9 Complications in Total Temporomandibular Joint Reconstruction

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Surgeons undertaking TMJ surgery of any kind are aware of all the usual postsurgical issues and complications associated with surgical approach and access to the joint, such as scar, bleeding, swelling, injury to facial nerve branches, and pain. Good surgical technique can mitigate the risk of unpleasant scar, excessive bleeding, and injury to the facial nerve. Perioperative steroid administration to minimize surgical edema is as useful in TMJ surgery as it is in orthognathic surgery, and postoperative pain is managed in the same way as for other reconstructive surgeries. This chapter will cover the types of complications or findings that arise specifically from total joint reconstruction and will provide guidance for the surgical team ranging from how to mitigate the risk of these events to how to treat complications should they arise.

9.1 Most Common Complications Requiring Postoperative Intervention

The four complications that most commonly result in the need for a postoperative intervention of some kind (manipulation of the joint, revision surgery, or re-do surgery) are: dislocation, infection, hardware failure, and hardware design error.

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9.1.1 Dislocation

The placement of a prosthetic joint requires the detachment of the muscles of mastication, which increases the risk of the condylar component dislocating. The masseter muscle is detached from the mandible in order to install the mandibular component of the total joint prosthesis. The lateral pterygoid muscle is detached by the removal of the native condylar head, and the temporalis muscle insertion at the coronoid process is eliminated if a coronoidectomy is done. Joint dislocation risk is highest in the first 48 h following total joint reconstruction (TJR), especially in bilateral cases. Frequently, the problem is noted while the surgical team is still in the operating room and the patient is in the process of emerging from anesthesia. Other times, the patient is noted to have a new, significant malocclusion on postoperative day 1 or 2 (Fig. 9.1). The TMJ Concepts prosthesis displacement usually occurs when the condylar component displaces anterior to the fossa component, and less commonly laterally or medially. The Biomet prosthesis displacement, typically occurring when the condylar component displaces posterior to the fossa component, is related to the absence of a posterior stop. Displacement of the prosthetic condylar head occurs much less commonly laterally, medially, and anteriorly (Fig. 9.1).

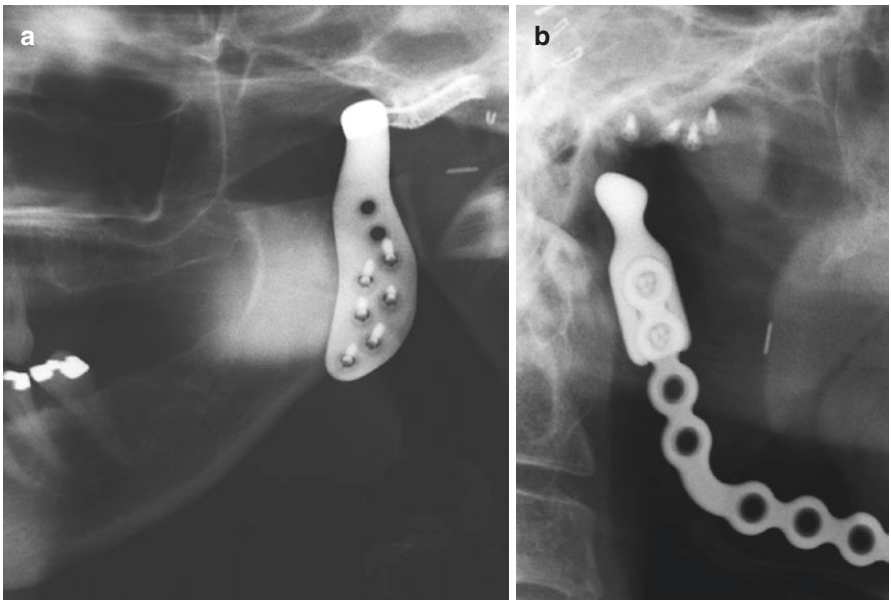

Fig. 9.1 (**a**) The mandibular component of the TMJ Concepts custom prosthesis is dislocated anterior to the prosthetic fossa on postoperative day 2. The titanium mesh supporting the polyethylene fossa (not visible) is seen on x-ray. (**b**) The patient required temporary stabilization of the mandible following jaw resection. The head of a temporary condylar prosthesis articulating against a Biomet polyethylene fossa (not visible on x-ray) is shifted posterior to the fossa component. Only the screws fixating the polyethylene fossa are visible but the condylar head is more posterior than the posterior-most screw, which is not how the mandibular prosthesis was originally positioned

Preoperative considerations: Patients with a significant history of presurgical dislocation from joint hypermobility may require a custom fossa prosthesis that is angled down more steeply at the anterior aspect, to corral the prosthetic joint and prevent postoperative anterior dislocation.

Prevention: While placing the mandibular component in position, aim to position the condylar head toward the posterior aspect of the fossa. This gives the prosthetic joint head a little extra room to "translate" forward if the patient opens wide postoperatively. Because most dislocations occur within the first 48 h, and often within the first few minutes of recovery from general anesthesia, maintenance of maxillomandibular fixation for at least 2 days is advised. Lighter guiding elastics may be employed for several more days or weeks, especially if patient has difficulty finding his/her occlusion or if both joints were replaced. Elastics will provide assistance for the mandible and improved comfort for the patient until the masseter muscle can attach on the surgical side, which may take several weeks following surgery. One may consider leaving the coronoid process in place if the patient had good preoperative mandibular opening. If only the TMJ prosthesis is placed with no concomitant orthognathic surgery requiring counterclockwise rotation or significant advancement, the coronoid and temporalis muscle can remain attached. Leaving the temporalis attachment intact at the coronoid process might help decrease risk of postoperative dislocation, however this may come at the risk of a more limited postoperative opening due to the pull of a strong temporalis muscle. If the surgical plan does call for significant counterclockwise rotation of the maxillomandibular complex, a custom-fitted TMJ Concepts prosthesis with a posterior stop in the fossa component will afford a decreased risk for posterior condylar displacement.

For patients who may require resection of the ramus and the placement of an extended TMJ total joint prosthesis, the anterior displacement risk is very high as the pterygoid-masseteric sling will not be stable to vertically support the mandibular component in the fossa. In this situation when using a custom prosthesis, a preplanned hole can be placed through the head of the mandibular component to support an artificial "ligament" to stabilize the condyle in the fossa. A double-armed #5 braided polyester suture is placed through the hole in the condyle and each end passed through the posterior flange of the fossa component and tied behind the posterior flange of the fossa component. This thick, nonresorbable suture has excellent tensile strength and increased knot security due to the braiding.

Maxillomandibular fixation via screws, temporary anchorage devices (TADs), or hybrid arch bars can be screwed into the maxillary and mandibular alveolar bone, instead of traditional arch bars. Orthodontic appliances or arch bars and elastics can extrude or displace teeth due to the attachment to dental units and vertical tension created from the elastics.

Treatment: If anterior displacement occurs and identified early, manual manipulation with a downward and posterior movement similar to repositioning a displaced natural condyle will usually be effective in reduction. If out of place for more than a couple days, then for patient comfort, general anesthesia or IV sedation may be necessary to reposition a prosthetic joint should it become dislocated. Repositioning will require a significant downward and posterior vector on the mandible, due to the

presence of the fossa's anterior lip of polyethylene for both custom and stock prostheses. Long-term anterior displacement may result in foreshortening of the pterygomasseteric sling restricting manual manipulation and may require surgery to detach the pterygo-masseteric and temporalis musculature in order to disengage the condylar component from its anterior and superior displacement. If posterior displacement occurs in stock prosthesis cases due to lack of a posterior lip of polyethylene, especially when the patient's occlusion has a large centric relation-centric occlusion (CR-CO) slide, the patient might respond to weeks of training with guiding elastics to draw the mandible forward. If not, it may ultimately become necessary to replace the stock joints with custom joints.

9.1.2 Infection

The diagnosis of prosthetic joint infection may be challenging because the signs and symptoms can be intermittent or very subtle and infection workup is hampered by significant imaging limitations or negative laboratory findings. Infection may end up being the diagnosis of exclusion, and long delays in reaching that determination are common. Once an infection is identified, it must be vigorously treated. Much of what our specialty knows about joint prostheses infection comes from the orthopedic literature and research relevant to hip and knee joint replacement. The incidence of infection for hip or knee arthroplasty is estimated to be in the range of 0.9–2.5% [1–3], with the range due in part to whether superficial surgical site infections are considered along with deep prosthetic joint infections. Published data on the infection rate for TMJ total joint prostheses is limited. McKenzie reported an infection rate of 4.5% in a series of 178 joints [4], while Wolford reported an infection rate of 1.6% in a series of 579 joints [5]. Thus the overall incidence of infection for TMJ total joint prostheses for these two studies combined is 2.2% (17 infections in 757 prosthetic joints). Another study published data from a survey of TMJ surgeons. The reported infection rate was 1.51% overall, with most infections appearing within the first 6 months of joint replacement [6]. Most of the infected prostheses in this survey required removal.

