Prophylactic Intraoperative Nasolacrimal Duct Intubation in Surgical Treatment of Facial Fractures—Is There a Role?

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Abstract

Nasolacrimal duct (NLD) damage is associated in the majority of type II and III naso-orbito-ethmoid (NOE) fractures.[1] Our study aims to investigate the efficacy and safety of prophylactic NLD intubation in the setting of facial fractures, by comparing incidence of postoperative epiphora and wound infection. A retrospective matched control study was conducted on all patients with surgically treated facial fractures from 2008 to 2013 ($n = 280$) (IRB ref number: DSRB 2013/01198). Patients with the following fracture types were included: NOE ($n = 16$), frontal sinus ($n = 2$), Le Fort II/III ($n = 8$), and > 1 type ($n = 48$). All patients in this study were included with the intention to treat. The study group comprised patients who were intubated, while the control group patients were not intubated. Each group had 37 patients matched for age, gender, fracture type, and injury type. A single oculoplastic surgeon skilled in lacrimal surgery performed the procedure for all intubated patients. Patients with more severe and complex facial fractures were intubated with bicanalicular Crawford stents. Postoperative epiphora and infective complications (both facial wound and dacryocystitis) were assessed at 1, 3, 6, and 12 months. There was no significant difference in incidence of either postoperative epiphora ($p = 0.152$) or wound infection ($p = 0.556$) comparing both groups. Reduced incidence of postoperative epiphora in the study group is statistically not significant and does not support the need for prophylactic intubation. If radiographic evidence of NLD disruption or regurgitation seen on syringing on the NLD intraoperatively is present, intubation is safe and efficacious only if performed by an expert.

Keywords
- nasolacrimal
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- orbit
- epiphora

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Posttraumatic nasolacrimal duct (NLD) damage is commonly associated with naso-orbito-ethmoid (NOE), frontal sinus, and panfacial fractures. Markowitz et al previously described three types of NOE fractures.[1] NLD damage and resultant epiphora is associated with type II and type III NOE fractures due to extensive comminution of the central segment. Displaced fracture fragments impinge on the lacrimal apparatus and cause obstruction. In type III NOE fractures, complete avulsion of the medial canthal ligament may compress on and occlude the NLD, contributing to nasolacrimal obstruction and epiphora. Markowitz et al's study determined that surgically managed NOE fractures require open reduction and internal fixation. Markowitz et al's study[1] further detailed surgical exposure and fixation techniques, with little emphasis on the role of NLD intubation in NOE fractures. Nasolacrimal manipulation was only indicated in cases of obvious lacrimal system transection.

Unger reported that nasolacrimal fractures are often associated with complex fractures of the midface.[2] Three consequences of these fractures include fracture of the nasolacrimal fossa with avulsed fragment, comminution of the fossa or canal, and linear fractures of the nasolacrimal canal. NLD damage associated with NOE fractures needs attention because of the intimate relationship between the lacrimal sac and medial canthal ligament at the inner canthus.[3]

Optimal treatment and outcomes of treated lacrimal injuries were not reported in these studies. Moreover, there are currently no clear indications for concomitant intraoperative NLD intubation. Suggested indications include massive epiphora, penetrating trauma directed antero-posteriorly, and high-velocity Le Fort II fractures.[4] Other studies have cited prevention of persistent epiphora as a singular indication for NLD intubation.[5] If left untreated, persistent epiphora may cause chronic dacryocystitis and lacrimal abscesses in up to 15% of patients. In Markowitz et al's study,[1] the incidence of late lacrimal obstruction and dacryocystitis requiring an external dacryocystorhinostomy (DCR) was 5% following acute fracture treatment. Without clear indications for NLD intubation, large adult studies have previously reported NLD patency rates without intraoperative intubation[6] or evaluation after primary DCR[7] to demonstrate the efficacy of nonintubation strategies.

