PREHOSPITAL CARE

Prehospital canthotomy: A sight-saving procedure in case series

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Abstract

Objective: Orbital compartment syndrome (OCS) is a time critical condition, with ischaemic complications occurring after 90–120 min. In the prehospital setting, the diagnosis and management of OCS is challenging due to complex environmental considerations, competing clinical priorities, and limited equipment. This study aims to provide learning points on performing lateral canthotomy and cantholysis (LCC) in the prehospital setting.

Methods: We performed a retrospective audit of LCC in our service from January 2016 to December 2020 by retrieving demographic and clinical details from LifeFlight Retrieval Medicine electronic database using ‘OCS’ and ‘LCC’ as keywords.

Results: Three cases out of 7413 trauma missions were identified over the 5-year period. LCC was performed at the primary scene in two cases, while one patient underwent LCC at a rural hospital near the scene of injury. Clinical findings, aeromedical considerations, and radiological findings at the receiving facility, along with visual outcomes at time of discharge are discussed.

Conclusion: Prehospital LCC is rare. The Australian aeromedical context often involves lengthy transfers of trauma patients. Clinical diagnosis and management of OCS are highly challenging in the prehospital setting. It is important that prehospital physicians have access to appropriate equipment to perform LCC. They should be provided with suitable training and supported by a standard operating procedure.

Key words: canthotomy and cantholysis, orbital compartment syndrome, orbital trauma, prehospital canthotomy and cantholysis.

Introduction

Orbital compartment syndrome (OCS) is an ophthalmic emergency, characterised by raised intra-orbital pressure and subsequent ocular ischemia. To prevent irreversible eye damage, OCS requires urgent diagnosis and treatment, both of which are challenging in the prehospital environment. The key clinical features of OCS are reduced visual acuity, proptosis, restricted extraocular movements, relative afferent pupillary defect (RAPD) and raised intraocular pressure (IOP). Lateral canthotomy and cantholysis (LCC) is the standard treatment to decompress the orbit and performing LCC within 2 h is associated with good visual outcomes.1

In the prehospital setting, the challenges faced by retrieval clinicians include time pressures, competing clinical interests, inability to assess visual acuity due to both patient and scene factors, absence of tonometer to measure IOP, lack of focused training to perform the procedure and limitations on the equipment available to perform LCC. One key principle of prehospital trauma management is to limit scene times and deliver patients to definitive care as soon as possible, thereby limiting assessment and interventions to those that add immediate value to the patient’s care. Environmental factors include variable light, space limitations, vibrations in the

Key findings

- LCC is a time sensitive, vision saving procedure. If a patient cannot be delivered to a hospital with staff trained in LCC in a timeframe under 90–120 min post injury, prehospital LCC is indicated and should not be delayed.
- Prehospital LCC may be required in the Australian aeromedical context given long transfer times.
- Aeromedical clinicians should be familiar with, trained for, and have access to equipment to perform LCC.

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### TABLE 1. Case series summary of clinical data, aeromedical information and follow-up findings (radiology, visual acuity at time of discharge)