As trends go, more microorganisms that may be responsible for periprosthetic joint infections have become resistant to antibiotics, and patients who are candidates for TMJ prosthetic joint replacement may present with more comorbidities than ever before. As a result, it is important to recognize the various patient-specific factors, surgery-specific factors, and postoperative-related factors that can increase the risk of infection [7–10]. Based largely upon the orthopedic literature and the author's experience, the risk factors are discussed below.

Perioperative Considerations: Some of the risk factors can be positively modified or eliminated, to improve the odds of a successful surgical outcome.

Patient-specific risk factors

- Obesity BMI ≥ 35 kg/m^2
- Diabetes
- Cardiovascular disease

- Older age
- Genetic predisposition
- History of multiple invasive joint operations at the same site
- History of infection at surgical site
- Immunosuppression secondary to medications and chronic diseases (e.g., chronic renal disease, hemodialysis, or organ transplantation, cancer treatment, cirrhosis)
- Malnutrition
- Poor body hygiene
- Rheumatoid arthritis and treatment
- Anticoagulants
- Infection at remote site (e.g., skin, urinary, digestive, respiratory, and dental infection)
- Bacterial colonization (urinary tract, nares)
- Smoking
- Alcoholism
- Intravenous drug use
- Socioeconomic status (associated with many of the comorbidities listed above)

Surgery-specific risk factors
- Duration of surgery
- Suboptimal antimicrobial prophylaxis
- Blood transfusion
- Operating room traffic or number of persons within the operating room
- Cross-contamination from the oral cavity, ear, or hair

Postoperative-related risk factors
- Wound or incision factors (e.g., wound dehiscence or necrosis, hematoma, superficial infection)
- Presence of a surgical drain
- Atrial fibrillation, myocardial infarction, urinary tract infection
- Prolonged hospital stay
- *Staphylococcus aureus* bacteremia

9.1.2.1 Diagnosis

In 2013, the Musculoskeletal Infection Society published revised criteria for periprosthetic joint infections (PJI). These criteria have been widely adopted by the orthopedic community although it is also acknowledged that PJI may exist without meeting these criteria, especially in the case of less virulent organisms. The PJI diagnosis requires a positive finding for one of the major criteria or a positive finding for three out of five of the minor criteria [11, 12]. Although these criteria apply to orthopedic joint infections, we may be able to apply much of the information to TMJ prostheses infections.

Major criteria (one of two criteria must exist)
- Two positive periprosthetic cultures with phenotypically identical organisms
- Sinus tract communicating with the joint

Or,

Minor criteria (three of five criteria must exist)
- Elevated serum C-reactive protein (CRP) ≥ 10 mg/L *and* erythrocyte sedimentation rate (ESR) ≥ 30 mm/h
  - Comment: A positive result in CRP and ESR is nonspecific to joint infection. Multiple conditions can elevate CRP and ESR. In addition, CRP may be normal in patients with chronic and low-grade prosthetic orthopedic joint infection [13].
- Elevated synovial fluid white blood cell (WBC) count ≥3000 *or* ++ change on leukocyte esterase test strip
  - Comment: Synovial WBC count may be altered by inflammatory conditions or immunocompromised. Leukocyte esterase test strip results are often affected by blood and debris in the sample and cannot be interpreted.
- Elevated synovial fluid polymorphonuclear neutrophil (PMN) percentage ≥80%
- Positive histological analysis of periprosthetic tissue >5 neutrophils per high-power field in five high-power fields
- A single positive culture

Causative organisms associated with orthopedic prosthetic joint infection are staphylococcal species (e.g., *S. aureus* and especially MRSA in the United States), and coagulase-negative staphylococci (e.g., *S. epidermidis*, *S. haemolyticus*, *S. hominis*, *S. warneri*) are estimated to cause at least half of the prosthetic joint infections [9, 14]. The coagulase-negative staphylococci can also be a culture contaminant, which complicates culture interpretation. It has been noted that early PJI infections that appear within the first 3 months are usually *S. aureus*. In contrast, infections appearing after 3 months tend to be coagulase-negative staphylococci [15]. Negative cultures, despite clinical evidence for infection, may be encountered when prior antibiotic therapy has been instituted. Among the bacteria cultured in TMJ joint prostheses infections, the most common culprits appear to be *Staphylococcus aureus*, MRSA, coagulase-negative staphylococci, *Pseudomonas aeruginosa*, alpha-hemolytic streptococcus, *Serratia*, *Peptostreptococcus*, and *Propionibacterium acnes* [4–6, 16].

Propionibacterium acnes, a low-virulence anaerobic Gram-positive bacillus, has emerged as a leading cause of PJI in shoulder prosthesis infections and can be encountered in TMJ prostheses infections as well. To rule-in or rule-out a *P acnes* infection, the culture should be held by the lab for two weeks. This pathogen has been shown to preferentially colonize the skin above the shoulder, as opposed to the skin around the knee or hip, and may be in higher numbers in males than females [17].

Recently, the diagnosis of PJI has markedly improved through the use of biomarkers. Of the synovial fluid biomarkers that have been studied, alpha-defensin was found

to be the best candidate for the development of an immunoassay test [18] commercially available as the Synovasure Alpha-Defensin test (Zimmer Inc., Warsaw, IN, USA). Alpha-defensin is an antimicrobial peptide released by neutrophils in response to pathogens; it can cause depolarization of the bacterial cell membrane resulting in bacterial cell death [19, 20]. Due to its high sensitivity (97–100%) and specificity (95–100%), ease of use, quick results, and resistance to influence by antibiotics, metallosis, and systemic inflammatory disease, alpha-defensin is an excellent biomarker for PJI [21–25]. The test has not yet been validated to diagnose infection in a native joint or to confirm the presence or absence of infection prior to reimplantation. In addition, its use in the diagnosis of TMJ prosthesis infection has yet to be established and may be hampered by the difficulty in collecting scant synovial fluid.

9.1.2.2 Prevention

A significant risk for infection in TMJ total joint reconstruction cases comes from the ear, followed by poor attention to sterile technique to keep oral, nasal, and hair/scalp bacteria from entering the wound. The following preventative measures are recommended for all total joint cases, based on clinical experience and literature review:

1. Address patient-specific risk factors above, as part of the patient selection criteria, and optimize those factors that can be improved.
2. Reduce OR traffic to a minimum by posting warning signs on the OR door and limiting entry/exit to the OR through one door. Position the patient and instrument table away from the door in use for entry and exit.
3. Administer preoperative antibiotic dose within 1 h of incision. A cephalosporin combined with a beta-lactamase inhibitor is a good choice in non-allergic patients. A typical regimen is ampicillin-sulbactam (Pfizer, New York City, NY, USA), 3 grams IV as a single dose within 60 minutes prior to surgical incision, with intraoperative re-dosing every 2 h up to 3 times, then change to 1.5 g or 3 g IV every 6 hours. For penicillin-allergic patients, clindamycin or vancomycin is recommended. Strictly follow antibiotic re-dosing guidelines, especially in long cases.
4. In bilateral joint cases when the mandibular position will not be changed, place the prosthetic joint on one side, and close the wound completely prior to addressing the contralateral side. When the mandibular position will be altered, carry out the bilateral surgical dissection and joint resection, and then implant the prosthesis on one side and close the wound fully, followed by implantation of the second prosthesis and wound closure on the contralateral side.
5. Avoid shaving the patient's facial hair, or shave facial hair >24 h in advance to avoid small nicks or cuts that can introduce skin contaminants.
6. Patient should shower and shampoo with a chlorhexidine gluconate (CHG) bath product the day prior to surgery.
7. Prior to draping the patient, gently irrigate the ear canal on the surgical side for 5 min using povidone-iodine solution with a syringe and blunt tip catheter (Fig. 9.2 left), or use a chlorhexidine swab to clean the ear canal.

