



# DENTAL EXPRESSIONS®

DE 2015 ISSUE 1

## Trigeminal Nerve Injuries: An Interview with Michael Miloro, DMD, MD, FACS

Dental Expressions® typically provides risk management recommendations on a specific patient safety or quality of care topic. This edition departs from the pattern. Not only is it longer than usual, but it also features a discussion by an outside researcher on a clinical subject: trigeminal nerve injury.

We offer this platform to Dr. Michael Miloro, a recognized expert in the field of oral surgery, because the issue is both timely and important to our insureds. The interview with Dr. Miloro also addresses traditional risk management matters, such as informed consent, pre-surgery assessment, and post-incident monitoring and follow-up. (Please note that the views expressed in this article are Dr. Miloro's alone, and do not necessarily reflect those of CNA or the standard of care.)

Nerve damage to the lingual and inferior alveolar nerves can result from both surgical and non-surgical dental procedures. Surgical injuries are well understood and occur most commonly following wisdom tooth removal, while those associated with non-surgical procedures may involve the injection of local anesthetic solution, although the precise mechanism remains unclear. Paresthesia and other dental-induced nerve injuries may be either reversible or permanent. Although each situation is unique, early intervention is vital to the successful management and treatment of both surgical and non-surgical nerve injuries.

Both the frequency and severity of CNA nerve injury claims have increased in recent years, as shown in the following table:

**Figure 1 – Average Number of CNA Nerve Injury-related Claims per Year**

YEARS	AVERAGE NUMBER OF CLAIMS/YEAR	NUMBER OF \$100K+ CLAIMS/YEAR	NUMBER OF \$200K+ CLAIMS/YEAR
2004-2008	48 (range: 34 to 69)	4 to 6	1 to 3
2009-2013	81 (range: 67 to 95)	11 to 18	4 to 8*

\*Including two claims of over \$1 million.

Patients and their attorneys often allege lack of informed consent in claims involving nerve injury. For nerve injuries specifically associated with surgical procedures, such as the extraction of impacted third molars, another common allegation is failure to refer to an appropriate specialist for timely assessment and management of the injury after it had been become known. Juries often view patients with nerve injuries in a sympathetic manner, and may conclude (falsely) that such an adverse event is always the result of negligence on the part of the practitioner.

To help dentists better understand this important issue, this edition of *Dental Expressions*<sup>®</sup> features an interview with Michael Miloro, DMD, MD, FACS, Professor of Oral and Maxillofacial Surgery, Department Head and Program Director at the University of Illinois in Chicago (UIC).<sup>1</sup> He is also the editor of the book *Trigeminal Nerve Injuries* (Springer, 2013).<sup>2</sup> This interview was conducted on September 30, 2014.

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1 A faculty biosketch of Dr. Miloro is available at <http://dentistry.uic.edu/departments/omfs/faculty/mmiloro/> (last accessed 10/4/2014).

2 Ordering information is available at <http://link.springer.com/book/10.1007%2F978-3-642-35539-4> (last accessed 10/4/2014).

**DENTAL EXPRESSIONS (DE):** Many nerve injury claims reported to CNA involve either third molar surgery or placement of dental implants. What clinical findings, patient factors or other concerns are most important in the dentist's decision to treat or refer the patient for these procedures?

**DR. MILORO:** Injuries to the terminal branches of the trigeminal nerve – mostly the inferior alveolar nerve (IAN), lingual nerve (LN) or mental nerve (MN) – can have many causes. Certainly, dentists who undertake advanced procedures, such as third molar extractions and placement of dental implants, are likely to see a greater number of non-resolving trigeminal nerve injuries. However, as most dentists will see one or more patients who sustain a non-resolving injury at some point in their career, it is important to understand the initial assessment and management of these cases.

We know that for third molar surgery, certain patient characteristics are associated with a greater risk of nerve injury. Probably the number-one factor to consider is the patient's age. Typically, patients over 25 years of age are at a significantly greater risk for a non-resolving injury, even when treated by an experienced surgeon. Other important risk factors include distoangular or linguovered impactions (associated with increased risk of LN injury) and deep horizontal or vertical impactions (associated with increased risk of IAN injuries). Some studies indicate that women are more likely to suffer non-resolving nerve injuries, including both decreased and unpleasant sensation, which is consistent with my clinical practice observations.<sup>3</sup> In *Trigeminal Nerve Injuries* (page 66), Dr. Søren Hillerup makes a similar observation regarding injuries associated with local anesthetic injections, possibly reflecting a gender difference in spontaneous healing ability.