|                      | Case 1                       | Case 2                       | Case 3                       |
|----------------------|------------------------------|------------------------------|------------------------------|
| **Demographics**     | 42-year-old male             | 17-year-old male             | 39-year-old male             |
| **Time between injury** | 240                          | 120                          | 90                           |
| **LCC (min)**        |                              |                              |                              |
| **Flight time to trauma centre** | 100                          | 45                           | 75                           |
| **after LCC (min)**  |                              |                              |                              |
| **Mode of transport**| Fixed wing                   | Rotary wing                  | Rotary wing                  |
| **Location**         | Roadside                     | Roadside                     | Rural hospital (no CT available) |
| **Glasgow Coma Score** | 7                           | 8                            | 13                           |
| **Mechanism of injury** | Fall 3 m off tree            | Motor vehicle accident       | Motor vehicle accident       |
| **Clinical signs prior to LCC** | Tense orbit                 | Tense orbit                  | Tense orbit                  |
| | Pupil size: 4 mm, initially sluggish, then progressed to unreactive | Pupil size: 5 mm, initially sluggish, then progressed to unreactive | Pupil size: 5 mm, initially sluggish, then progressed to unreactive |
| | Proptosis                    | Proptosis                    | Proptosis                    |
| | Periorbital hematoma         | Periorbital hematoma         | Relative afferent pupillary defect |
| **Contraindications to procedure (suspected globe rupture)** | Nil                          | Nil                          | Nil                          |
| **Clinical signs post-procedure** | Pupil size: 2 mm Unreactive Anterior displacement of globe | Pupil size: 3 mm Reactive Anterior displacement of globe | Pupil size: 5 mm Unreactive Anterior displacement of globe |
| **CT scan findings**  | Comminuted fractures of the lateral, medial, inferior and superior left orbital walls with a depressed bone fragment superiorly, associated with a superior extraconal haematoma, retrobulbar intraconal fat stranding, surgical emphysema and proptosis. Significant left inferior frontal haemorrhagic brain contusion. | Comminuted fractures of the medial and superior right orbital walls and associated preseptal haematoma, retrobulbar intraconal fat stranding, surgical emphysema and proptosis. | Minimally displaced fractures of the medial and lateral left orbital walls and associated retrobulbar intraconal fat stranding, surgical emphysema and proptosis. Intracranial and infratemporal fossa haematoma and marked pneumocephalus. |
| **Proptosis†**        | By 5.3 mm                    | By 0.8 mm                    | By 5.7 mm                    |
| **Haematoma size and location** | $13 \times 21 \times 7.5$ mm Superior extraconal | $7.7 \times 9.4 \times 6.2$ mm Superior extraconal | Not measurable due to diffuse fat stranding |

(Continues)
helicopter and noise. Patient factors include the presence of concomitant head injury resulting in altered level of consciousness and rendering meaningful assessment of visual acuity and orbital movements impossible. There may be limitation on personnel availability to retract tense eyelids for inspection of the orbit. Prehospital kits including in our organisation do not contain visual acuity charts and tonometry devices. Use of a tonometer, a key diagnostic hospital tool, is not practical in the aeromedical setting where there are limitations on equipment including weight, size and durability. There are constraints on positioning patients in the upright position to facilitate IOP measurement, such as spinal immobilisation and aircraft configuration.

**Methods and results**

LifeFlight Retrieval Medicine (LRM) is an aeromedical service that operates across Queensland, Australia. Community missions are tasked by the Medical Coordinator at Retrieval Services Queensland, the aeromedical coordination agency for Queensland Health. We performed a retrospective audit on LCC in our service from January 2016 to December 2020; LRM electronic database, which contains all mission details and patient records, was searched for OCS and LCC. We identified three patients out of 7413 trauma missions performed by LRM, over the 5-year period. LCC was performed at the primary scene in two of the cases, whereas one patient underwent LCC at a rural hospital near the scene of injury. Clinical findings, aeromedical considerations and radiological findings at the receiving facility, along with visual outcomes at discharge are presented in Table 1.

| Site of fat stranding | Case 1 | Case 2 | Case 3 |
|----------------------|--------|--------|--------|
| Pre-septal, superior intra and extraconal | Pre-septal, superior and medial extraconal | Lateral and superior, intra and extraconal |
| Optic nerve length | | | |
| Affected eye | 36 mm | 32.5 mm | 38 mm |
| Contralateral eye | 26.3 mm | 30.6 mm | 34 mm |
| Visual acuity on discharge | | | |
| Affected eye | 6/30 | 6/7.5 | Hand movement |
| Unaffected eye | 6/9.5 | 6/7.5 | 6/5 |

†Proptosis is measured by the length of a line drawn perpendicular to the inter-zygomatic line to the posterior sclera. The above measurements depict the difference between the normal and the globe with proptosis. LCC, lateral canthotomy and cantholysis.

Figure 1. Computed tomography scan showing left retrobulbar stranding consistent with haemorrhage (*) and depressed left superior and lateral orbital wall fractures with surrounding haematoma (**).
time of discharge are outlined in Table 1 and Figures 1–3. The cases provide learning points relating to equipment, personnel, formalised training within aeromedical services and development of a standard operating procedure (SOP).