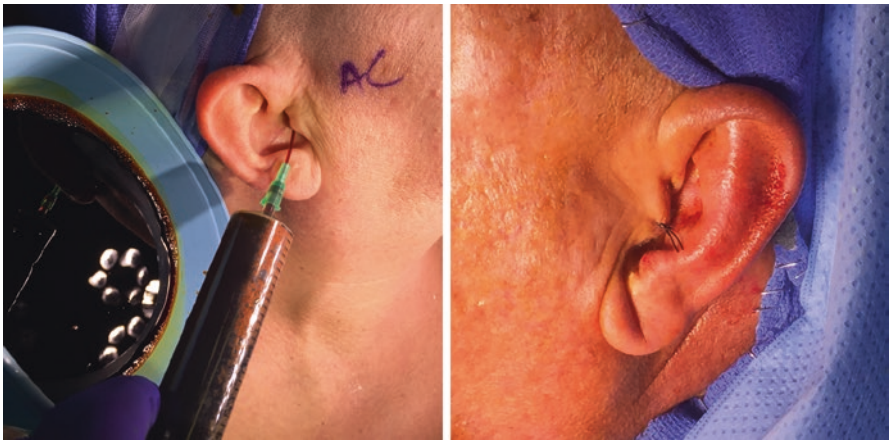

Fig. 9.2 Left: The ear canal is irrigated directly with povidone-iodine to reduce risk of infection from skin contaminants. Right: The tragus is closed with a single suture to prevent Xeroform gauze packing from falling into the wound and potentially contaminating the surgical field

8. Place a small Xeroform (Medtronic, Minneapolis, MN, USA) gauze strip within the external auditory canal, mark the preauricular or endaural incision with a sterile marking pen, and suture the tragus closed with a mattress suture to prevent the Xeroform gauze from falling out (Fig. 9.2 right). When the tragus is sutured closed, it may slightly distort the skin and tragal cartilage and make it more difficult to mark the incision.
9. Keep hair away from the preauricular wound by parting the hair or trimming it with a clipper, but shaving the head is to be avoided due to the possibility of introducing bacteria through small nicks and cuts.
10. Liberal use of sterile towels, paper drapes, clear adhesive drapes, and clear adhesive dressings over the face, neck, and mouth.
11. When placing the patient into maxillomandibular fixation prior to implantation of the prosthesis, designate one surgeon as the "dirty" surgeon and that individual re-scrubs and gowns before rejoining the case. The intraoral instrumentation is kept completely separate, and suction and light handles are changed if they were contaminated with intraoral flora.
12. Do not open prosthetic components until the moment of implantation. If components are opened prematurely, store them in antibiotic-containing solution.
13. Use irrigation with antibiotic throughout the case or after implantation of the prosthesis, prior to closure. Common regimens are vancomycin 1 g per one liter of sterile saline, or Bacitracin 50,000 units per one liter of sterile saline.
14. Close the incision in several well-defined layers.
15. Avoid the use of drains. Drains are often mishandled postoperatively, and introduction of bacteria deep into the wound is possible. It is best to employ meticulous control of bleeding through the use of vessel ties and clips, Bovie, or bipolar cautery.

16. Apply a pressure dressing for 1–2 days to prevent hematoma.
17. Remove the indwelling Foley catheter early to minimize the development of a urinary tract infection.
18. Postoperative antibiotic regimen is intravenous while the patient is in the hospital. Following discharge, an oral antibiotic regimen is recommended for 7 days, although there is not strong evidence for this practice. The antibiotic selected should cover the skin, ear, and oral flora.
19. Patient education: Upon discharge, patients should be educated regarding hand hygiene, incision care, shaving, showering, and hair washing. Incisions should not be handled by the patient except to apply a thin layer of an antibiotic ointment with clean hands or disposable gloves. Shaving in the area of the incision should be avoided. Unless strict care is taken, showering and hair washing tends to soak the incision sites. A lightly moistened washcloth can be used for cleaning the head and neck areas, including the hair.
20. Following total joint replacement of the TMJ, the use of prophylactic antibiotics prior to invasive dental procedures is not supported by data. However, it is an option to use it for at least 2 years postimplantation. The tips of the screws of the mandibular component of the prosthesis lie within the pterygomandibular space and may come into contact with oral flora through the introduction of the needle used for inferior alveolar blocks. Thus, in addition to invasive dental procedures that may release blood-borne pathogens, any dental procedure that requires an inferior alveolar block on the surgical side should stimulate the need for standard orthopedic-style oral antibiotic prophylaxis.

9.1.2.3 Treatment

TMJ prosthesis infections arising acutely within the first few days to weeks following surgery are often superficial and have been managed with retention of the prosthesis in many patients via a technique described by Wolford et al. [5] that includes IV antibiotics via a peripherally inserted central catheter (PICC line), surgical debridement, scrubbing of the prosthesis in situ, and placement of irrigating catheters and drains. Patients with chronic PJI were successfully treated with removal of the prosthesis, and placement of an acrylic spacer and irrigating catheters/drains (Stage I surgery), followed by reconstruction with a new prosthesis several months after the infected prosthesis, was removed (Stage II surgery). As with the acute infection cohort, the chronically infected patients also received a PICC line for outpatient antibiotic therapy for 4–6 weeks. After removing infected prostheses and placing antibiotic-impregnated bone cement as a spacer, Mercuri reported that he was able to salvage the original custom mandibular prosthesis after 3 months by passivating the surface of the prosthesis, re-sterilizing it, and reimplanting it against a new custom fossa [26]. The polyethylene component of the fossa prosthesis cannot be re-sterilized. In the series of eight PJI cases offered by McKenzie, all patients underwent removal of the infected prosthesis without placement of a spacer and a course of IV antibiotics.

Table 9.1 Suggested protocol when total joint prosthesis infection is encountered

Procedure	Comment
Labs: CBC with differential, serum CRP and ESR	Lab testing is likely to be within normal limits in many infection cases
Imaging: CT with contrast, ultrasound to look for possible fluid collection, nuclear medicine scan	Imaging is likely to be negative or equivocal
If fluid collection found, aspirate under sterile conditions and send for anaerobic culture	If possible, use joint aspirate for Synovasure test
Removal of joint prosthesis and placement of antibiotic-impregnated bone cement as spacer, or place silicone orbital implant as a spacer (available in sizes from 12 to 22 mm diameter)	Send tissue, exudate and prosthetic components for culture. Order gram stain, aerobic and anaerobic culture. Ask micro lab to hold cultures for 2 weeks to determine if there is a *P acnes* infection. Send tissue for pathology.
Place in MMF to help patient maintain occlusion	
PICC line for home IV therapy, guided by culture results and infectious disease (ID) consultation	Typical regimen is 6 weeks of home IV therapy
Monitor WBC, CRP, ESR throughout course of treatment	Downward trend should be maintained if values were initially elevated
Discontinue home IV therapy after 6 weeks, and begin oral antibiotic course if advised by ID consultant	
Implantation of new joint no earlier than 3–6 months following explantation of contaminated prosthesis	If custom joint is planned, obtain new CT scan for TMJ concepts

Most patients underwent implantation of new prostheses after complete resolution of the infection [4].

Based on the available literature cited above and clinical experience, the following treatment protocol is recommended for chronic PJI (Table 9.1):

9.1.3 Hardware Failure

Hardware failure may result in an acute change in occlusion and a sudden escalation in pain. Fracture of hardware components is fortunately uncommon, but when it occurs, it is often difficult to visualize on radiographs due to artifact from the metal prosthesis itself and thus may go unrecognized for longer than it should (Fig. 9.3). Screws used in the custom and stock TMJ prostheses are not the locking screw variety often used in mandibular reconstruction plates; if the bone around the screw thread becomes lytic, the screw will loosen quickly, and under function, the situation may cause other screws to loosen as well.

Preoperative considerations: Careful attention should be paid to the preoperative CT scan to look for bony irregularities that may prevent solid seating of the components.

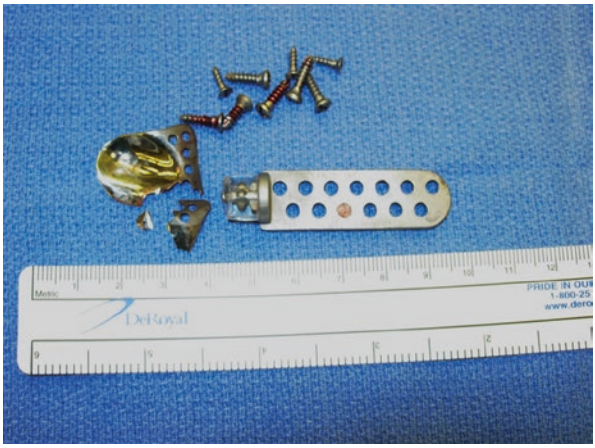

Fig. 9.3 Fracture of the fossa component in a Christensen stock TMJ total joint prosthesis. The patient underwent explantation of the entire prosthesis and eventual reconstruction with a custom prosthesis

Prevention: For custom fossa and mandibular components, bony irregularities must be dispensed with if it is indicated in the TMJ Concepts surgical plan. For cases where a stock prosthesis is being used, take the time to ensure that the underlying bone is as adapted and smoothed as possible to accommodate the prosthetic components without rocking or a significant gap. Regardless of whether a custom or stock prosthesis is used, each fossa component should have four screws, and each mandibular component should have at least six screws. The screws should be tight, but if not, use the emergency screws provided. Despite careful technique, occasionally a gap develops under the mandibular prosthesis between it and the bone, particularly if the screw holes selected are all at the lower end (Fig. 9.4). In theory, this will recreate an unsupported lever arm that could lead to prosthesis micromovement under function and ultimately screw failure. In placing the screws, select a lower screw hole first, lightly tighten the screw, and then select an upper screw hole. Drill and tighten an upper screw into place, then return to the lower screw, and tighten it all the way.

