. (c) Housings positioned for space verification. (d) Space verification.

Fig 7  (a) Block-out spacers in place. (b) Housings positioned. (c) PMMA resin filled in housing space. (d) IOD in situ with patient in centric occlusion.
**Fig 8**  (a) Processed housings in IOD. (b) Multi-tool. (c, d) Removal of processing insert with side marked “OUT.”

**Fig 9**  (a, b) Insertion of green retentive insert with side marked “IN.” (c) Finished prosthesis. (d) Prostheses in situ.
a desire for a prosthesis without a palate. The definitive treatment plan included a palate-free maxillary IOD retained by four tissue-level implants and a mandibular tooth-supported, chrome-cast RDP and a root canal treatment (RCT) planned for tooth 43. Furthermore, the maxillary IOD was planned to be reinforced with a PEKK framework (Pekkton, Cendres+Métaux).

As a first step, the RCT was performed on tooth 43. Next, four Regular Neck Tissue-Level Straumann implants (Institut Straumann) were placed in the maxilla, in the regions of 15, 13, 23, and 25, in a single-stage surgery adhering to the implant manufacturer’s recommended standard surgical protocol (Fig 10a). The immediate denture was well relieved to not engage the implants during the healing phase and was subsequently relined using a functional tissue-conditioning material (F. I. T. T., Kerr). A cast post-and-core coping with a ball anchor was planned for 43 in order to eliminate an unesthetic anterior clasp assembly in the mandibular cast RDP. However, it was then decided to not engage the tooth for RDP support, as the tooth was not entirely symptom-free and the prognosis was considered

CASE 2: PEKKTON (PEKK)-REINFORCED MAXILLARY IOD RETAINED BY FOUR CM LOC FLEX ATTACHMENTS

A 72-year-old man was referred to the Removable Prosthodontic Clinic for the rehabilitation of a completely edentulous maxilla and partially edentulous mandible. His chief complaints included inability to eat properly and poor esthetics. His desire was to have a good reconstruction that was functional and esthetic. His extraoral examination revealed a piercing in the left ala of the nose, no pathologies, a mouth opening that was considered normal, and no evidence of TMJ problems. He did not report any history of parafunctional habits. Intraoral and radiographic examinations revealed a completely edentulous maxilla rehabilitated with an immediate CD opposing a Kennedy Class III, Division 1 partially edentulous mandible with the following remaining teeth: 48, 43, 42, 41, 31, 32, 33, and 38. Tooth 43 was nonvital and revealed an apical pathology. The patient reported that he was very uncomfortable with the palatal part of the immediate denture and expressed

Fig 10  (a) Orthopantomogram (OPG) showing initial situation. (b) Occlusal view of partially edentulous mandible. (c) Healed implants in maxilla. (d) Impression transfers in place, illustrating inter-implant axial divergences.
questionable. Hence, a decision was made to amputate the crown portion of 43 to the level of the gingival margin, and a composite restoration was placed to cover the amputated part. The tooth was left in place, unloaded, to help maintain the bone in that region (Fig 10b). The implants were allowed to heal for a period of 6 weeks before construction of the definitive prostheses commenced (Fig 10c). Standard clinical steps and protocols for the construction of an IOD and a cast RDP were followed. During the impression phase it was confirmed that the implants were divergent to one another and that an inter-implant angular discrepancy of over 40 degrees existed (Fig 10d). Therefore, the decision to use the CM LOC FLEX anchors was made. After the clinical verification of the wax trial dentures (Fig 11a), the maxillary definitive model and the teeth setup in wax were scanned by the digital dental lab technician. This information was essential for a digital design of the PEKK framework. A final design preview was then sent to the treating clinician for approval (Fig 11b). The PEKK framework was subsequently milled after design approval and then sent to the clinician. The framework was tried-in for fit and stability (Fig 11c). The teeth were then transferred onto this framework using a silicone key, exactly as the earlier approved setup. This setup on the framework was verified and approved by the patient before denture processing. The definitive maxillary IOD with a PEKK framework and a conventional cast RDP (Figs 11d to 12b) was then manufactured by a dental technician in a conventional dental lab. The housing spaces for the intraoral processing of the housings were already incorporated into the finished IOD by the technician (Fig 12a). The prostheses were tried-in intraorally and checked for retention, stability, fit, extensions, aesthetics, and occlusion.