**Ethical approval and patient consent**

Ethical approval was obtained with HREC Reference: LNR/2020 QTDD/69377. Consent was obtained from all patients.

**Discussion**

Prehospital LCC is rarely performed and a 5-year retrospective analysis at LRM identified only three cases. Flight times in our aeromedical service frequently exceed 1 h. Therefore, it is essential that retrieval clinicians working in our aeromedical service or similar settings can both diagnose and treat OCS. The signs most examinable by the roadside are proptosis, tense globe on palpation, pupil abnormalities, including RAPD. All our patients had altered level of consciousness from significant head injury and could not have visual acuity tested. The only contraindication to LCC is eye globe rupture and suggestive clinical signs are hyphaemia, misshapen pupil, enophthalmos, globe hypotony and exposed uveal tissue. These signs are identifiable on careful eye examination at the site of retrieval, and generally without the aid of portable slitlamp biomicroscope.

In blunt trauma which represents all our cases, mechanisms of OCS are acute post-septal haemorrhage, foreign body or oedema. The resulting retinal and optic nerve ischemia, if lasting more than 90–120 min, may lead to irreversible blindness. The diagnosis of this condition in the prehospital setting relies solely upon clinical assessment without tonometry. If the patient cannot be promptly delivered to a hospital with staff trained in LCC in a timeframe under 90–120 min post injury, prehospital LCC is indicated and should not be delayed. Retrieval physicians should be mindful of this important condition and be prepared to perform LCC immediately, when indicated.

The diagnostic imaging modality available to retrieval clinicians is point-of-care ultrasound; it can be performed quickly by the roadside and can detect retroorbital haemorrhage and ‘guitar pick sign’. However, it requires additional training; retrobulbar haemorrhage is not essential in diagnosing OCS; its use does not add to the clinical picture and will unlikely change management while potentially prolonging clinical assessment. Point-of-care ultrasound should not dissuade retrieval clinicians from performing LCC and we do not advocate for its use. Computed tomography (CT) features include proptosis, tenting of the posterior globe and optic nerve stretching, defined by 20% increase in length of the optic nerve relative to contralateral side. Only one of our patients displayed optic nerve stretching by >20% (29.9%), with measurements below the 20% threshold in case 2 (5.8%) and case 3 (10.5%), though these studies were performed post-intervention which limits the utility of nerve measurements; LCC decreases optic nerve stretching. One patient had a clinical diagnosis of proptosis in the field, which was subsequently excluded on CT scan at the receiving facility. This highlights that clinical assessment is challenging in the field and lid oedema may create a false appearance of proptosis. None of our patients showed imaging evidence of discrete retrobulbar haematoma (RBH), highlighting that the presence or absence of RBH neither precludes nor necessitates LCC. Clinicians should not conceptualise LCC as a procedure for RBH but rather as a procedure for OCS of any cause.

LCC involves a full thickness skin incision at the site of the lateral canthus and subsequent division of the inferior lateral canthal tendon. Additional division of the superior...
lateral canthal tendon may also be undertaken if adequate orbital decompression is not achieved with inferior cantholysis alone. Equipment needed should be easily found in most prehospital kits: local anaesthetic (lignocaine 1% with adrenaline), artery or straight forceps and iris or suture scissors. LRM does not carry a specialised kit to carry out LCC; however, all of this equipment is readily available within the LRM primary pack. In our case series, LCC was performed after rapid sequence induction due to significant head injury; LRM clinicians used suture scissors and straight forceps, and no technical problems were noted.

After orbital pressure is relieved, subsequent repair of the lateral canthotomy wound, including repair of the lateral canthal tendons, can often be organised with the local ophthalmology service on a routine operating list. An excellent functional and cosmetic result is generally achieved through subsequent tissue repair. Concerns over wound healing and cosmesis should not deter from performing LCC. All patients in our series were followed up by their local ophthalmology service and sustained no complications to the lateral rectus muscle, lacrimal gland, lacrimal artery, damage to the eyelids, haemorrhage and infection.