Treatment: Mandibular components are so sturdy that they do not fracture, but there is no choice but to remove and replace a fractured fossa component should there be a fracture of the TMJ Concepts titanium mesh supporting the UHDPE fossa. Although such a fracture is extremely rare, it is usually related to the surgeon improperly positioning the fossa component with a residual "rock" in the device. Unlike the mandibular component, which is designed with more than six potential screw sites, if one or more screws loosen at the custom fossa component, one must remove and replace, since the fossa is usually only designed with four screw holes and no less than four are needed to hold it in place.

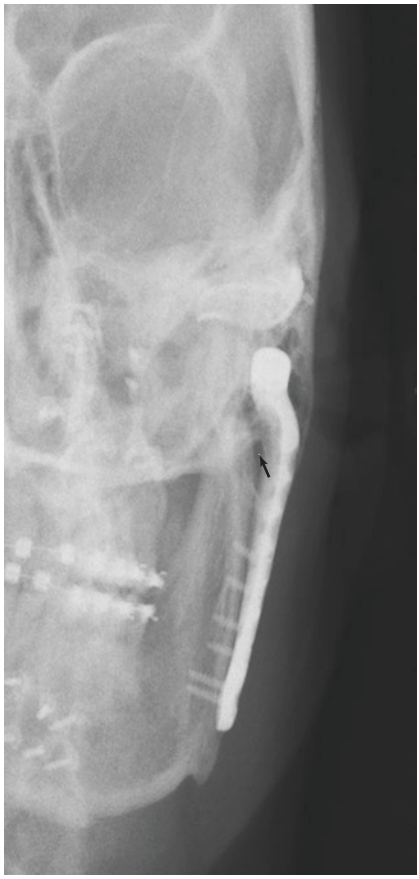

Fig. 9.4 The prosthesis is slightly lifted off the ramus of the mandible in this PA view. This may lead to screw fracture or mobility in the future

9.1.4 Hardware Design Error

A custom TMJ prosthesis has a significant obvious advantage over a stock prosthesis; it fits precisely and often drops into place assuming that soft tissue has been cleared off and bone irregularities/interferences have been removed. However, the accuracy of the prosthesis is only as good as the scan. If the surgeon indicates that the patient's presurgical occlusion is good, a one-piece stereolithic model is planned by TMJ Concepts for prosthesis fabrication, since there is no need to alter good occlusion.

Preoperative considerations: The surgeon *must verify* that the patient reproduced his or her occlusion on the CT scan, because the scan is done without the surgeon present to prompt the patient to put his or her teeth together properly. TMJ Concepts will either physically send the stereolithic model to the surgeon, email 3D reconstruction renderings of the CT scan, or both. Failure to spot that the patient did

not faithfully reproduce their normal occlusion during the CT scan will result in a prosthesis that does not fit properly; specifically the prosthetic joint head will not mate well with the prosthetic fossa, which will result in an obvious malocclusion intraoperatively. Patients with teeth worn flat due to bruxism and those with large centric relation-centric occlusion (CR-CO) shifts are particularly vulnerable to demonstrating one occlusion in the clinic while sitting in the exam chair and a different occlusion in the scanner while laying on the CT scanner bed. The CT technician cannot be relied upon to instruct patients how to bite their teeth together during the CT scan.

Prevention: Rehearse the occlusion with the patient several times prior to obtaining the CT scan. If confidence is low that the patient can distinguish when the teeth are properly touching, then it is very worthwhile to not only provide a custom acrylic splint for the patient to use during the CT scan but also provide TMJ Concepts with stone models of the patient's upper and lower arches and a bite registration. The stone models are scanned and digitally pasted into the CT scan resulting in a very faithful reproduction of the exact occlusion desired (Fig. 9.5).

Treatment: Hardware design errors are very expensive. If a hardware design error is discovered during surgery, the surgeon can abandon the custom prosthesis and place a stock prosthesis instead, which is a very good argument for being familiar with both systems and always having the stock prosthesis system on hand as a backup. Alternatively, a new custom prosthesis can be commissioned. Because hardware design errors are discovered after the native joint is already removed and prosthesis installation is attempted, a temporary spacer is needed (e.g., methyl methacrylate), and a new CT scan can be done with the patient in the ideal occlusion held by solid maxillomandibular fixation.

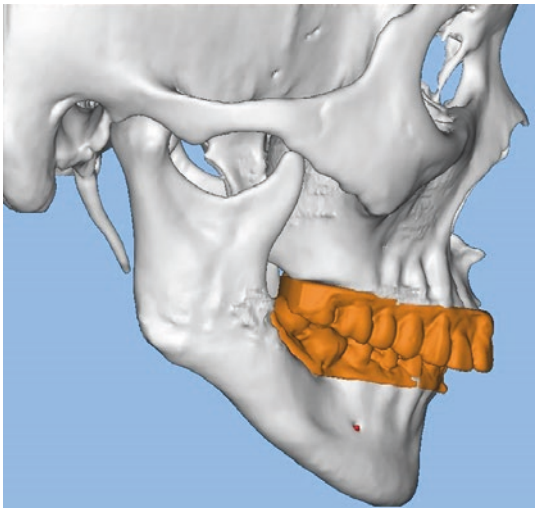

Fig. 9.5 Stone model integration into the CT scan. For patients who have severe dental attrition or who have a large CO-CR slide, a surgical splint made through CAD/CAM methods is strongly advised, even when the plan is to maintain the patient's existing occlusion during unilateral or bilateral total joint replacement

9.1.5 Pain

Pain is a nonspecific finding whose origin may be murky or varied. The etiology may include upregulation of pain receptors, neuroma formation, infection, failed hardware, metallosis, or heterotopic bone formation. Surgeons may be tempted to undertake a surgical exploration of the prosthetic joint if the pain workup is unrevealing, and physical therapy and other modalities are unable to improve the situation. Unexplained postoperative pain is one of the most frustrating problems that a TMJ surgeon can face.

Preoperative considerations: Patients with long-standing TMD chronic pain are unlikely to have sensational pain relief after total joint replacement surgery, even if function is improved. It is wise to have a conversation with the patient to lower expectations about pain relief. The surgical team should line up a chronic pain specialist who can work with the patient perioperatively, as well as a physical therapist, to be a treatment partner in the postoperative period.

Prevention and treatment: Upregulation of pain receptors is hard to prevent even when one practices very careful management of pre- and postoperative opioid consumption. Again, a chronic pain specialist is an ally in the struggle to control perioperative pain. Infection and failed hardware can certainly be responsible for chronic pain and have already been discussed in previous sections.

9.1.5.1 Neuroma Formation

Neuromas of sensory nerves can occur following surgery as a result of nerve trauma. The proliferation of unorganized nerve fascicles within a fibrotic scar can be very painful. If a neuroma of the auriculotemporal nerve is the suspected source of pain, it can be treated surgically through the exploration of the prosthetic joint and careful removal of tissue around the neck and head of the mandibular component. It is logical to blame the auriculotemporal nerve for this condition, as it is the principal sensory nerve of the TMJ. Post-traumatic auriculotemporal neuralgia has been reported as a complication of endaural incision [27]. Prior to committing to surgery, it is worthwhile to try an injection of local anesthesia and steroids at the posterior aspect of the prosthetic condyle to determine if the auriculotemporal neuralgia pain can be ameliorated.

9.1.5.2 Metallosis and Metal Allergy

Metallosis is defined as a tissue reaction to metal corrosion and metal ions released into the bloodstream by the abrasion of metallic components in medical prostheses. The tissue reaction consists of an aseptic fibrosis and necrosis, which leads to loosening of the prosthesis secondary to metal corrosion and release of wear debris. Metal debris within the joint from cast CoCrMo, the alloy found in older hip prostheses, as well as the cast metal-on-metal Christensen TMJ prosthesis (Nexus CMF, Salt Lake City, UT, USA) are in the nanometer range and can activate the host immune response and lead to a foreign body reaction in some patients that results in pain, swelling, osteolysis, and loosening of the metal components. Loose metal prostheses can result in metal fatigue failure and fracture (see Hardware Failure section). Circulating Co

and Cr ions are low when a prosthesis functions well; high blood serum concentrations of Cr or Co suggest significant prosthesis wear in hip prostheses and have been shown to lead to neuropsychiatric deficits in one recent study [28]. In removing the Christensen TMJ prosthesis, the surgeon may see dark metallic tattooing of the surrounding soft tissue or dark fluid at the surgical site, a classic metallosis finding. In the orthopedic gold standard of metal-on-ultra-high-molecular-weight polyethylene (UMWPE) prostheses, the evidence of metallosis is scant or nil.