3 Hillerup, S. "Iatrogenic Injury to Oral Branches of the Trigeminal Nerve: Records of 449 Cases." *Clinical Oral Investigations*, June 2007, volume 11:2, pages 133-42. Available at <http://www.ncbi.nlm.nih.gov/pubmed/17186310>. See also Kjolle, G. and Bjørnland, T. "Low Risk of Neurosensory Dysfunction After Mandibular Third Molar Surgery in Patients Less than 30 Years of Age: A Prospective Study Following Removal of 1220 Mandibular Third Molars." *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology*. October 2013, volume 116:4, pages 411-17. Available at [http://www.oooojournal.net/article/S2212-4403\(13\)00345-3/pdf](http://www.oooojournal.net/article/S2212-4403(13)00345-3/pdf).

Certain features on panoramic radiographs also may help identify higher-risk patients. A darkening of the tooth root in the area of the inferior alveolar nerve is one sign to consider, as are deflection of the root and, importantly, an interruption in the cortical bone (white line) of the IAN canal. This may indicate that the root is very close to or in contact with the IAN canal. When appropriate, use of cone beam computed tomography (CBCT) and other forms of advanced imaging may further elucidate anatomy and potential risk of nerve injury, although this is not currently the standard of practice. For example, use of CBCT for third molar surgical evaluation may be useful if certain radiographic predictors are present on a two-dimensional image (panoramic radiograph). In my practice, about 10 to 15 percent of third molar surgery cases require advanced imagery.

I see many injuries related to the placement of dental implants. However, the incidence of implant-related injuries is not well known at present, and experts have not arrived at a consensus about the management of nerve injuries related to dental implant placement. The literature indicates that following placement of implants in the posterior mandible, we may see injuries to the IAN up to 40 or 50 percent of the time. Regarding so-called "mini-implants," I have not seen a large number of nerve injuries related to these devices in my practice so far.

With dental implants, the amount of available bone may be overestimated when using two-dimensional images (panoramic or periapical) to plan implant placement due to image distortion and magnification, resulting in penetration of the superior border of the IAN canal. The use of CBCT and other advanced imaging and treatment planning software techniques can reduce the risk of this complication. Also, it seems that more dentists are using computer-guided surgical planning to place dental implants. This process can provide a virtually undistorted image of the available bone, along with computer-aided selection of the best implant for the intended implant site. While this protocol is helpful, it does not guarantee the outcome or completely prevent nerve injuries, since the operator must understand the uses of the treatment planning software as well as its inherent limitations.

In my opinion, obtaining a radiograph following any device implantation, including dental implants, is necessary to confirm and document appropriate placement, and also to evaluate for proximity to the IAN canal. In addition, the patient should be monitored very closely after the procedure. If the patient exhibits persistent numbness or other symptoms of nerve injury, the surgeon should consider backing out the implant a few millimeters, immediately removing it, or replacing it with a shorter implant at the same time or at a later date. A rapid response to a potential nerve injury can significantly affect the patient's outcome. This also may include the prescription of oral systemic corticosteroids in the peri-operative period to decrease perineural edema and allow the injured nerve to heal with improved vascularity to the site.

Another important issue is how to respond appropriately when the dental implant appears to violate the IAN canal, but the patient does not report hypoesthesia or dysesthesia. Sometimes no paresthesia occurs during the osseointegration period, following restoration of the implant with a crown. However, with flexure of the jaw during mastication and implant loading, these patients may later report pain or paresthesia due to pressure transmitted to the IAN from the crown to the implant to the nerve. A prompt decision to either back out, remove or replace an implant can have a major impact on long-term outcomes.

Implant-related injuries are more likely to result in dysesthesia, stemming from increased pressure in the IAN canal, as nerves do not tolerate pressure well at all. Tingling, burning, electric shock-like sensations and other unpleasant symptoms can be difficult to manage clinically. Again, although there is no consensus regarding the management of dental implant-related trigeminal nerve injuries, various algorithms for management have been described.<sup>4</sup>

<sup>4</sup> See *Trigeminal Nerve Injuries*, table 6.1, page 94.