The first published case of prehospital LCC was described by Hill et al., with a 21-year-old patient who underwent LCC following a penetrating head injury. An important conclusion from this case was the need to ensure training exists for retrieval clinicians. Subsequently, Whitford et al. authored a case series of three prehospital LCCs and described a three-point decision tool to aid diagnosis in the field: ‘look, feel and evaluate’; look for proptosis, feel for a tense globe and evaluate for visual acuity changes and/or pupillary abnormalities. The authors advocated LCC when of two of the three assessment points are positive, accepting that there will be false-positive LCC on occasion. This has not been validated across other aeromedical services and the LRM SOP does not include any decision-making tool. The decision-making is shared between the retrieval clinician and the Medical Coordinator at Retrieval Services Queensland.

Applying the look, feel and evaluate tool to our case series, one of the patients had severe eye lid oedema which gave a false appearance of proptosis, with a CT which showed no radiological proptosis. None of the patients would not have been able to have a visual assessment performed due to altered conscious state and in the presence of coexisting head injury. Furthermore, significant head injury can result in pupillary abnormalities due to raised intracranial pressure, manifested as a fixed and dilated pupil(s). As such, RAPD may be a more specific sign than other pupillary abnormalities in the presence of severe head injury. RAPD was documented in only one of our cases.

As a result of our experience with LCC, LRM has recently published a SOP. The SOP includes an overview of indications and contraindications, technique, educational diagrams and videos, along with key references. In addition to this, there is scope for LRM to expand education on LCC. Areas of opportunity include the training week that occurs six monthly at start of each registrar term, incorporating LCC in the weekly LRM teaching programme, and ongoing procedural training on each base led by senior clinicians. Plans have also been made to film a training video on LCC for the LRM procedure video platform.

Conclusion

The Australian aeromedical context often involves lengthy transfers of trauma patients. OCS is a time critical condition, with ischaemic complications occurring after 90–120 min. Clinical diagnosis and management of OCS are highly challenging in the prehospital setting. It is important that prehospital physicians have access to appropriate equipment to perform LCC. They should be
provided with suitable training and supported by a SOP.

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Author contributions
All authors contributed to the manuscript and revised the manuscript.

Competing interests
None declared.

Data availability statement
Data sharing is not applicable to this article as no new data were created or analyzed in this study.

References
1. McCallum E, Keren S, Lapira M, Norris JH. Orbital compartment syndrome: an update with review of the literature. Clin. Ophthalmol. 2019; 13: 2189–94.
2. Amer E, El-Rahman Abbas A. Ocular compartment syndrome and lateral canthotomy procedure. J. Emerg. Med. 2019; 56: 294–7.
3. Whitford R, Continenza S, Liebman J, Peng J, Powell EK, Tilney PVR. Out-of-hospital lateral canthotomy and cantholysis: a case series and screening tool for identification of orbital compartment syndrome. Air Med. J. 2018; 37: 7–11.
4. McInnes G, Howes DW, McInnes Gord, Howes Daniel W. Lateral canthotomy and cantholysis: a simple, vision-saving procedure. CJEM 2002; 4: 49–52.
5. Ballard SR, Enzenauer RW, O'Donnell T, Fleming JC, Risk G, Waite AN. Emergency lateral canthotomy and cantholysis: a simple procedure to preserve vision from sight threatening orbital hemorrhage. J. Spec. Oper. Med. 2009; 9: 26–32.
6. Kniess CK, Fong TC, Reilly AJ, Laoteppitaks C. Early detection of traumatic retrobulbar hemorrhage using bedside ocular ultrasound. J. Emerg. Med. 2015; 49: 58–60.
7. Murali S, Davis C, McCrea MJ, Plewa MC. Orbital compartment syndrome: pearls and pitfalls for the emergency physician. J. Am. Coll. Emerg. Phys. Open. 2021; 2: e12372.
8. Kucharski CJ, Tao J. Optic nerve stretch in orbital compartment syndrome. Invest. Ophthalmol. Vis. Sci. 2007; 48: 1–2.
9. Hill C, Reid C, Tzannes A, Burns B, Bartlett M. Prehospital lateral canthotomy. Emerg. Med. J. 2013; 30: 155–6.