The healing abutments were first removed from the implants (Figs 12c), and the case guides (Cendres+Métaux) were mounted for measuring the correct gingival cuff height (Figs 12d and 13a). The cuff heights were measured to be 1 mm for all the implants, and the appropriate FLEX abutment (GH1) was selected (Figs 13b to 13d). Pekkton housings with PEKK inserts were selected to be used in this case to keep the IOD metal-free. The abutment tightening and aligning were performed in the same manner as described in the previous case (Figs 14a to 15c). The housing space was

![Fig 11](a) Try-in of tooth setup. (b) Design preview of Pekkton framework. (c) Try-in of milled Pekkton framework. (d) Final completed prosthesis.
Fig 12  (a) Finished prosthesis with housing spaces. (b) Finished cast RPD. (c) Healing abutments being removed. (d) Case guides being positioned.

Fig 13  (a) Case guides in place showing implant divergences. (b) Selected abutment with 1-mm cuff height (GH1). (c, d) Hand tightening of abutments.
then verified (Fig 15d). An additional step was necessary during the processing of the housings in this case to facilitate the adhesion between the framework and the PMMA resin. The housing spaces were first sandblasted with aluminum oxide particles (Fig 16c). Then a PMMA and composite primer (Visio.link, Bredent) was applied on the Pekkton surfaces and light cured for 90 seconds (Fig 16d). Following this, the usual steps of processing

**Fig 14**  
(a) Abutment torqued to 35 Ncm.  
(b) Abutments ready for aligning.  
(c) Aligners in place.  
(d) Injection of dual-curing resin cement.

**Fig 15**  
(a) Aligners tipped to correct parallelism.  
(b) Corrected alignment.  
(c) Aligners and excess cement removed.  
(d) Space verification.
the housings with autopolymerizing PMMA were followed (Figs 17a to 17c). The processing inserts were removed (Fig 17d) and replaced with yellow (extra-low retentive strength) inserts, as the retention strength was deemed sufficient initially both by the clinician and the patient (Figs 18a and 18b). After denture delivery, detailed postinsertion and hygiene instructions were given to the patient (Figs 18c and 18d).
DISCUSSION

In the past, bar attachments (splinted attachments) have often been used as the attachments of choice for situations where implants were not parallel to one another. However, bar attachments are cumbersome to fabricate, present problems with hygiene and gingival hyperplasia under the bar, are not easy to repair or remake, and may be too retentive for elderly individuals with poor manual dexterity. Finally, they are relatively expensive, especially concerning the initial cost. Moreover, bar attachments require ideal inter-arch distances, the lack of which may compromise the esthetics or the functionality of the IOD. Even though some unsplinted anchorage systems are known to compensate for angular deviations to a certain degree, premature loss of retention, attachment, and insert wear, as well as an increased need for maintenance, have all been reported as frequent complications. The compensatory mechanism provided by these unsplinted attachments are either via their geometric configurations, separate angulated options available in their midst, and/or purpose-built retentive inserts, none of which provide an actual alignment correction. The highlighted cases were examples where implants were either improperly positioned or where axial deviations were dictated by anatomical constraints and limitations concerning the invasiveness of the intervention. A lack of parallelism is frequently a cause for unsuccessful rehabilitation because of premature or rapid retention loss, inadequate retention, and poor stability, leading to excessive maintenance costs that often result in patient dissatisfaction, potentially even affecting the OHRQoL.

Attachments with true-alignment correction capabilities promise to sustain their intended retentive behavior even in situations of large inter-implant angular deviations. These unsplinted attachments should theoretically perform better than those unsplinted attachments without a true-alignment correction mechanism. However, this needs to be confirmed with well-designed clinical trials. Novel attachments such as the one described in this report seem highly advantageous, notably by providing solutions that remain within the spectrum of geriatric treatment concepts of remaining minimally invasive, as they may enable a reduction of treatment burden through avoiding bone grafting procedures. The demonstrated attachment highlights the possibility of providing a simple, efficient, and cost-effective solution. The entire procedure was completed in a single chairside visit, avoiding multiple patient visits.