**DE:** When a patient reports symptoms of nerve injury after an injection and/or surgical procedure, what initial steps do you recommend in terms of patient management/assessment? Does it matter if the injury is post-surgery or associated with a non-surgical procedure? And are any medications indicated or contraindicated at this stage?

**DR. MILORO:** When the patient calls and says that his or her lip or tongue is still numb, the practitioner should speak with the patient personally, either taking the call immediately or returning it as soon as possible. Empathize with the patient, show concern over the situation, and provide reassurance that most injuries improve quickly and resolve completely. Also, it may be appropriate at this point to review the informed consent discussion that took place prior to surgery regarding the possibility of nerve injury, especially if the patient seems angry or highly anxious.

The patient should be scheduled for an examination on the same day or within one to two days, if possible. Time is critical if any surgical procedure – such as backing out or removing/replacing an implant – is anticipated. Remember that these nerves do not tolerate compression or pressure well, whether caused by the implant itself or by local bleeding near the IAN canal space (if, for example, the pilot drill damaged the associated inferior alveolar vein).

Next, review the progress notes from the surgery, assessing the quality and completeness of the documentation and noting if any important details have been overlooked. Finally, enter a new note with the current date and time, documenting the patient phone call and discussion. If anything significant was omitted from the progress note post-surgery – such as flap design, bone removal, visualization of the LN or IAN during surgery, etc. – include that information as part of the current note. Obviously, do not change the initial, post-surgical note or alter the record in any manner.

Immediate actions may also include the prescription of medications. If there are no medical contraindications, a short course of corticosteroid therapy (e.g., Medrol® Dosepak™) may decrease perineural edema related to the traumatized nerve. We have found that this course of treatment can aid in long-term neurosensory recovery. Also, taking vitamin B12 or B complex for a number of weeks or months may augment neurosensory recovery, although evidence to support this practice is limited at this time.

The patient examination should include basic objective and subjective neurosensory testing, as described in a number of resources, including *Trigeminal Nerve Injuries*.<sup>5</sup> Post-surgical radiographs are necessary for assessing dental implant position and ruling out such possibilities as retained roots, foreign bodies, etc. There should be a very low threshold for obtaining radiographs following a surgical procedure for a patient who reports symptoms consistent with nerve injury. The patient should be seen again a week or so after the initial evaluation for continued assessment.

Regarding surgical injuries versus non-surgical injuries due to local anesthetic nerve blocks, the consensus among experts is that, in view of current skills and technology, microneurosurgery cannot be adequately or safely performed in the pterygomandibular space, which offers limited access. The bottom line is that microneurosurgery is *not* an option for injuries related to a mandibular nerve block. It is not currently possible to adequately assess, resect, graft or repair the nerve in this area, so treatment for patients with this type of injury is limited to pharmacological and/or behavioral approaches. Medications may include those already discussed and/or others – e.g., Neurontin (gabapentin) and others – but microneurosurgery cannot help patients with local anesthetic-related injuries at the present time. The same is true of chemical nerve insults from sodium hypochlorite or other chemicals used in endodontic root canal therapy. Treatment to debride neurotoxic chemicals from the vicinity of the nerve should be performed promptly in these endodontic injuries. The goals are to manage swelling and inflammation and prevent infection, but again, depending upon the location of the nerve injury or the specific nerve involved – e.g., the second division of the trigeminal nerve (infraorbital nerve) – surgical repair may not be an option.

I also wish to note that injuries related to endodontic filling materials may require prompt microneurosurgical treatment, as certain materials potentially have neurotoxic properties and/or cause pressure in the IAN canal. If a patient reports significant symptoms consistent with nerve injury after the placement of the endodontic filling material, the situation should be addressed within 24 to 48 hours to prevent long-term injury. Similarly, if an endodontic file breaks and penetrates the IAN canal, immediate removal is recommended.

<sup>5</sup> See table 10.14, page 183, and also appendices A1 and A2, pages 191-196.

