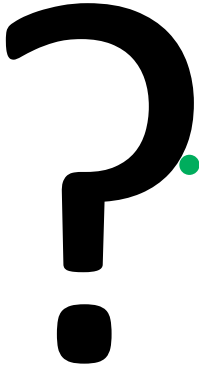


Inferior Rectus flap tear: does it exist? How to fix it.

Katarina Creese and Lionel Kowal
The Royal Victorian Eye and Ear Hospital, Melbourne

Causes of diplopia after blunt eye trauma

- 
- **Early causes** – soft tissue oedema, haemorrhage, direct nerve injury, entrapment of orbital contents in a bony fracture.
 - **Late causes** – fibrosis after pre-existing oedema and haemorrhage, direct muscle or nerve injury, ischaemia, scarring and fixation of previously entrapped tissue.
 - ? most common cause is a **flap tear** (longitudinal tear most commonly on IR)

048 Magnetic resonance imaging (MRI) of inferior rectus (IR) flap tears. Tina G. Damarjian, Joseph L. Demer

Introduction: Thus far, the only evidence for existence of flap tears in EOMs has been observations during surgical repair. This study employed MRI to investigate anatomy of flap tears of the IR.

Methods: Five adults (ages 25-68 years) who sustained trauma to the IR were studied prospectively using a 1.5 Tesla MRI scanner with surface coils and fixation targets. Sagittal and coronal T2 sequences were performed in upward, downward, and central gaze for each eye, permitting comparison with age-matched controls.

Results: Patients exhibited infraduction limitation greatest in abduction, and incomitant ipsilateral hypertropia greatest in infraversion. All but one had associated orbital fractures. Three torn IRs exhibited a longitudinal fissure separating the orbital (OL) and global layers (GL), with avulsion of the GL from the sclera in one case, and avulsion of the OL from its pulley in two cases. Two involved IRs exhibited a longitudinal fissure separating medial portion of the GL that was attached to the sclera, from the avulsed lateral portion. All cases manifested extensive inferior orbital scarring. Surgical repair was possible in 3 cases.

Discussion: Blunt trauma may cause longitudinal tears in the IR having variable orientations: longitudinal separation of OL from GL, or disinsertion of only the lateral IR from sclera. Both diminish infraduction. Due to traumatic anatomic distortions and their posterior locations, these flap tears would be difficult to recognize surgically.

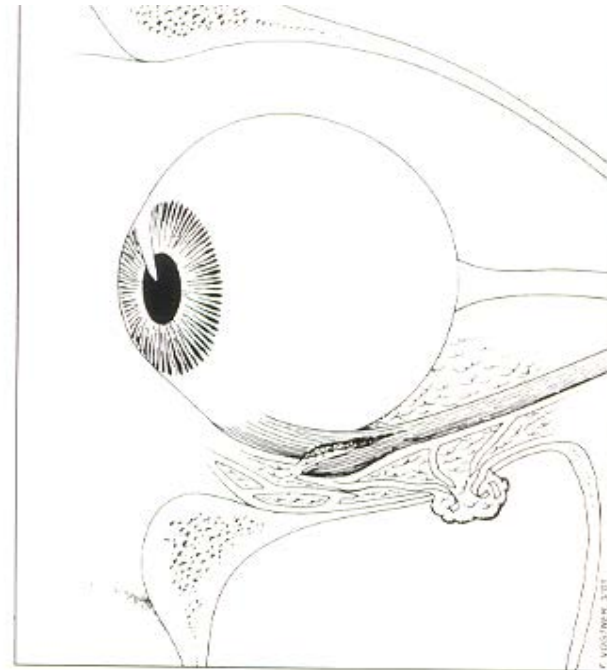
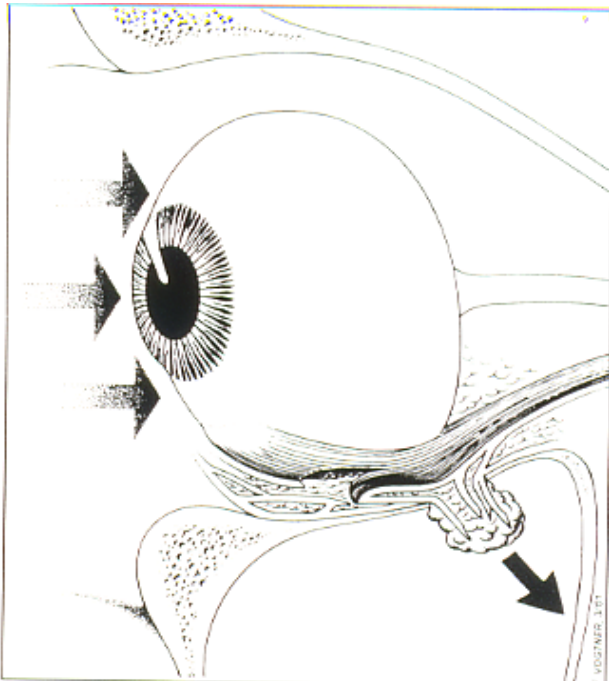
Conclusions: Longitudinal tears may selectively avulse one compartment of the IR, sparing the other, but both compromising infraducting function. Demonstration of this pathologic anatomy requires high resolution orbital imaging.