Allergy to one or more of the elements in the prosthesis alloy should be among the top diagnoses when managing a patient with unexplained postoperative pain, especially if accompanied by lymphadenopathy, swelling, and limited opening. It is estimated that 10–15% of the general population has a metal allergy, and women outnumber men in this condition [29]. One theory is that females become exposed to sensitizing metals at a young age through exposure to cheap metal jewelry on the skin and in pierced ears. Metal sensitivity can either be acute or delayed in presentation, although prosthesis-related reactions are more likely to be delayed reactions. Nickel is the most common metal to cause allergic reactions, and it is found in significant percentages in stainless steel and to a very minor degree in CoCr alloys. Up to 1–3% of the general population has an allergy to Cr or Co, which is found in all TMJ prostheses on the market [30].

When metal hypersensitivity occurs, or metallosis, from a metal-on-metal prosthesis, removal of the prosthesis and replacement with a titanium-on-UHMWPE prosthesis are recommended. Fortunately, the Biomet TMJ prosthesis product line does offer a Ti (Ti-6Al-4V) prosthesis that has a Ti alloy coating. This alloy contains no Ni, Cr, or Co and is at least 88% Ti. Titanium has excellent biocompatibility and has high resistance to corrosion; thus it is considered to be relatively inert compared to other metals, and the incidence of reactions to Ti is very low, although not zero [31].

In the preoperative phase, patients should be questioned about possible metal allergy symptoms, including reaction to watches, rings, necklaces, earrings, and other piercings. A referral to an allergist for testing is warranted if there is cause for concern. The author (RS) uses only the titanium alloy Biomet prosthesis if planning a stock joint replacement.

9.1.5.3 Heterotopic Bone

Heterotopic bone formation has been addressed in the previous chapter. The fat graft, taken in whole, not via liposuction, has been shown to inhibit heterotopic bone formation by eliminating dead space, thus preventing blood clot organization around the prosthetic joint head and fossa (Fig. 9.6). The fat graft harvest is very straightforward and should be a standard part of all TMJ total joint replacement surgery. If excessive heterotopic bone is noted, revision surgery is indicated, especially if it is associated with increasing pain and/or interferes with function of the prosthetic joint. Low-grade heterotopic bone formation may be asymptomatic, but typically patients experience pain and limitation of range of motion. The author (RS) noted that in one case, the implanted abdominal fat grew in volume as the patient gained weight. Facial swelling and discomfort brought the patient back to the clinic over 5 years after the total joint prosthesis and fat graft were placed (Fig. 9.7).

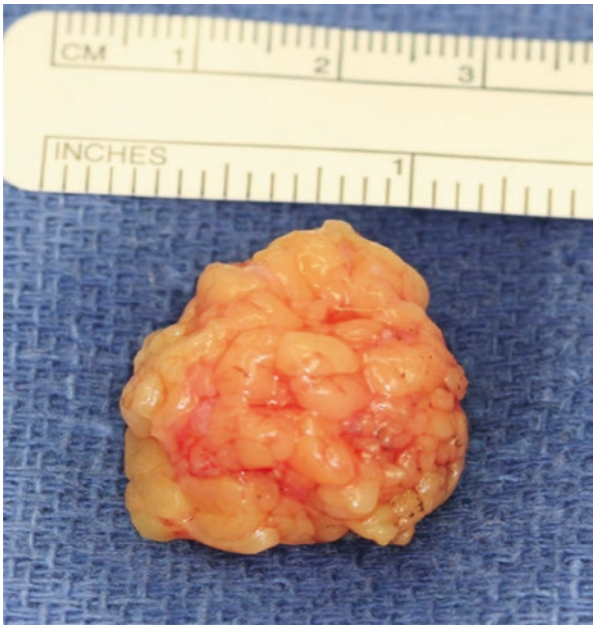

Fig. 9.6 Good-quality abdominal fat is easy to procure and very beneficial for the prevention of heterotopic bone

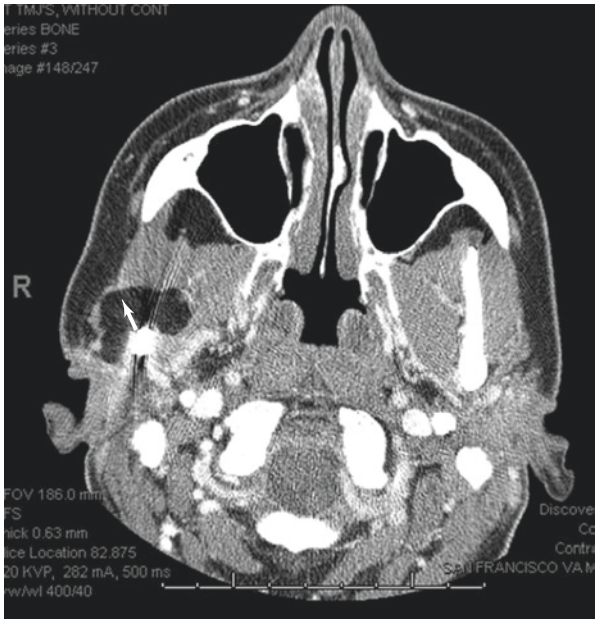

Fig. 9.7 The radiolucency in the area of the right joint represents enlargement of the fat graft placed several years prior to the patient's weight gain. Soft tissue swelling is noted (arrow)

For the patient with significant prosthesis-related pain postsurgically, surgical exploration is not discouraged but is best undertaken if one has narrowed the list of possible etiologies and has a plan for every single one of those possibilities.

The following conditions are included in this chapter because they have been repeatedly observed and are worthy of mention, not only for academic purposes but as part of the informed consent process with the TJR candidate.

9.2 Other Problems and Complications Encountered During and After TMJ Surgery

9.2.1 New or Aggravated Contralateral TMJ Dysfunction

Many TMJ surgical procedures result in a permanent jaw deviation with function, toward the side of the TMJ surgery. This is especially true when the lateral pterygoid muscle is disturbed, as in total joint reconstruction. The question is whether patients with unilateral joint reconstruction are exposed to increased risk of having contralateral TMD symptoms that may or may not result in the need for an intervention. Researchers have studied the masticatory patterns in patients who have had unilateral total joint replacement and have noted the kinematic differences between the prosthetic and natural joints [32, 33]. When a total joint prosthesis is placed, it has no forward translational movement and thus changes the load on the contralateral natural joint and the mechanics on how it moves in function. In addition, the surgical technique for placing the prosthetic joint requires stripping of the masseter muscle and often the temporalis muscle. Postoperatively, the patient naturally uses the intact side for chewing and places high forces on the disc during bruxism. Bekcioglu and colleagues, using finite-element analysis, found that the stress on the contralateral disc increases by over 54% in a unilateral joint replacement model [34]. A subset of patients may begin to experience new or aggravated contralateral TMD symptoms if the native joint cannot tolerate the increased forces. Although Perez's group did not find any adverse effects on the healthy contralateral joint in a group of 61 patients with unilaterally reconstructed joints [13], others' experience is that over several months to 3 years, some patients will return with new or aggravated contralateral complaints requiring interventions ranging from intra-articular steroid injection to joint replacement of the contralateral TMJ in a significant percentage. In a series of 77 consecutive patients who underwent any type of unilateral TMJ surgery and were followed 1–15 years postoperatively, up to 32% required a procedure on the contralateral joint (author's unpublished data). In this series, contralateral procedures ranged from arthrocentesis to total joint replacement. The patients with the highest incidence of contralateral total joint replacement surgery are those who undergo unilateral total joint replacement. More research is clearly needed in this domain to further our understanding of the long-term effects of the biomechanical mismatch that occurs when a natural joint works in concert with a prosthetic joint. The surgeon contemplating

unilateral total joint surgery is advised to warn the patient of the possible activation of contralateral symptoms, especially if there are early changes or symptoms already exist.

9.2.2 Malocclusion

It may be surprising to encounter patients with malocclusion postoperatively because the mandibular component of the TMJ prosthesis is always positioned and fixated with screws while the patient is in tight maxillomandibular fixation (MMF). Nevertheless, occasionally a patient will demonstrate an ipsilateral posterior open bite (Fig. 9.8).