I think that these mandibular block injuries occur commonly, but the vast majority go unreported, as they resolve spontaneously in a period of days to weeks. Frequency estimates vary widely, but we do know that the LN is much more likely than the IAN to be injured by local anesthetic injection – probably around 80/20 percent, respectively. This may be due to the fact that the LN is closer to the surface mucosa, and when the mouth is opened, the LN is stretched nearer to the surface and is therefore more vulnerable to injury by a local anesthetic needle. Multiple injections during the same procedure may increase the risk of injury if trauma from the needle is involved, although the damage is more likely due to the drug itself and the concentration gradient effect.

In the past, four percent prilocaine was implicated as the most common etiologic agent in local anesthetic nerve injuries. Since the introduction of articaine into our armamentarium, four percent articaine has been associated with a higher incidence of nerve injuries compared with lower-concentration anesthetics. In our program at UIC and a number of other schools in the U.S., four percent anesthetic solutions are contraindicated for mandibular blocks. This position is supported by some authors, although universal agreement is lacking on this issue.<sup>6</sup> Compared to surgical injury patients, a higher proportion of patients with anesthetic block injection injuries have dysesthesia, as with implant-related nerve injuries.

One of my current areas of interest is the radiographic or radiologic evaluation of nerve injuries. It would be very helpful to be able to visualize the individual fascicles or fascicular pattern of the nerves. At present, we lack a means of doing so, although magnetic resonance neurography shows promise in this area. Such imaging would allow us to know, just by looking at the fascicles of the nerve, whether or not the injury was in the pterygomandibular space from the local anesthetic block or at the surgical site from third molar removal, for example. We could thus judge whether the injury was due to the surgery or the local anesthetic, both of which might manifest with similar clinical signs and symptoms. However, at this point, it is difficult to determine the site of injury using clinical neurosensory testing alone.

<sup>6</sup> Garisto, G. et al. "Occurrence of Paresthesia After Dental Local Anesthetic Administration in the United States." *Journal of the American Dental Association (JADA)*, July 2010, volume 141:11, pages 836-844. See also Moore, P. and Hersh, E. Letters: "Oral Paresthesia," and Dower, J., "More About Oral Paresthesia," followed by the authors' response. *JADA*, November 2010, volume 141:11, pages 1300-1303.

**DE:** Some facial and hypoglossal nerve fibers are associated with taste sensation in the tongue. Are there any special considerations or treatment methods for injuries that involve the reported loss of taste sensation?

**DR. MILORO:** These chorda tympani fibers from the facial nerve are admixed with lingual nerve fibers, so we do not treat them separately or differently. When repairing the LN, we anticipate recovery of the chorda tympani branch of the facial nerve, which supplies taste to the anterior two-thirds of the tongue, along with the lingual nerve, but that may or may not happen. In fact, studies have not shown much correlation between recovery of taste and recovery of sensation following lingual nerve repair. So again, we do not dissect out the chorda tympani branch or treat these fibers differently in any way. The hypoglossal nerve provides motor function to the tongue and is generally not involved in most cases of lingual nerve injury.

**DE:** CNA's informed consent templates for surgical and non-surgical procedures – such as crown, bridge and endodontic therapy – include information about the risk of nerve injuries with local anesthesia. What is your perspective on this?

**DR. MILORO:** I am pleased to hear you say that about your informed consent templates. In my opinion, this information should be placed on standard consent forms.

**DE:** What evaluations or tests should be performed upon initial examination and/or at follow-up assessments? Is a specific reassessment schedule recommended?

**DR. MILORO:** There are several recommended tests, which are simple to perform and require no special equipment. First, there is a very simple subjective test, which involves posing the question, "On a scale of zero to 10, with zero being no sensation and 10 being fully normal sensation, what number would you assign to the sensation you have in the involved area?" This subjective evaluation is typically performed using a visual analog scale (VAS), where the patient makes an "X" on a line to indicate the level of sensation. Dentists who do not have a VAS template in their office can ask patients to rate the paresthesia verbally. The test can be repeated at future office visits for purposes of comparison over time.

The next tests are simple objective procedures involving cotton-tip applicators. The second test is the two-point discrimination test, in which the bare wooden ends of two standard cotton-tip applicators are held a few millimeters apart on the skin or mucosa in the affected area. The two applicators are moved progressively

closer together until the patient, whose eyes are closed, can no longer discern two distinct points. The closest distance where two points can be felt is considered the threshold. This test is performed bilaterally, permitting comparison with the uninjured side.