2016 update ARVO & AAPOS MRI images of the flap tear

Validates Irene Ludwig's observations first published in 2001.

Flap tear hypothesis (Dr Irene Ludwig)

- Blunt trauma causes traction on orbital septae.
- Orbital connective tissue, which attaches onto EOM pulls away portion of muscle & weakens it.
- Flap can act as a tether, further restricting & complicating motility.



Ocular motility changes

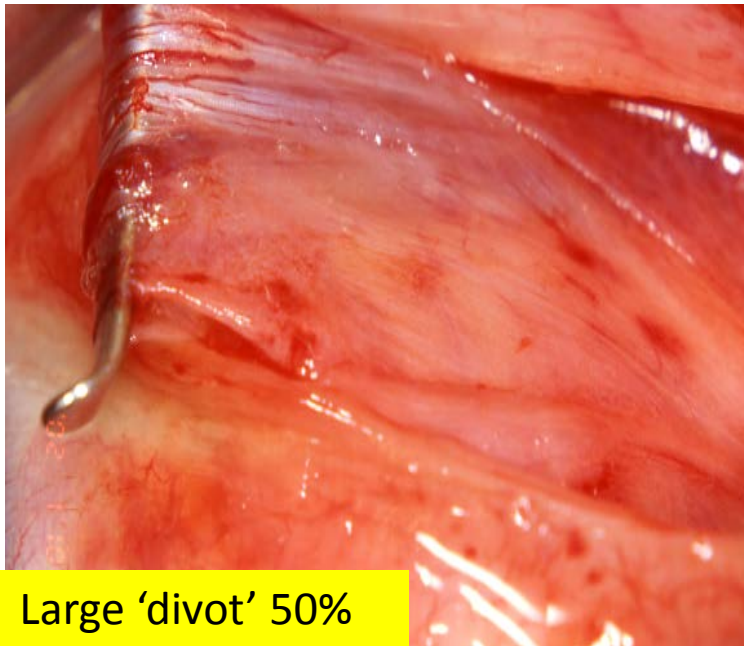
- Limitation toward the field of action of the affected muscle (tether created by the torn flap simulating muscle palsy).
- Restriction away from the field of action of the affected muscle (simulating entrapment).

Intraoperative appearance

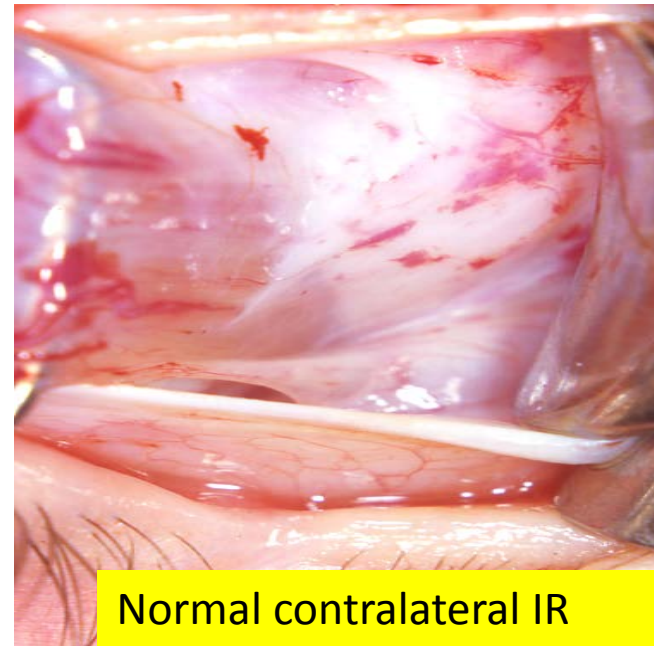
- Segment of muscle and tendon missing – narrowed attachment.
- Outer orbital layer missing – muscles appear thinned, disrupted muscle capsule.
- Muscle flap that has been torn away is encased in surrounding orbital fat.

Intraoperative photo from Dr Ludwig

Example where 'divot' of muscle has been 'sliced' off



Large 'divot' 50%



Normal contralateral IR

Surgical technique

(Dr I. Ludwig's cohort of 500 cases)

- Forced duction test – restriction toward field of action.
- Find the flap and dissect from surrounding tissue.
- Suture flap to the remaining muscle with non-absorbable suture (braided 6-0 polyester).
- Repair defect in Tenon's capsule to reduce adhesions with 6-0 vicryl +/- Tenon's graft from unaffected quadrant of the same eye.
- No adjustables. No steroids.

Other surgical techniques of flap tear repair (not recommended by Dr Ludwig)

- Excise flap tear – resect bad muscle (Raab, 2012)
- Plication or resect the abnormal zone of muscle +/- operate on other muscles (LK)

Results (Dr I. Ludwig)

- Best if simultaneous repair of orbital fracture and flap tear.
- Worst if initial orbital fracture repair +/- strabismus surgery and flap tear repaired later.