Fig 18   (a) Placement of definitive inserts (yellow). (b) Finished prosthesis ready for insertion. (c, d) Final result: Occlusal views of prostheses in situ.
and extensive clinical as well as laboratory procedures. In effect, the same existing prosthesis was used and corrected to provide a viable and satisfactory outcome. From a geriatric perspective, this is highly advantageous, especially for elderly patients with dependency and limited access to care. The attachment is fairly new, and mechanical problems encountered with this system have yet to be documented. Therefore, the frequency of the possible mechanical complications, such as wear of the attachment head and damage to the retention insert and/or the housing assembly, all may be important factors in clinical decision making when choosing to employ this system. Moreover, the use of unspliced attachments in the maxilla has been documented to increase the probability of implant failure. This factor must be considered before using these attachments, and careful case selection is pertinent to avoid failure.

PEKK is a strong and durable polymer that displays both amorphous and crystalline material properties. This unique property makes it an apt material for implant reconstructions. It can be milled and pressed with a surface that can be easily polished. Although it is strong, it is light in weight and metal-free, insulant to thermal and electrical conductivity, has no odor or taste, can be sterilized, and is radiopaque. Since it is metal-free, it can be used safely in patients with metal allergies. A huge advantage of this material is its compatibility with various different veneering materials. Its beige (ivory) color may present an aesthetic and psychologic advantage. PEKK-reinforced IODs are lightweight and do not have the gray shadows that are usually seen in IODs with metal reinforcements. Another advantage of this material is that although it is strong, it can be easily trimmed and adjusted when required. The enumerated advantages thus make PEKK a suitable choice for a framework material in both fixed and removable implant reconstructions, but its clinical long-term performance remains to be evaluated.

CONCLUSIONS

- The CM LOC FLEX abutment has a true-alignment correction mechanism that can be advantageous in clinical situations where the inter-implant axial alignments are not parallel.
- In terms of its clinical manipulation, these attachments are simple to employ, but the manufacturer’s instructions must be strictly adhered to in order to avoid processing errors.
- PEKK frameworks are lightweight, strong, and can be esthetic substitutes for conventional metal frameworks.
- Well-designed clinical studies are further needed to assess the clinical performance, as well as the maintenance requirements, of the illustrated novel attachment and the PEKK framework before advocating them as validated and standard protocols.
- Although novel systems provide solutions to complex clinical situations, appropriate prosthetically driven implant planning along with a close working relationship between the surgeon and the prosthodontist are cardinal to avoid poor implant positioning.

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REFERENCES

Rehabilitation of the Edentulous Mandible with an Immediately Loaded Full-Arch Fixed Prosthesis Supported by Three Implants: A 5-Year Retrospective Analysis

The purpose of this study was to evaluate the clinical and radiographic outcomes of full-arch mandibular rehabilitation with a fixed prosthesis supported by three immediately loaded implants after at least 5 years of follow-up. The sample was comprised of 58 patients who underwent prosthetic treatment with immediate loading. Radiographic evaluation of bone loss was carried out in Adobe Photoshop CS5 by a single calibrated examiner using digitized panoramic radiographs. Clinical examination of the technical conditions of the prosthetic device assessed the condition of the acrylic resin base, dental occlusion, metal framework, presence of cover screws, screw fixation of the prosthesis and abutments, and length of cantilevers and resistance arms. Five implants in four patients failed for an overall success rate of 97.13%. Mean bone loss was 2.65 ± 1.06 mm around central implants and 2.11 ± 0.84 mm around distal implants. The most common complication was loss of abutment torque. Half of all patients in the sample experienced some prosthetic complication. There was no evidence of a statistically significant cantilever length with bone loss or prosthetic complications. The immediately loaded three-implant–supported fixed prosthesis protocol tested in this study proved to be a viable therapeutic strategy for mandibular rehabilitation in edentulous patients with favorable outcomes after 5 years of clinical and radiographic follow-up.