The most common reason for an immediate post surgery posterior open bite results from operator miscalculation or error in positioning the mandibular component or lack of proper placement and stability of the maxilla in double jaw surgery. A simple factor is failure to drill the pilot hole "dead center" in the middle of the screw hole in the mandibular component. Drilling the hole toward the top of the screw hole will shift the mandibular component upward, opening the bite

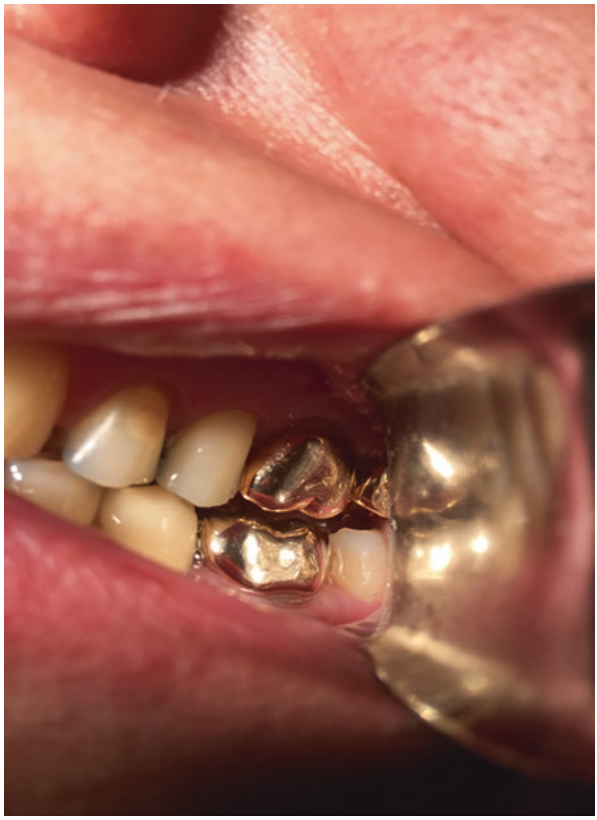

Fig. 9.8 A 1 mm ipsilateral posterior open bite is noted on postoperative day 1, after placing a stock total joint prosthesis

posteriorly. If the mandibular component is not sitting tight against the ramus when the first two screws are placed, the shift of the mandibular component medial-lateral can also cause a shift of the mandibular component creating the posterior open bite. Another reason for a posterior open bite is due to surgical edema or formation of a hematoma. In double jaw surgery, malpositioning of the maxilla can result in a posterior open bite.

The most common cause for an anterior open bite is not seating the mandibular component into the fossa and against the posterior stop in the fossa component. Also, when drilling the pilot hole in the mandibular component, if the pilot hole is drilled against the bottom of the screw hole in the mandibular component, the mandibular component will be displace downward. In double jaw surgery, malpositioning of the maxilla can result in an anterior open bite.

Rather than removing the MMF devices immediately postoperatively or within a few days, consider maintaining the patient in guiding elastics for 1–2 weeks or longer to orthodontically settle the bite into position. If a large anterior or posterior open bite occurs with inability to correct with orthodontic mechanics, then one should consider repositioning the maxilla, performing bilateral sagittal split osteotomies (can be safely done with appropriate surgical protocol in most cases), or repositioning the mandibular component(s).

In other cases, postoperative malocclusion cannot be corrected with guiding elastics. The etiology of the malocclusion may be related to improper intraoperative mandibular positioning during application of MMF. When using the Biomet Microfixation system to implant stock prostheses, especially in bilateral cases, patients with flat or very worn teeth may develop a centric relation-centric occlusion (CR-CO) slide that is not appreciated until the MMF is released. If loosening of the MMF wires occurs while the jaw is manipulated during the screw fixation step of the mandibular prosthesis, or if the mandible is aggressively handled during drilling and screwing, the postoperative result may be an ipsilateral open bite in addition to shifting of the jaw to the contralateral side. The patient may report pain at the contralateral joint due to the torquing of the natural condyle. If this occurs, the prosthesis may need to be repositioned surgically.

The following eight strategies may help prevent postoperative malocclusion:

1. Use of an occlusal splint to help stabilize the mandible, especially when there is significant dental wear or multiple missing teeth.
2. Document the preoperative occlusion with a photo, and post the picture in the operating room for reference.
3. Instead of traditional arch bars with circumdental wiring, consider the use of bone-supported screws or screw-retained anchoring devices. These are less likely to extrude or move teeth if the patient needs to be in postoperative elastic traction for days or weeks.
4. Just prior to fitting and screwing in the TMJ prosthesis, place at least four, tight MMF wires, evenly applied across the arch. Visually verify the occlusion achieved and compared with the preoperative photo, if available.

5. With stock TMJ prosthesis placement, consider interposing a neurosurgical patty between the joint head and the fossa when fixating the mandibular component while the patient is in tight maxillomandibular fixation. This will allow the posterior dentition to act as the vertical stop rather than the prosthetic joint.
6. Do not allow heavy lateral forces to shift the mandible when drilling and screwing down the mandibular prosthetic component. A member of the surgical team should stabilize the jaw during this step.
7. For custom devices, set the condylar head into the fossa against the posterior stop (TMJ Concepts fossa). Set the mandibular component into position on the ramus. Drill the pilot hole "dead center" in the screw hole of the mandibular component. If the pilot hole is not "dead center," then insertion of the screw can produce a slight shift in the occlusion.
8. After placement of two screws (one low and one high) in the mandibular component(s), consider releasing the MMF wires, and check the occlusion prior to placement of the final screws. If bite is off, then remove the screws from the mandibular component, reapply MMF, reposition the mandibular component, and replace the screws. Once this step is completed, then proceed to placing the fat grafts and wound closure. This must be done with great care due to risk of contamination of the surgical field with oral flora.

9.2.3 Preauricular Numbness

Patients should be advised that following open joint surgery, the preauricular skin will be hypoesthetic due to injury of the auriculotemporal nerve. While the affected area frequently shrinks with time, there may be a permanent zone of numbness in front of the ear, which fortunately appears to be of limited consequence except when shaving or applying makeup to the area.

9.2.4 Inferior Alveolar (IA) Nerve Numbness

Three possible etiologies are considered: In the first, screw placement for the mandibular component of the stock prosthesis may inadvertently misdirect a screw toward the nerve, but this will not happen for the custom TMJ Concepts prostheses, which are designed so that the screw holes avoid the IA canal. The second arises from the overzealous use of the mandibular mobilizer or similar device, or a bone tenaculum engaged near the angle of the mandible. The mandibular mobilizer or tenaculum is helpful to exert a downward and forward pull on the mandible while operating at the articular fossa (Fig. 9.9). This movement can stretch the inferior alveolar nerve causing injury. When using the tenaculum, one often finds there is a need to reposition the instrument more superiorly on th ramus than is safe, because it often slips off the narrow bone at the angle of the mandible during traction. This blind maneuver risks damaging the mandibular nerve as it enters the foramen at the lingula.

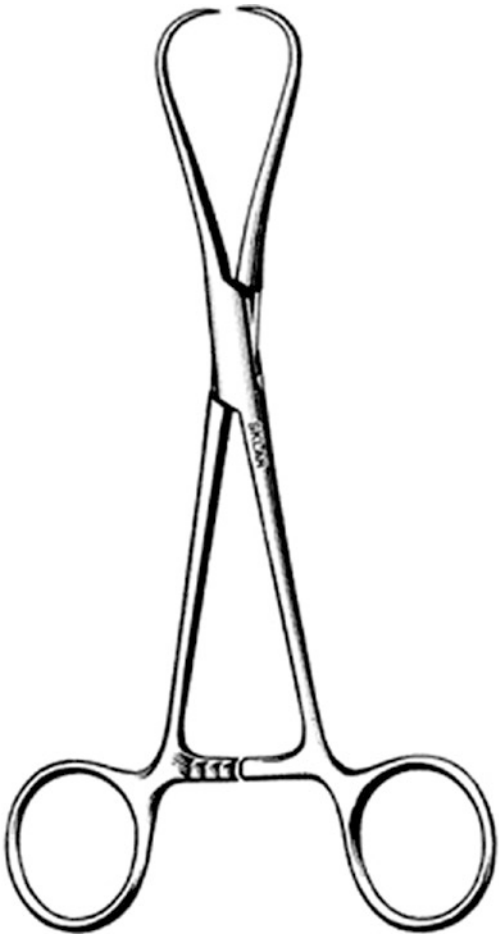

Fig. 9.9 A tenaculum forceps for grasping the mandibular angle and pulling it inferiorly. The sharp tips of the tenaculum may injury the mandibular nerve at the lingula when positioning the instrument to apply downward traction on the mandible

The inferior alveolar nerve may be nicked or severed while creating the gap between the top of the ramus and the articular fossa. The recommended gap is no less than 20 mm, which allows adequate room for the prosthetic fossa and the prosthetic joint head. In cases where the native ramus length is quite short (often due to severe degenerative joint disease), creating the gap needed to accommodate the prosthesis is tricky and more likely to result in encroachment by the saw to the IA nerve. The surgeon needs to pay close attention to how much bone is being removed from the top of the ramus (Fig. 9.10). Measure the bone removal needed in situ, and use a sterile pencil to mark the bone just prior to introducing the saw. The use of a piezoelectric or ultrasonic bone saw may reduce the risk of nerve injury due to its preferential bone cutting action, but careful measurement is still the key to avoidance of injury.

