#### ORIGINAL ARTICLE



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### Catastrophic implant failure after immediate loading of full arch implant prosthesis and its association with CPAP therapy: A case report

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#### Abstract

Full arch implant-supported restorations are a common treatment modality for patients with a terminal dentition or an edentulous mouth. Several mechanical and biological factors that contribute to complications or failure are already extensively documented. Some patients receiving complex implant-based treatment plans also suffer from obstructive sleep apnea (OSA). The use of a continuous positive airway pressure (CPAP) mask in some of these patients is a lesser-known factor that could contribute to implant complications or failures. This article describes how the use of a CPAP machine may be a risk factor in implant dentistry and describes a patient whose use of a CPAP machine and mask led to a catastrophic failure of mandibular full arch dental implants.

#### KEYWORDS

continuous positive airway pressure, CPAP, full arch implant restoration, implant failure

Prosthodontic rehabilitation changed forever after the discovery and application of the concept of osseointegration by a Swedish physician, Per Ingvar Branemark, in the 1960s.<sup>1</sup> Mandibular complete-arch fixed implant-supported prostheses are recognized as one of the earliest and most popular prostheses in implant dentistry. This prosthesis was the spotlight of the early era of osseointegration and is still the cutting-edge treatment modality today in treating edentulism. A report described a 30-year follow-up of a patient who underwent treatment for a mandibular complete-arch fixed implant-supported prosthesis with four machined surfaced implants.<sup>2</sup> However, 30 years of success does not always occur. Early implant experiments were wrought with infection, extensive bone loss, pain, poor mastication, and failure with removal of the offending implants.<sup>3</sup> Nonetheless, with careful execution of Branemark's prescribed surgical and prosthodontic protocols, clinicians began to experience a high degree of implant survival.

The literature is saturated with success stories of osseointegrated implants retaining full arch prostheses. One study evaluated 152 patients, comprising 200 arches (800 implants) from May 2005 until December 2011. Overall implant cumulative survival rate (CSR) was 97.3% (778 of 800). Two hundred eighty-nine of 300 maxillary implants and 489 of 500 mandibular implants survived, for CSRs of 96.3% and 97.8%, respectively.<sup>4</sup> With this survival rate in the literature, it is imperative to educate the profession on any potential risk factors that can affect these successful rehabilitation procedures.

Malo et al. demonstrated in 2005 that maxillary All-on-Four rehabilitations had a CSR of 97.6%, approximately 1% higher than their 2003 study in the mandible (96.7%) CSR).<sup>5</sup> Nevertheless, clinical complications with implants and implant prostheses can occur, related to implant loss, bone loss, peri-implant soft tissue inflammation/hyperplasia, mechanical, and aesthetic/phonetic.<sup>6</sup> Of the possible complications in implant dentistry, mechanical complications are one of the most prevalent.<sup>6,7</sup> Mechanical complications may occur such as prosthetic screw loosening, prosthetic screw fracture, abutment screw loosening, abutment screw fracture, implant fractures, framework fracture, or loss of retention (for cemented prostheses).<sup>6–9</sup> According to the literature, potential risk indicators for the prevalence of mechanical complications include: bruxism, cantilever extensions, length of the reconstruction, and implant distribution.<sup>9</sup> Of all these complications, there is one that is not in the dental literature—CPAP (continuous positive airway pressure) mask pressure between the mucosa flap and the intaglio surface

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of the immediate load conversion prosthesis. This is a landmark article that will add CPAP equipment use to the list of osseointegration risk factors. The authors predict CPAP use is a high-risk contributing factor for implant failure due to the following reasons: mechanical pressure exerted by the mask margin on the mucosal flap closure, positive air pressure on the bone, and bacteria forced under the mucosal flaps from the CPAP tube.

It is imperative to educate the profession on any new risk factors. This article will describe a patient who experienced the detrimental effects of a CPAP mask on the healing of an AO4 immediate load protocol. In this patient, use of a CPAP machine led to catastrophic failure of all implants.