The third test is the brush-stroke discrimination test, in which the cotton-sided tip of the applicator is used in a brush-stroke motion on the skin or mucosa to determine directional discrimination. With eyes closed, the patient is asked to note the direction of the motion as the applicator is moved from right to left and then left to right (or back to front and then front to back). Again, the site is compared with the uninjured side.

Finally, there are the pinprick and thermal discrimination tests, which are used to evaluate the smaller nerve fibers associated with pain and temperature sensation. These can be performed using a local anesthetic needle for the pinprick, and hot or cold water (or ethyl chloride spray) on the cotton tip applicator for supra-threshold responses to pain and temperature sensation. The two-point and brush-stroke discrimination tests evaluate larger myelinated nerve fibers, which are more important in nerve recovery, while these latter two tests indicate overall injury status and aid in determining the prognosis for neurosensory recovery.

**DE:** In a recent issue of *JADA*, Drs. Shahrokh Bagheri and Roger Meyer published a paper on when to refer patients with nerve injuries to a practitioner experienced in their assessment and treatment.<sup>7</sup> Is there general agreement among specialists in the field regarding referral timing, as well as the signs and symptoms that indicate the need for referral?

**DR. MILORO:** This is an important issue, on which Dr. Bagheri and I lectured together recently. The nerve injury community is pretty clear about the one-month post-injury referral recommendation time frame, and I would like to emphasize this point to all practitioners. If the patient with a non-resolving paresthesia is a surgical candidate, the surgery should be performed on the LN one to three months following the injury. For the IAN, three to six months post-injury is the best surgical window. The reason for this difference is that the IAN has a higher spontaneous recovery rate than the LN, as the bony canal helps guide neurosensory recovery. So we wait a bit longer for spontaneous nerve healing to occur with the IAN. Spontaneous regeneration is significantly less likely with the LN, which is in soft tissue.

As previously noted, the dentist or surgeon should see the patient as soon as the problem is reported. Typically, the patient should be reassessed one week after the initial assessment, then at two weeks post-assessment and again at one month post-injury. The dentist can then determine whether the patient is getting better or not and has regained an acceptable level of sensation. If the patient is improving, the dentist could evaluate the patient again three weeks later, with follow-up in another three weeks. If, at every visit, the patient continues to improve based on subjective and objective testing, then it is appropriate to continue to evaluate and reassure the patient. If sensation does not improve in the first month or the improvement stops at any point, then it is unlikely to spontaneously start improving again, and the patient should be referred to a specialist.

The confidence level of the dentist is a factor in this treatment plan, as he or she must be comfortable performing neurosensory testing to determine improvement. If the dentist is not comfortable conducting or interpreting the subjective and objective tests, then immediate referral may be the best option.

From nine months to a year post-injury, the surgical success rate drops precipitously. So the goal of the one-month referral recommendation is to get the patient to someone who is experienced in this type of testing and evaluation, and to understand if the patient is going to continue to improve on his or her own. If the answer is no, then proceeding as soon as possible to microneurosurgery offers the best chance for success. Sufficient time must be permitted for spontaneous recovery to occur, but not so much time that central cortical changes make peripheral nerve treatments ineffective. To reiterate: If after three months it is determined that the LN is not improving, or after six months for the IAN, microneurosurgery would be the next treatment option.

If referral is needed, most dentists would refer the patient to an oral and maxillofacial surgeon. However, few oral surgeons – perhaps only 15 to 20 in the U.S. – have experience in the evaluation and treatment of nerve injuries.<sup>8</sup> Oral surgeons to whom a dentist customarily refers patients may be helpful in identifying another professional who is experienced in treating nerve injuries, if they themselves do not.

7 "When to Refer a Patient with a Nerve Injury to a Specialist." *JADA*, August 2014, volume 145:8, pages 859-861. Available at <http://jada.ada.org/article/S0002-8177%2814%2960197-5/abstract>.

8 The Nerve Surgeon Locator Tool, a database of surgeons with this expertise, is now in its infancy, but will improve and expand over time. The Locator Tool can be accessed at <http://www.axogeninc.com/surgeon-locator/> (last accessed 10/4/2014).