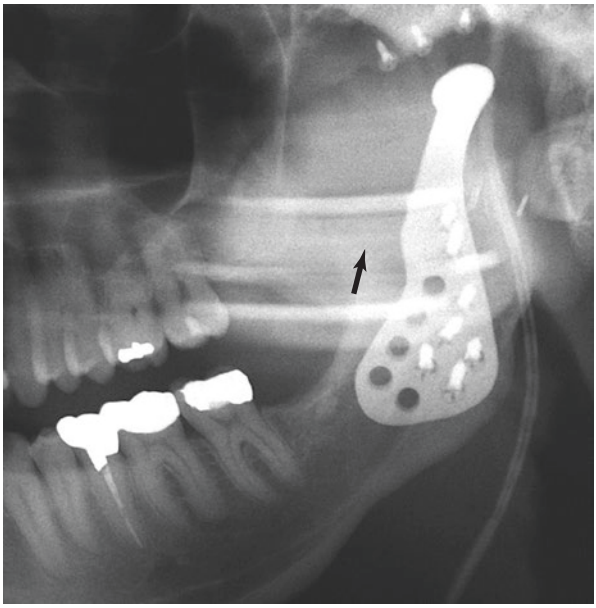

Fig. 9.10 A ramus cut that is too low or at a steep angle many place the inferior alveolar nerve at risk

9.2.5 Bleeding

Experience has shown that problematic bleeding often occurs in patients who have had multiple previous ipsilateral TMJ surgery and in those where the condylar head was previously fractured. Scar development on the medial aspect of the joint head and entrapment of blood vessels is a frequent feature and can result in significant bleeding when the bone is cut and removed. Most arterial bleeding in TMJ arthrotomy arises from the middle meningeal and posterior deep temporal arteries, branches of the internal maxillary artery, or direct injury to the maxillary artery. Venous bleeding is from the retrodiscal tissue and the retromandibular vein. The following top ten strategies to reduce blood loss are recommended:

1. Hypotensive anesthesia technique to keep mean arterial pressure low.
2. Use of piezoelectric or ultrasonic bone saw when osteotomizing the condylar head and the superior portion of the ramus. The BoneScalpel (Misonix, Farmingdale, NY, USA) is an instrument that may significantly reduce total blood loss in TMJ total joint replacement [35] (Fig. 9.11).
3. Neural patties soaked in thrombin pre-prepared and ready to pack into the wound after excision of the condylar head.
4. Gelfoam or Surgicel within the wound.
5. Apply intraoral pressure to bleeding vessels medial to the mandible.
6. Prior to osteotomizing the superior portion of the ramus, open the submandibular incision, and fully dissect down to the inferior border of the mandible first.

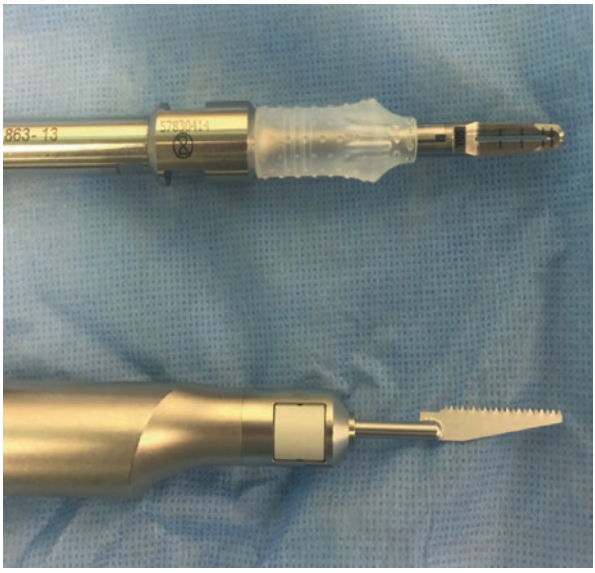

Fig. 9.11 The BoneScalpel (top) versus a reciprocating saw (bottom). The BoneScalpel is a piezoelectric device that preferentially cuts the bone instead of soft tissue. The device has been shown to significantly reduce intraoperative bleeding during TMJ replacement surgery

If uncontrolled arterial bleeding should occur, dissection down to the external carotid artery (ECA) can be rapidly accomplished if the neck incision is already open. Ligation of the ECA is ideally done at a level higher than the bifurcation of the common carotid to control internal maxillary artery hemorrhage, but bleeding control is imperfect. Although technically more difficult, the best results are achieved when ligation is done distal to the origin of the posterior auricular artery branch [36].

7. If bleeding remains uncontrolled, emergent interventional radiology is needed to embolize the bleeding vessel.
8. Control of unnecessary, noxious airway stimulation and blood pressure during emergence from general anesthesia.
9. Pressure dressing for 12–24 h.
10. Surgical drains not advised, due to potential for introduction of bacteria within the wound.

Use of thrombin-containing hemostatic agents such as Floseal (Baxter, US) may be problematic and should be used with caution. The author's (RS) experience with TMJ reconstruction patients who had Floseal placed in the wound prior to closure and who then traveled home on a multi-hour flight is that there was a higher than anticipated risk of VTE in this cohort. As a result, the author no longer uses Floseal on a regular basis, but does utilize postoperative low-molecular-weight heparin starting 1 day after surgery.

9.2.6 Lingual Nerve Numbness

This rare complication may be related to injury to the nerve with removal of the top of the ramus, during the secondary osteotomy needed to create the recommended gap. A piezoelectric bone saw is preferred to prevent inadvertent injury to soft tissues on the medial aspect of the mandible that may contain the lingual nerve. Alternatively, lingual nerve injury may be due to compression of the nerve secondary to bleeding on the lingual aspect of the mandible.

9.2.7 Facial Nerve Injury

Multiple upper and lower division branches of the facial nerve are at risk during TMJ total joint reconstruction surgery, and facial nerve injury appears to be more likely when patients have undergone multiple prior TMJ surgeries. The use of a disposable nerve stimulator or the more sophisticated four-channel nerve monitor such as NIM (Medtronic, Minneapolis, MN, USA) is strongly advised as it provides audible and visual warnings that enable surgeons to identify, confirm, and monitor nerve function to reduce the risk of nerve damage (Fig. 9.12). An eight-channel monitor, if available, is preferable during bilateral TMJ surgery so that leads from one side do not have to be disconnected when the contralateral surgery is being carried out. Often, full facial nerve function is observed while the patient is emerging from general anesthesia, only to progress into weakness as surgical edema develops.

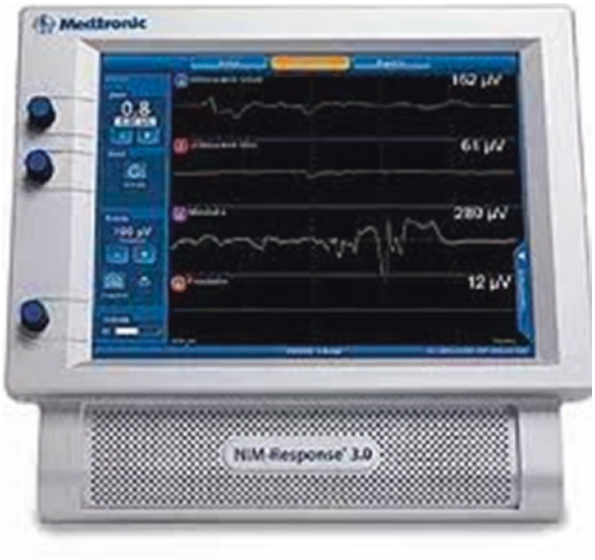

Fig. 9.12 The Medtronic four-channel NIM monitor, for assessing facial nerve function intraoperatively

This is a very common occurrence that patients should be reassured about. Fortunately, many cases of early facial nerve branch weakness resolve given 4–6 months of time.