#### PATIENT TREATMENT REPORTS

The patient (S.A.), a 71-year-old male, presented to the Nova Southeastern University Post Graduate Prosthodontics clinic with a chief complaint, "I want to have my lower teeth done". Clinical and radiographic examination revealed terminal mandibular dentition due to compromised periodontal status, mobility, and non-restorable prognosis. Maxillary teeth #3 and #4 had full coverage crowns with open margins and secondary dental caries. Periodontal status was stage II grade B. The angle classification was class III molar relationship for both right and left sides with a canine classification of class 1. Overjet was 2 mm and overbite was 2 mm. The patient's medical history is suggestive of ASA class II. Medications include Crestor (Rosuvastatin), Aspirin, and multivitamins. No allergies were reported. The patient revealed he was diagnosed with sleep apnea disorder and uses a CPAP at night for treatment. This medical finding came only after the AO4 surgery and immediate loading was completed. The CPAP use was not disclosed during the initial review of the patient's medical and dental history. There was no history of parafunctional habits. The patient had a history of smoking about a pack per day for 11 years but quit 10 years prior to the current dental treatment. The patient understood the risks and benefits of the dental treatment and agreed upon the following treatment sequence: (1) Full arch extraction of mandibular teeth, (2) Immediate implant placement, and (3) Insertion and immediate load of mandibular fixed prosthesis. This will be followed up by periodontal treatment and fixed partial dentures in the maxilla.

Restorative diagnosis: non-restorable mandibular dentition.

Periodontal diagnosis: Stage II Grade B periodontal disease.

Prognosis: Fair prognosis for the maxillary arch. Hopeless prognosis for the natural dentition in the mandibular arch.

#### Appointment #1

Extraction of all mandibular teeth with moderate alveoloplasty and placement of four Dentsply Sirona implants (Astra Tech EV; Dentsply Sirona International, Inc, York, PA, USA)

- 1. Angulated posterior implants were placed in an effort to increase AP spread (Figure 1).
- 2. Multiunit abutments were placed on implants to correct angle and torqued to 25 Ncm. Temporary cylinders were hand-tightened onto abutments. A removable denture was used as a conversion prosthesis on temporary cylinders. Approximately 5 mm diameter preparation holes were made to accommodate temporary cylinders. Temporary cylinders were picked up under rubber dam isolation with polymethlymethacrylate (PMMA).
- 3. Primary closure was achieved with 4.0 Vicryl sutures single interrupted, 4 mm apart. There was no tension on closure and hemostasis was achieved.
- 4. Conversion prosthesis was finished and polished in the laboratory. It was then inserted, and hand tightened using prosthetic screws to 15 Ncm to the implant multiunit abutments. Occlusion was refined and adjusted to provide multiple centric occlusion contacts and adequate anterior guidance with no pressure on the conversion prosthesis posterior to the distal implants. A minimal distal cantilever of one bicuspid was provided for esthetics and tongue control.
- 5. Hemostasis was achieved. No additional anesthesia was required at the end of the appointment. Patient was able to drive home. Sterile surgical setting was adhered to during the entirety of surgery, copious normal saline irrigation was used during implant placement, and manufacturer recommendations were strictly adhered to through the entirety of the All On 4 "Teeth in A Day" procedure. Lastly, occlusion was confirmed to be stable by both clinician (Prosthodontist) and patient.

#### Appointment #2: 24 h post-operative follow up

The patient was called the following day and reported little swelling and no pain. Patient elected not to come in person for evaluation the day following surgery.

# Appointment #3: 10 days post-operative follow up

The patient returned 10 days post-surgery to report increasing discomfort and minor swelling. Clinical examination revealed flaps wide open with extensive bone exposed in the anterior area of the mandible. The bone was cleaned, carefully removing a layer of necrotic bone. Bone was also removed at the margins of the flaps to enhance primary closure. The implants and prosthesis remained stable. The patient was instructed on appropriate home care and appointed to return for reevaluation and suture removal in 4 weeks.

**FIGURE 1** Initial surgery post-operative panoramic radiographic.





FIGURE 2 Removal of failed All on four prostheses with implants.

#### **Appointment #4: Suture removal**

During this visit, the flaps appeared to be reopened, exposing a significant amount of bone. The conversion prosthesis was carefully removed in order to access the implants and surrounding bone. When removing the seals from the screw access channels, the entire prosthesis was mobile and was easily removed out of the mandible including all Astra Tech EV implants. Significant facial and lingual cortical plates remained attached to the implants as the entire prosthesis was removed (Figure 2).

