ABSTRACT
The authors present the case of a patient that demonstrates resolution of delayed onset hypoglossal nerve palsy (HNP) subsequent to occipital condyle fracture following a motor vehicle accident. Decompression of the hypoglossal nerve and craniocervical fixation led to satisfactory long-term (>5 years) outcome. There is a scarcity of literature in recognizing HNPs following trauma and a lack of pathophysiological understanding to both a delayed presentation and to resolution versus persistence. This is the first report demonstrating long-term resolution of hypoglossal nerve injury following trauma to the craniocervical junction.

Keywords: Cranial nerve palsy, craniocervical fracture, hypoglossal, nerve compression, neuropraxia, occipital condyle fracture, tongue anesthesia

INTRODUCTION
A growing number of reports have illustrated hypoglossal nerve injury after occipital condyle fractures (OCFs).""[1-9] Despite rare recognition, treatment options remain indicated on the severity of OCF.""[10,11] Only one case in the literature has suggested improvement in the subacute presentation of hypoglossal nerve palsy (HNP).""[7] Unfortunately, all other studies have demonstrated persistence HNP varying from 3.5 months to 2 years following OCF [Table 1].

The exact mechanism by which OCFs contribute to HNP and in the delayed presentation is unclear. Thus far, case reports have demonstrated an association between OCFs and hypoglossal nerve injury [Table 1], but no case has demonstrated causality. Here, we report on a patient in whom an avulsed OCF was identified with a delayed presentation of HNP, and after removal and stabilization, resolution of neuropraxia was demonstrated on long-term follow-up (>5 years).

CASE REPORT
Here, we report on a 20-year-old unrestrained female passenger involved in a motor vehicle accident (MVA) who presented to an outside hospital. Neurological examination revealed no focal deficits on the initial presentation or during inpatient course. She was diagnosed with right hip, pelvis, and OCF and underwent right hip open reduction and internal...
fixation as well as placed in a hard collar. At 6 weeks, she presented to our institution with a new complaint of rightward tongue deviation. Repeat computed tomography (CT) imaging revealed an Anderson and Montesano (AM) Type III OCF with a large bone fragment resting in the epidural space at the foramen magnum-C1 junction without change from the initial CT imaging study after MVA [Figure 1]. The patient was recommended for surgery and subsequently underwent a limited suboccipital craniectomy with C1 laminectomy, removal of bone fragment in C1 ventrolateral epidural space [Figures 2 and 3] with lysis of arachnoid adhesions, and occipit to C1 fusion [Figure 4]. Postoperatively, her right tongue deviation appeared to improve on postoperative day (POD) 1 and completely resolved by POD 2. On both short- and long-term follow-up, she remained without evidence of tongue deviation at 2 weeks and 5 years, respectively.

**DISCUSSION**

This is the first case in which a causal relationship has been reported between an OCF and neuropraxia of the hypoglossal nerve. We illustrate delayed presentation of unilateral tongue deviation after AM Type III OCF and importantly after surgical decompression with fixation, the palsy resolved. Evidence here, after removal of the avulsed OCF, suggests compression along the deep course of the hypoglossal nerve may contribute to delayed neuropraxia.

![Figure 1: Computed tomography imaging-based evidence of a displaced right occipital condyle fragment in the epidural space adjacent to the hypoglossal canal](image1)

![Figure 2: Magnetic resonance imaging-based evidence of a displaced right occipital condyle fragment in the epidural space adjacent to the hypoglossal canal](image2)

| Prior literature first author | Age/sex | Mechanism injury | CN12 palsy/onset | LOC | Time until onset | Fx class | CCJ misalignment | Tx | Follow-up period | CN12 palsy outcome |
|------------------------------|---------|------------------|------------------|-----|------------------|----------|-----------------|----|-----------------|-------------------|
| Muthukumar                   | 32 male | Motorcycle       | Yes/delayed      | Yes | 3 weeks          | N/A      | No              | Rigid cervical collar for 12 weeks | 18 months | Unchanged |
| Demisch                     | 45 female | MVA             | Yes/delayed      | Yes | 9 weeks          | N/A      | Yes             | Rigid cervical collar 12 months | 15 months | Unchanged |
| Orbay                       | 37 male | MVA             | Yes/delayed      | No  | 12 weeks         | N/A      | No              | Soft cervical collar 2 years | Unchanged |
| Hicks                       | 21 male | Motorcycle fall | Yes/delayed      | Yes | 6 days           | Anderson and Montesano Type II | N/A | Cervical brace unspecified | Remote unspecified | Unchanged |
| Rué                         | 19 male | MVA             | Yes/delayed      | No  | 2 weeks          | N/A      | No              | Remote unspecified | N/A | Unchanged |
| Wasserberg                  | 39 male | MVA             | Yes/delayed      | Yes | 3 weeks          | Anderson and Montesano Type III | N/A | None             | N/A | Unchanged |
| Legros                      | 44 male | MVA             | Yes/delayed      | No  | 2 days           | Anderson and Montesano Type II | N/A | None             | 3.5 months | Resolved |
| Noble                       | 33 male | MVA             | Yes/delayed      | N/A | N/A (S)          | Anderson and Montesano Type I | N/A | None             | Unreported | N/A |
| Bridgman                    | 32 male | Fall down stairs 12 feet | Yes/delayed | No  | Few days         | Anderson and Montesano Type III | N/A | Rigid cervical collar 1 year | Unchanged |
| Current Study               | 20 female | MVA           | Yes/delayed      | No  | 6 weeks          | Anderson and Montesano Type III | Yes | Decompression, bone fragment removal, O-C1 fusion | 5 years | Resolved |