Proponents of NLD intubation believe that the high incidence of posttraumatic epiphora is sufficient indication for prophylactic intubation. Becelli et al reported the incidence of posttraumatic postoperative epiphora was 47% (27/58 patients) in a group of retrospectively analyzed 58 patients with facial fractures involving the NOE complex. Becelli et al further described significant challenges in delayed treatment of epiphora (up to 2 weeks postinjury), including permanent nasolacrimal apparatus compression by fracture fragments, lacrimal bone loss, and fibrotic scar retraction of the lacrimal system.[12] The added risk of false passage and incomplete intubation[13] when attempting to intubate the NLD during secondary surgery suggests prophylactic intubation during initial surgery is indicated. Opponents of NLD intubation argue that the intubation process causes unnecessary trauma to the nasolacrimal apparatus, and excessive instrumentation may worsen localized edema. Gruss et al reported that such instrumentation was deemed unnecessary unless the NLD was obviously lacerated, as posttraumatic epiphora tended to resolve spontaneously within 6 weeks.[14]

Our study aims to investigate the safety and efficacy of intraoperative NLD intubation in preventing posttraumatic epiphora and associated postoperative symptoms,[8] by comparing relative incidence. We further examine if prophylactic NLD intubation should be performed routinely in the surgical management of facial fractures.

Methods

From 2008 to 2013, 280 patients with NOE, frontal sinus, and Le Fort II/III facial fractures operated upon at a single large tertiary hospital in Singapore were identified and included in this retrospective matched control study. This study was approved by the institutional review board (ref number: DSRB 2013/01198).

The study group comprised 37 consecutive patients who sustained one or more of the above fracture types and underwent surgical fixation with intraoperative NLD intubation. Thirty-seven consecutive matched controls—patients who matched the above group but underwent surgical fixation without NLD intubation—were included in the control group. Criteria for matching were age, gender, fracture type, and injury type. All patients were included in this study with intention to treat, and subsequently studied. All underwent preoperative computed tomography scan of the face to assess (1) extent of the fracture pattern, (2) degree of comminution, and (3) extent of damage to the nasolacrimal apparatus. We were unable to match exact fracture configurations for every patient but ensured that the fractures were at least identical in number, laterality, and combination of affected regions.

Of the 74 patients studied, the average age was 37.6 (17–64) and 33.6 (15–61) years in the study group and control group, respectively. The study group had 35 males and 2 females while the control group had 33 males and 4 females. The majority of patients sustained blunt facial trauma, resulting in multiple facial fractures. The clinical profile of patients in both groups is detailed in ►**Table 1**.

Management

Our institution has the following standard oculoplastics protocol.

Intraoperative probing and syringing of the nasolacrimal system is performed to evaluate the patency and level of stenosis. This was achieved by inserting a lubricated Bowman's probe vertically into the upper or lower canaliculus and ampulla, with rotation along the nasolacrimal system sequentially. Any obstruction encountered indicates a corresponding nasolacrimal stenosis or bony lesions. Bicanalicular intubation was performed with Crawford intubation set and tubes to stent the ducts and maintain patency, promoting recanalization postoperatively. Intubation mirrors the process of nasolacrimal probing, with passage of the

Table 1 Clinical profile of facial fracture patients

	Nasolacrimal duct (NLD) intubation group ($n = 37$)	Study group ($n = 37$)
Injury mechanism type	Blunt = 36/37 Penetrating = 1/37	Blunt = 36/37 Penetrating = 1/37
Fracture type (total $n = 37$)		
Naso-orbito-ethmoid (NOE)	8	8
Panfacial	4	4
Frontal sinus	1	1
Multiple facial fractures[a]	24	24

[a]Multiple fractures were defined as the presence of two or more concomitant fracture types in the same patient, e.g., NOE and frontal sinus, frontal sinus and panfacial. Only patients with identical combinations of fractures were matched.