**DE:** Given the limited number of qualified microneurosurgeons in the dental or maxillofacial area, can physicians help manage this issue?

**DR. MILORO:** Excellent question! And the answer is yes. A neurologist is the best non-dental medical professional to manage these patients because, as previously noted, drug therapy can be a component of treatment for dysesthesia, and many patients are not surgical candidates. For example, if a patient is going to be prescribed long-term anticonvulsive medications or membrane-stabilizing agents, a neurologist may be the best choice. I am very experienced in microneurosurgery, and I may manage the patient short-term with some medications that I am comfortable prescribing. But for long-term dysesthesia, I am likely to refer the patient to a neurologist for management of the drug therapy regimen. There are many medications that can be used for neuropathic pain, including gabapentin (Neurotin).

**DE:** In the preface of *Trigeminal Nerve Injuries*, you note the need for a multi-center prospective trial to help answer key questions related to these injuries. Is such a project underway?

**DR. MILORO:** Plans for a multi-center trial were discussed at the September 2014 annual meeting of the American Association of Oral and Maxillofacial Surgeons. Investigators plan to pool patients from five centers, with five microneurosurgeons from across the country participating. In previous studies, sample sizes have been too small and not sufficiently standardized for patient assessment, treatment or follow-up. We are just now designing this long-overdue study.

To close, I would like to make one point about microneurosurgery. Dentists may believe that referral after a nerve injury is not needed, because of the supposedly low rate of success with surgical repair. I have heard this comment often, even from OMF surgeons. A recent systematic review of prior studies showed a success rate in the range of 25 to 67 percent, and none of us would say that this is acceptable. However, recent studies by Drs. Bagheri and Meyer indicate that the rate of functional sensory recovery following microneurosurgery can be much higher – reportedly around 90 percent. So I would advise dentists to remember that *referral is important*, because surgery may be able to help these patients. Also, if pain or dysesthesia is a predominant symptom, it is important to encourage the patient to consider medication therapy before the pain becomes centralized, and this may involve consultation with a neurologist.

## RISK MANAGEMENT RECOMMENDATIONS FROM CNA

As Dr. Miloro observes in his interview, trigeminal nerve injuries typically resolve spontaneously. However, based on reports from specialists and findings from the CNA dental claims database, persistent and non-resolving injuries appear to be on the rise. The following measures can help protect patients and reduce liability exposures associated with nerve injuries:

- *Review informed consent protocols for both surgical and non-surgical procedures*, paying particular attention to the information shared with patients on the likelihood of nerve injury. The CNA informed consent templates, which include sample text on nerve injury risks, may be accessed at the Professional Protector Plan for Dentists® website (see below).
- *Promptly assess all patients who report symptoms of nerve injury*, first by telephone and then in person within one to two days, if possible. If you are not comfortable performing a clinical assessment, immediately refer the patient for evaluation.
- *Empathize with the patient during the assessment* and clarify that his or her concerns are taken seriously. Be supportive and reassuring, and explain that the majority of nerve injuries improve quickly and resolve completely.
- *Review the informed consent discussion if appropriate*, assessing the completeness and accuracy of chart notes. Add important information in a *new* chart note, if appropriate.
- *Notify your professional liability carrier* regarding the incident/potential claim.
- *Follow patient progress closely for one month*, using the three tests described by Dr. Miloro, if you are comfortable doing so. If the patient's symptoms are improving, continue to follow the patient until improvement stops or symptoms resolve. If little or no improvement is seen or the symptoms stop improving, refer the patient to a specialist.
- *Remember that the best window for surgical repair is one to three months post-injury for LN injuries and three to six months for IAN damage*. During this period, carefully monitor the patient's progress and refer as appropriate.

*Dental Expressions*® wishes to thank Dr. Michael Miloro for sharing his knowledge, experience and recommendations regarding trigeminal nerve injuries. For further information on a variety of risk management and patient safety topics, please visit the Professional Protector Plan for Dentists® website at <http://www.protectorplan.com/dental-risk-management/>.

## LOOKING FOR ADDITIONAL RISK MANAGEMENT INFORMATION?

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Dentists can obtain risk management information by attending any of the risk management seminars listed below, or by completing the CNA online self-study CE course (see above). For more information about our in-person seminars, please contact the nearest Professional Protector Plan state administrator agent.

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