With the implants removed, all granulation tissue and necrotic bone were thoroughly excavated. Remaining bone was scrapped to cause bleeding indicating vital bone with potential of new bone formation. Chlorohexidine solution was used to irrigate the surgical site.

Primary closure of the elevated flap was achieved with Cytoplast 4.0 single interrupted suture. After learning that the



**FIGURE 3** (a) Sagittal view of the patient wearing CPAP mask; (b) CPAP mask.

patient was using the CPAP with pressure, he was advised to not use said CPAP face mask device for the following 3 weeks (Figure 3). The patient's sleep physician approved this and recommended different sleeping positions that would help the patient with the chronic sleep apnea. The physician recommended elevating the head of the bed 3–4 inches.

### **Appointment #5: Revision surgery consultation**

Patient presented 3 weeks later for suture removal and reevaluation of the existing bone. Mucosal soft tissue was well healed. A CBCT was taken to evaluate bone availability to plan the new implant placement (Figure 4).

Revision implant surgery was planned in Nobel BioCare DTX studio dental software (Nobel Biocare, Yorba Linda, California) based on the bone remaining and bone available. Branemark NobelSpeedy Groovy external hex design implants were chosen for the revision surgery. These new implants are different than the failed Astra EV Osseospeed implants that were originally placed.

In addition, the patient was offered the option of guided bone regeneration (GBR) to build up the bone with new



**FIGURE 4** (a) CBCT assessment and (b) Intraoral view (post full arch implant extraction).



implant placement in 6 months. The patient declined the GBR option desiring expedient treatment to provide teeth as soon as possible. Guided bone regeneration was not required; a functionally viable solution that met the patient's requirements of not having GBR was also possible. This procedure was therefore not performed in accordance with the patient's desires for an expedited functional outcome.

Patient was advised of the following treatment plan: mandibular complete denture implant support prosthesis on five implants. Three implants will be placed in the interforaminal region, and two implants will be placed posterior to the mental foramen. The two posterior implants will be placed bilaterally to avoid cantilever with early implant loading.

#### Appointment #6: Revision surgery—placement of posterior implants

After 4 weeks of uneventful healing, posterior implant placement was performed. The patient was premedicated with 600 mg Clindamycin. After infiltration of local anesthetic in areas #18,19,20 and #29,30,31, a crestal incision was made from in the middle of the ridge in the posterior area with distal vertical release incisions bilaterally. Full thickness flap was elevated beyond the mucogingival junction. Implant osteotomy was done using Nobel Speedy External hex surgical drill kit.

A Nobel Branemark Speedy Groove RP  $4.0 \times 10$  mm was placed at the site of #19; insertion torque was recorded at 45 Ncm. A straight 1 mm height multiunit abutment was placed over the implant. Implant stability was measured using Osstell which gave a value of 65/66 indicating excellent primary stability. The same protocol was done for the implant at site #30. #30i recorded an insertion torque of 40Ncm. Stability was measured using Osstell which gave a value of 65/63 indicating equally good primary stability. Multiunit healing abutments were placed on both implants. 4.0 Chromic gut single interrupted sutures were used to obtain primary closure with excellent hemostasis bilaterally. The patient's interim removable prosthesis was relieved to ensure no pressure was applied to the implant healing abutments.



**FIGURE 5** Revision surgery, post-operative osseointegration panoramic radiographic.

#### **Appointment #7: Revision surgery—placement** of anterior implants

Three weeks later the patient returned for implant surgery in the anterior mandible. The patient was premedicated with 600 mg Clindamycin. After infiltration of local anesthetic in the anterior of the mandible, a crestal incision was made in the middle of the ridge and two vertical releasing incisions were created in areas #20 and #29. A full thickness flap was elevated beyond the mucogingival junction so that mental foramens could be identified. Implant osteotomy was done using Nobel Speedy External hex surgical kit. The following implants were placed (Figure 5):

- Site #24 4.0 × 10 mm Nobel Branemark Speedy Groovy with 45 Ncm insertion torque and Osstell was used to measure Implant stability quotient (ISQ) 53/57.
- Site #27 4.0 × 11.5 mm Nobel Branemark Speedy Groovy with 50 Ncm insertion torque and Osstell was used to measure ISQ 59/60.
- Site #22 4.0 × 10 mm Nobel Branemark Speedy Groovy with 30 Ncm insertion torque and Osstell was used to measure ISQ 52/54.
- Straight 3 mm collar height multiunit abutments were placed on the implant #24,27, and cover screw was placed in the implant #22.