Crawford probe and its attached silicon tube through the duct, exiting from under the inferior nasal turbinate. Retrieval of the olive-tipped probe was achieved either via direct visualization or nasal endoscopy. This was repeated with the remaining unintubated canaliculus and ampulla. Thereafter, the two metal probes were cut off from the tube and excess tubing extending beyond the external nares removed using a Crawford stripper. The silicone tube ends were tied with 6–0 suture, and anchored to the nasal septum or lateral alar cartilage by suturing.[9,10]

NLD intubation, if indicated, was performed at the start of the surgery, before local anatomy was disrupted by intraoperative manipulation and instrumentation. After successful intubation, all patients underwent open reduction and internal fixation of facial fractures with plates and screws.

Postoperative Evaluation

This study compared the incidence of postoperative epiphora and assessed incidence of wound infection complications (both of facial wounds and/or dacryocystitis) in both groups. Patients with postoperative epiphora were evaluated with lacrimal probing and fluorescein dye disappearance test. Other postoperative symptoms were assessed as part of routine follow-up clinical examinations. These were assessed at time points of 1, 3, 6, and 12 months.[11] Relative incidences were analyzed.

Results

The study group did not display any significant difference in outcomes compared with the control group with regard to both postoperative epiphora and wound infection. Only two cases of postoperative epiphora were encountered in the control group, and none in the NLD intubated study group (2 vs. 0, $p = 0.152$; nonsignificant [NS]). Comparing postoperative wound infection, one control group patient and two NLD intubated study group patients encountered this complication, respectively. There was no statistically significant difference (1 vs. 2, $p = 0.556$; NS) in incidence of wound infection (►**Table 2**). All reported complications resolved spontaneously within the 1-year follow-up period without further intervention or procedures.

Table 2 Incidence of postoperative epiphora and infection within 1 year

	Study group ($n = 37$)	Control ($n = 37$)	*p*-Value
Persistent epiphora	0	2	0.152
Wound infection	2	1	0.556

Discussion

Our study investigates the safety and efficacy of prophylactic NLD intubation. We highlight the study design limitations in existing studies and illustrate how our matched control study attempts to overcome these in addressing the above clinical topic.

Iwai et al[15] studied outcomes in a single group of NLD-intubated patients with NOE complex fractures. There were no stated indications for NLD intubation, or reported postoperative epiphora incidence in nonintubated patients. Without comparison to control treatment group, it is impossible to draw conclusions about the efficacy of NLD intubation. This contrasts with our study, where a direct comparison of postoperative complication rates was made with matched patient groups comprising intubated and nonintubated groups. Previous analyses of NLD intubation in literature have been confined to cases of obstruction arising from facial fractures involving the NOE complex[13] or single fracture types.[16] In our study, all fracture types in close proximity to the nasolacrimal apparatus, that is, frontal sinus, Le Fort II/III, and NOE fractures, were included. These fracture patterns commonly extend into the central segment, damage the nasolacrimal apparatus, and cause NLD obstruction. This allowed for more comprehensive evaluation of NLD intubation safety in the context of facial fracture management. Moreover, our study investigated patients who sustained multiple facial fractures. Multiple fractures occur in a considerable proportion of our patients (24/37, 64.9%), which is common in midfacial blunt trauma. Critique of previous studies of NLD intubation for posttraumatic epiphora suggests the differences in outcome may be due to baseline variation in specific types and severity of facial fractures involved, rather than attributed to differences in surgical treatment. Our study matched patients with the exact fracture combination type and severity after review of preoperative imaging, prior to selecting patients with multiple facial fractures.

Besides using postoperative epiphora to determine the efficacy of NLD intubation, we further considered wound infection (including dacryocystitis) as an additional marker

of safety in treated patients. Both incidences of postoperative epiphora and wound infection were not statistically significant between both study groups. Together, these results illustrate that the benefit of prophylactic NLD intubation is very minimal—postoperative epiphora can be prevented in approximately 1 out of 20 patients prophylactically intubated. In our study, both nonintubated patients who developed epiphora had relief within 2 months without infective complications.