9.2.8 Gustatory Sweating/Auriculotemporal Nerve Syndrome/ Frey's Syndrome

The auriculotemporal nerve is a branch of the third division of the trigeminal nerve, and it has many branches throughout the preauricular area and temple. Occasionally, post-TMJ surgery patients complain of gustatory sweating and facial flushing on the operated side, which is commonly known as Frey's syndrome. This condition is considered to be very prevalent after parotidectomy. Using Minor's starch-iodine test, the incidence has been reported to nearly 100% in some studies, although clinically symptomatic cases are much fewer [37]. Frey's syndrome can occur after TMJ surgery as well. When damaged parasympathetic postganglionic secretomotor fibers of the auriculotemporal nerve, normally intended for the parotid gland, inappropriately regenerate themselves and connect to the sympathetic receptors of facial sweat glands and vessels, sweating and facial flushing may occur during eating or even when thinking about food. The condition may become evident with a typical latency of 6–18 months after surgery.

Prevention of Frey's syndrome begins with appreciation of the auriculotemporal nerve's branching anatomy. The nerve's parotid branches run off the main trunk and enter the parotid at the superior border of the gland, approximately 8 mm anterior and 8 mm superior to the middle of the tragus [38]. Branches of the auriculotemporal nerve seem to communicate with the buccal and zygomatic branches of the facial nerve, passing on parasympathetic secretomotor fibers [39]. As a result, it should be no surprise that clinical and subclinical Frey's syndrome may arise after TMJ reconstructive surgery given the relationship of the nerve branches within the local anatomy. Surgical techniques for the prevention of Frey's syndrome following parotidectomy have been investigated by various authors, and they include the interposition of biologic and nonbiologic membranes as a barrier between the postganglionic nerve fibers and the target sweat glands and the interposition of various flaps over the parotidectomy bed. Biologic tissues that have been interposed to prevent Frey's syndrome include acellular human dermis (ACD) [40, 41] and free autologous dermal fat grafts [42, 43]. Local flaps include the superficial musculoaponeurotic system (SMAS) flap [44] and sternocleidomastoid (SCM) muscle flap. In the author's (RS) experience, the SMAS flap has the most practical application for the TMJ surgeon. The development of a SMAS flap during access to the TMJ, separate from the overlying skin flap, allows for good surgical repositioning and closure over the parotid at the end of the case. In this way, our group has been able to prevent Frey's syndrome in most patients compared to prior to the implementation of this technique. Supporting this technique variation is the fact that the SMAS flap has been shown to be highly effective in lowering the incidence of Frey's syndrome to around 5% in a study of patients undergoing parotidectomy [45].

The gold standard of Frey's syndrome treatment is botulinum toxin (BTX), which outperforms all other treatments [46]. BTX injection creates a cholinergic block to inhibit saliva production and success rate of averages 98% [47]. One may administer concentrated BTX (40 units/cc) as multiple small doses of 4 units per injection throughout the affected area, using a 30-gauge needle. Treatment is repeated every 12–16 weeks or more as needed, but fortunately, the troublesome symptoms of Frey's syndrome can fade away over time for many patients.

9.2.9 First Bite Syndrome

Postoperative first bite syndrome (FBS) is a rare and interesting complication of cervical and head and neck surgery. It is characterized by severe, sharp, electric-like pain at the affected parotid area upon the first couple of bites of food place into the mouth. Patients often describe an acute and unpleasant squeeze or spasm-like sensation of the parotid. The pain response lasts several seconds and then fades away with subsequent bites of food, just to repeat with the next meal after a period of salivary rest. The syndrome is quite debilitating and can very much have a life-altering effect on the patient's day-to-day life.

FBS has been described following parotidectomy, external carotid artery ligation, carotid endarterectomy, parapharyngeal surgery, infratemporal fossa surgery, bimaxillary osteotomy, and TMJ surgery [48–53]. FBS has occurred as an early symptom of salivary gland malignancy [54], and idiopathic, nonsurgical FBS has also been reported [55]. Although the overall incidence is unknown, it is probably underreported and underappreciated. FBS arises in the weeks to months following surgery. With respect to TMJ reconstruction, our experience has been that it occurs in cases where external carotid artery (ECA) ligation was necessary to control intraoperative bleeding following joint resection. The etiology is thought to be the loss of postganglionic sympathetic innervation of the parotid gland due to surgical disturbance, resulting in over-activation of the salivary myoepithelial cells in response to parasympathetic stimulation, unopposed by sympathetic innervation (Fig. 9.13) [52]. Isolation and ligation of the ECA is one way to disturb the postganglionic sympathetic fibers, which run as a network along the vessel and its branches. In other words, any injury to the sympathetic chain, including ligation of the ECA, increases the risk of development of FBS.

If injury of the postganglionic sympathetic fibers running toward the parotid gland is to blame for FBS, prevention of the syndrome is achieved by avoidance of manipulation or ligation of the ECA. If ligation of the ECA is needed to achieve hemostasis, then the surgeon is alerted to watch for symptoms of FBS developing in the postoperative period. The risk of postoperative FBS is not meant to discourage the surgeon from doing what is necessary to control excessive or catastrophic bleeding intraoperatively.

Diagnosis of FBS is made largely by patient history. In the clinic or office setting, pain can be reproduced by applying lemon juice or lemon glycerine swabs to the mouth to stimulate the flow of saliva. Occasionally, a technetium-99m

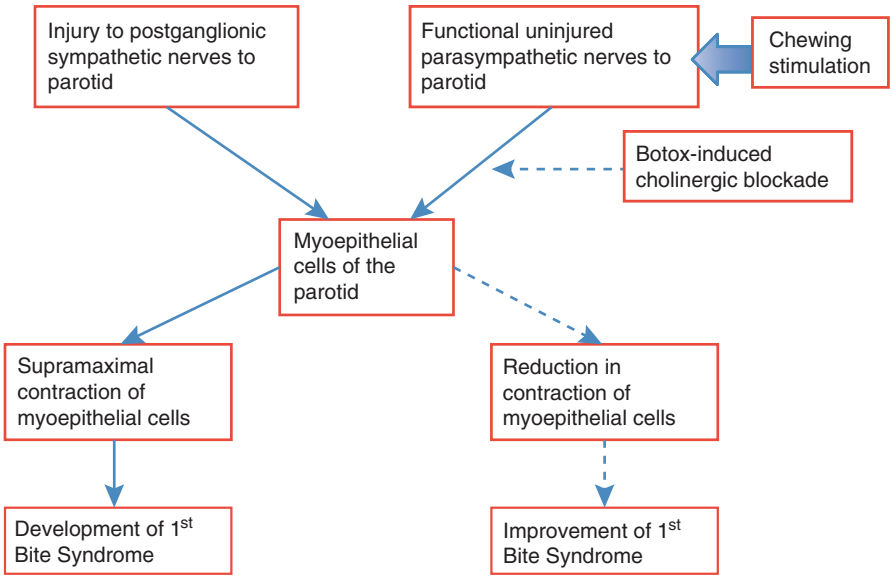

Fig. 9.13 Proposed mechanism of first bite syndrome

pertechnetate nuclear medicine study is ordered to study the affected salivary gland. The clinician may find that uptake of the isotope is within normal range but that stimulation of the gland with lemon will cause pain severe enough to prevent completion of the study. CT and MR imaging is typically negative.

Treatment of FBS is largely unsuccessful. Resolution of the syndrome has been described by Amin and colleagues via laser ablation of the tympanic plexus [53]. Other modalities of treatment that have varied rates of success include NSAIDs, narcotics, amitriptyline, carbamazepine, gabapentin, acupuncture, and Botox (BTX) injections [56–59]. BTX is advocated because it will cause a reduction in parasympathetic innervation to the parotid gland, but mixed results are reported. Ghosh and Mirza report some success with BTX doses up to 50 units into four or more sites within the parotid [60]. In some cases, the syndrome slowly fades away on its own after 4–24 months [61]. In the author's (RS) experience, one case of severe post-total joint replacement FBS could only be resolved with a superficial parotidectomy.

9.2.10 Narrowing of the External Auditory Canal (EAC)

Within the first 1–2 months of the postoperative period, it is common for patients to complain about muffled hearing, inability to clean the ear canal, and/or retention of water within the canal after showering, due to swelling. In addition, hearing aid wearers may not be able to insert the device comfortably or at all. After all surgical edema resolves, some patients may experience long-term narrowing

of the EAC due to scarring, but sometimes the anterior-posterior (A-P) position of the fossa component is to blame. When placing a stock prosthesis, the surgeon should keep in mind to select a fossa prosthesis position so there is no impingement of the ear canal.

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