Tetracycline solution was used to irrigate the surgical site. The flap was then sutured closed with 3.0 chromic gut



FIGURE 6 Intraoral view of healing mandibular arch.

single interrupted and 4.0 Vicryl single interrupted sutures. The patient's interim prosthesis was relined with COE-SOFT denture reline material (GC America 3737 W 127th St, Alsip, IL, USA). The soft reline was completed when the author confirmed that the denture base did not impinge upon the healing abutments.

#### **Appointment #8: Implant uncovery**

Eight weeks after the last surgery patient presented back to the Post Graduate Prosthodontic clinic for uncovery of implant #22 and early loading of all the implants (Figure 6). Stability of all the implants was measured again using Osstell; the ISQ value of implant #19 was 67/64, implant #22 was 55/60, implant was #24 57/61, implant #27 was 65/68, and implant #30 was 69/65 indicating highly acceptable stability. Healing abutments were removed followed by the placement of the titanium temporary cylinders over the implant abutments. The patient's existing monolithic denture (Avadent-Scottsdale, Arizona) was early loaded and modified into a conversion prosthesis via the Balshi technique.<sup>10</sup> Radiographs were taken to confirm complete seating of the prosthesis. Occlusion was adjusted to have even contacts and no excursive interferences. The patient was instructed to avoid using the CPAP mask and was followed up 1 week after conversion to re-evaluate occlusion and mucosal healing around the conversion prosthesis and abutments.

## **Appointment #9: Post-op visit and final impressions for definitive fabrication**

After 6 weeks, the patient presented to the clinic and the mandibular conversion prosthesis was removed for the first time. The patient was happy with the esthetics, phonetics, and function of the conversion prosthesis. A pickup impression of the conversion prosthesis was used to fabricate the master cast according to the published protocol (The Balshi technique).<sup>10</sup> The prosthesis and master cast were scanned using a 3Shape Trios Intraoral Scanner. The STL file acquired from the conversion prosthesis on the master cast was sent to Avadent (Global Dental Science, LLC, Scottsdale, AZ, USA) for fabrication of a mandibular PMMA Monolithic Wrap-around ISFCD commonly referred to as a "hybrid prosthesis" using

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**FIGURE 7** (a) Intraoral view of definitive "Hybrid" Avadent Monolithic PMMA with robotically milled titanium framework and (b) Closeup intraoral view of prosthesis.

a robotically milled titanium bar. This monolithic PMMA is eight times stronger than traditional lab-processed PMMA (Balshi, S—ACP 2019 Annual Scientific Session).

## Appointment #10: Delivery of definitive prosthesis

The provisional prosthesis was removed. All abutments were torque tightened to 25 Ncm and ISQs were recorded. The hybrid prosthesis was screwed in and 15 Ncm torque was applied to prosthetic screws (manufacturer recommendation) after confirming complete seating on radiographs. Minor occlusal adjustments were made. Teflon tape was compressed into the screw access holes and Telio (Ivoclar Vivadent, Liechtenstein, Switzerland) was used to fill the screw access holes. The patient was delighted with the outcome of the treatment. The patient was put on a 4-month re-care. Post-treatment photos are shown in Figures 7–10.

#### DISCUSSION

Prior to the implant surgery, this patient met the criteria for being an implant reconstruction candidate. He had no history of diabetes, no bisphosphonate history, was a nonsmoker, had systemic blood pressure within normal limits, no parafunctional habits, and was overall a healthy 71-yearold Caucasian male. What the authors did not know was the undisclosed history of wearing a CPAP machine at night. However, even if the patient did disclose this information





FIGURE 8 Close up smile of the definitive prosthesis in place.



FIGURE 9 Occlusal view of healed mandibular arch.



FIGURE 10 Panoramic: Definitive restoration.

many clinicians would not have recognized this red flag. This is because no dental literature exists reporting CPAP machine usage as an implant risk factor.