In our institution, NLD intubation is performed as a precautionary measure by a single oculoplastics surgeon experienced in lacrimal surgery. This is done for patients who have sustained complex and comminuted facial fractures. The average time taken for intubation was 10 minutes. This minimized the risks of unnecessary NLD trauma due to instrumentation, and did not prolong operative times. In such patients, considering NLD intubation is relevant because of the following reasons:

- A high incidence of damage to NLD resulting from the high energy mechanism of injury, and multiple displaced fracture fragments.
- Extensive intraoperative midfacial manipulation due to severity and complexity of multiple facial fractures, which may further damage the nasolacrimal apparatus. Hence, there is the need for atraumatic intubation before the commencement of midfacial manipulation.
- Increased risk of postoperative hyperostosis of nasolacrimal canal and thus difficulty in successful intubation to reestablish patency if postoperative epiphora develops.

Intraoperatively, a joint review by oculoplastics and craniomaxillofacial teams was conducted to assess the extent of injury and indications for NLD intubation. Indications for NLD intubation included:

- Patients who sustained NLD fractures with displacement and comminuted fractures involving the central segment, lacrimal sac fossa, and the bony NLD.
- Any suggestions of regurgitation on lacrimal irrigation.

Presence of one or both of the above suggests a more severe, complex facial injury necessitating intubation. Conversely, not meeting any of the above criteria suggests a nonsevere facial injury.

Specific challenges arise in performing successful NLD intubation. First, multiple fracture fragments distort local anatomy. Second, fibrosis and granulation tissue may be present around the injury site, especially in patients who are electively operated upon. Third, associated fractures of nasal bones and localized inflammatory reaction present difficulty in both passage and retrieval of the silicone tubes. These factors increase the risk of inadvertent false passage,[13] and support our assertion that the risks certainly outweigh the minimal benefits of prophylactically performing NLD intubation for every facial fracture patient. The procedure would be aborted after two failed attempts; however, this situation was not encountered in any of the patients in our study. There were also no adverse events where false passage or incomplete intubation occurred.

While our results demonstrate that there is no necessity to prophylactically intubate all facial fracture patients, there definitely exist patients in whom NLD intubation is indicated, as specified in our institution protocol above. Prophylactic NLD intubation where indicated would minimize postoperative epiphora, and avoid further operations including a secondary external DCR, which has its own risks and complications.[17] As reported by Spinelli et al,[18] NLD intubation performed skillfully is widely regarded as a safe, reliable, and effective measure for maintaining patency of a damaged or obstructed lacrimal drainage system while reepithelialization occurs. This safety and efficacy can only be achieved with correct procedural indications and by an expert surgeon. The patients treated in our study are Asian, and results may vary in different patient populations due to variations in facial skeleton anatomy. Especially in cases of complex facial fractures, skillful navigation of distorted midfacial anatomy is relevant. We hence stress that an expert surgeon is a prerequisite for successful NLD intubation, to ensure reproducible outcomes and minimize procedural complications.

Conclusion

In conclusion, intraoperative NLD intubation demonstrates a nonsignificant reduction of incidence of postoperative epiphora in patients with facial fractures involving the nasolacrimal apparatus. The is no necessity to prophylactically perform NLD intubation on all facial fracture patients as the procedural risks far outweigh the benefits. NLD intubation should instead be considered as a therapeutic procedure, for which our study has proposed specific indications. These must be evaluated in patients with severe and complex facial fractures. NLD intubation, when indicated, must be performed by a skilled and experienced surgeon.

Author Contributions

All authors were involved in the conceptualization, methodology, and project administration aspects of this study. T.C.L. and G.S. were involved in direct supervision of this study. R.L.W.T., P.Y.F., and T.C.L. were involved in the writing of the original draft, review, and editing of this study's manuscript.

Ethical Approval

The authors declare that this is an independent original study (IRB ref number: DSRB 2013/01198).

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None.

Conflict of Interest

None declared.

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