MVA - Motor vehicle accident; LOC - Loss of consciousness; CCJ - Craniocervical junction; N/A - Not available; S – Significant; CN - Cranial nerve
Delayed cranial nerve palsies after OCFs are a rare complication, with an incidence of <1%, and unilateral HNP the most commonly reported.[1‑9,12,13] Nine cases of delayed onset isolated HNP after OCFs have been previously reported [Table 1].

Two popular classification systems for OCFs help guide treatment options [Table 2].[14] The AM system classifies the fracture based on various unrelated factors that allow overlap between types and the Tuli et al. system on the location of the fragment and radiographic evidence of craniocervical joint (CCJ) instability.[10‑12] AM Type I and II OCFs are treated with rigid cervical orthosis with symptomatic improvements and complete union after 6–12 weeks in the majority of patients.[8,12,14,15] AM Type III OCFs are treated with halo fixation if unstable on flexion-extension imaging or rigid cervical collar if stable.[12,13,15] Despite the current classification systems, their clinical utility is limited since the treatment of the various types is similar.

The exact etiology of the delayed onset HNP after OCF is unknown. The hypothesized mechanisms of delayed onset include callus formation during normal healing applying traction to the hypoglossal nerve as it exits the canal, bone fragment movement impinging on the hypoglossal nerve near the canal, and secondary edema.[1,4,16] Furthermore, airway management has been reported to cause delayed HNP. When considering injury during airway securement, nearly, all HNPs presented in acute or subacute fashion (POD 1–3) and majority resolved within 6 months without intervention, unlike the cases reviewed in this paper.[17,18] Only one of the ten cases of delayed HNP involved intubation in the course of their management,[2] and all presented at least 1 week or later with symptoms persisting for months or greater despite conservative management.

The etiology of our patient’s HNP may be related to fracture instability [Figure 5] though no gross movement was identified on repetitive imaging. It is unlikely due to airway management given no recent history of intubation before symptom onset. The patient denied any event, traumatic or infectious, preceding the onset of her HNP.

CCJ misalignment and neural element compression are the predominant indications for surgical intervention despite the classification of fractures.[8,12,13,19,20] although conservative management has been reported for such instances.[21] In our case, the patient presented 6 weeks after her MVA with an acute onset of tongue deviation. The patient was started on steroids and taken to the OR <72 h from onset.
We present a case of HNP resolution after surgical decompression and posterior stabilization. In the setting of a nonhealed AM Type III condylar fracture, it was presumed that there was instability of the CCJ, and therefore fusion and decompression of the hypoglossal nerve was indicated. The hypoglossal canal was adequately decompressed posteriorly allowing for simultaneous hypoglossal decompression and occiput to C1 fusion without the need for a second stage procedure.

of symptoms. Due to the acute onset of symptoms and imaging evidence, the patient underwent decompression and posterior stabilization. In the setting of a nonhealed AM Type III condylar fracture, it was presumed that there was instability of the CCJ, and therefore fusion and decompression of the hypoglossal nerve was indicated. The hypoglossal canal was adequately decompressed posteriorly allowing for simultaneous hypoglossal decompression and occiput to C1 fusion without the need for a second stage procedure.

We present a case of HNP resolution after surgical decompression and posterior fixation following traumatic OCF. There are currently no well-established treatment guidelines. Most OCFs can be managed conservatively with collar or halo immobilization. Decisions for surgical intervention are based on stability and neurological compression with a correlative neurological examination. Our patient’s HNP resolved after decompression, and she continues to remain asymptomatic. Evidence here demonstrates for the first time causality in hypoglossal neuropraxia and OCFs.

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Conflicts of interest
There are no conflicts of interest.

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