The dental literature has reported risk factors for implant osseointegration for decades. Moy et al. reported on dental implant failure risk factors stating, "Patients who were over age 60, smoked, had a history of diabetes or head and neck radiation, or were postmenopausal and on hormone replacement therapy experienced significantly increased implant failure compared with healthy patients."<sup>11</sup> Can new risk factors emerge depending on the timeframe of osseointegration? One article describes implant failures as primary or secondary. Implant failures may occur early (primary) after implant placement or after the implant is loaded (secondary). There is no single etiological factor and failures have been attributed to poor surgical technique, host factors that impair healing, poor bone quality, peri-implant infections, poor prosthesis design, and traumatic loading conditions.<sup>12</sup> This patient treatment has demonstrated that sleep apnea and subsequent CPAP machine usage are new landmark risk factors that contributed to primary implant failure.

Sleep apnea is a major public health threat. "There is emerging evidence that sleep apnea may accelerate the aging process." Patients with sleep apnea have an increase in oxidative DNA damage, increase in DNA breakage, and poor DNA repair.<sup>13</sup> Additionally, there is evidence that heat shock proteins increase under stress and restore misfolded proteins and heat shock protein70 levels are decreased in obstructive sleep apnea. These levels normalize with CPAP treatment. <sup>14</sup> CPAP is the gold standard for treating sleep apnea.<sup>15</sup>

The authors believe it is imperative that the dental profession is aware of the risks of CPAP machine use during early osseointegration periods of full arch implant-supported restorative treatment. There are numerous alternatives to treating sleep apnea aside from the CPAP machine. A variety of other treatments, including mouth appliances, weight loss, and upper airway surgery, might be useful.<sup>15</sup>

In the authors' experience, the consequences of continuing to use a CPAP mask during the primary osseointegration period of an implant immediately loaded supported full arch reconstruction was catastrophic failure. Catastrophic failure is a major loss to the patient physically, psychologically, and financially.

If screening reveals CPAP usage, it may be necessary to have the patient on a "CPAP machine hiatus" prior to any surgical intervention and subsequent to surgery. This will likely prevent any primary failure of the implant therapy related to the deleterious effects of wearing a CPAP mask.

The extraoral use of a CPAP mask adds significant pressure to an immediately loaded prosthesis albeit extraorally and indirectly adds to the load that the implants experience. A large number of patients undergoing full mouth implant rehabilitation may also be using a CPAP mask for treatment of sleep apnea. It is therefore important that the profession is helped to understand the potential risk that such a mask poses to the success of implant rehabilitation. It is highly possible that the CPAP mask and the extraoral pressure that it applies was a significant contributing factor leading to failure in the first instance.

The alternative treatment would include submerged implants with a removable denture and delayed loading of these implants after osseointegration and discontinuation of the CPAP mask use. However, the patient declined this option desiring expedient treatment with immediate function.

If a dental surgeon finds themselves with a catastrophic implant rehabilitation failure due to undisclosed CPAP machine usage this article proves there is a rebound strategy. First, immediate CPAP machine hiatus and an alternative sleep apnea treatment must be prescribed. Next, controlled healing of the bone necrosis and retreatment of the implant placement is appropriate. The patient's successful implant revision and subsequent definitive restoration in this report show that a successful clinical revision is possible. This change was made in the best interest of the patient's long-term function and success with the definitive prosthesis. While a different implant system was used for rehabilitation of the patient, the authors believe that discontinuation of the CPAP mask added significantly to the potential for success. The change in an implant system cannot be a significant contributing factor in this success as both implant systems that were used are well documented in the literature with high success rates.<sup>4,5,10,16</sup> Ultimately extraoral pressure in any form translates into excessive external load on an immediately functional prosthesis.

With the increased use of implant-supported surgical treatment followed by a "Teeth in A Day"<sup>TM</sup> rehabilitation protocol, it is imperative to inform the dental profession of the CPAP machine risk factor. After complete osseointegration, the patient may return to wearing the CPAP machine at night to remedy the long-term harmful effects of sleep apnea. More studies would be helpful on short-term side effects of CPAP usage and complications with osseointegration.

#### CONCLUSION

Successful revision treatment using dental implants after a CPAP machine hiatus was initiated from the time of catastrophic failure of a mandibular full arch implant supported rehabilitation. Providing the patient with a functional and esthetic implant- supported prosthesis fulfilled this patient's goals for dental health and function. This treatment demonstrated the detrimental effects of CPAP machine on osseointegration. Guided bone regeneration is not required, as long as sufficient bone remains. Healing of the catastrophic failure followed by revision with a CPAP machine hiatus will yield a successful outcome.

#### CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

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