Case 1

- 37 female – right orbital floor fracture when fell face down while skiing
- Orbital floor # repaired, but persistent diplopia

Measurements made with Maddox rod

Up right RH 1		Up left RH 1
Right RH 14	Primary RH 6	Left 0
Down right RH 25		Down left RH 0.5

Measurements made with prism bar, trying to achieve single vision.
 *indicates single vision

Up right 0 *	Up LH 2 *	Up left 0 *
Right RH 16*	Primary RH 3 * Range single vision: lateral gaze <5 deg, Up gaze 20 deg	Right 0 *
Down right 13 *	Down gaze RH 9 , XT 6 *	Down left 3 *

26/7/2016

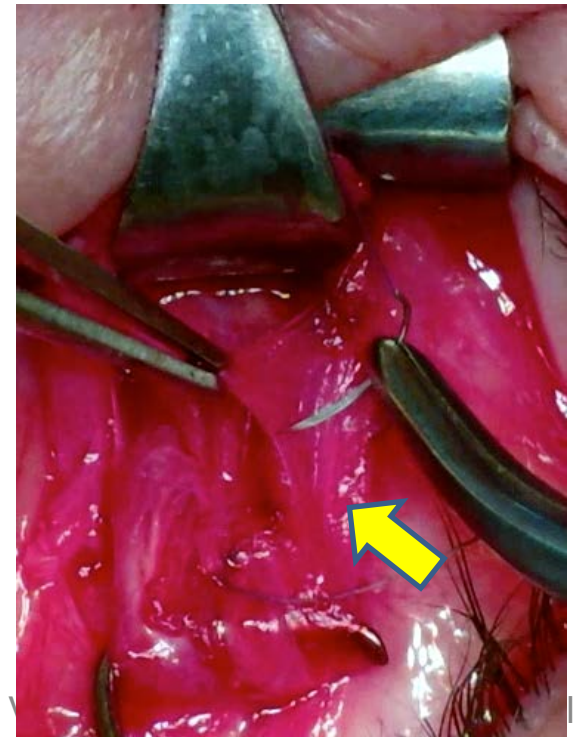
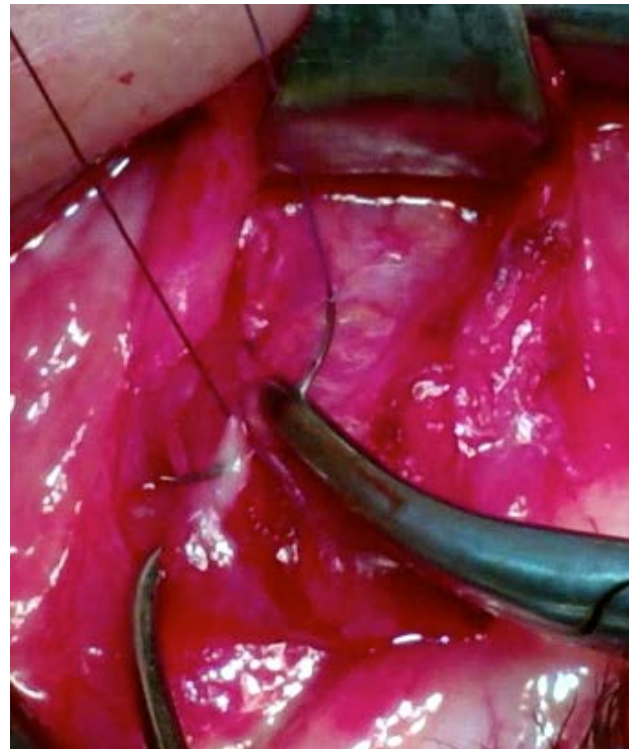
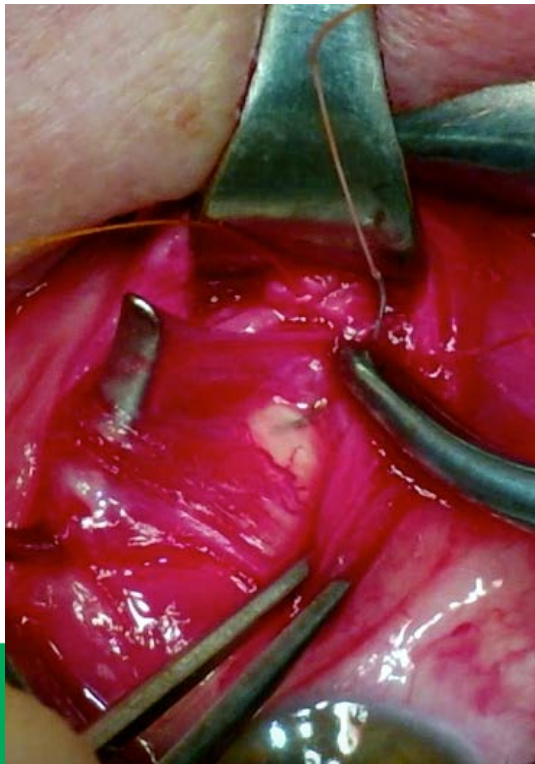
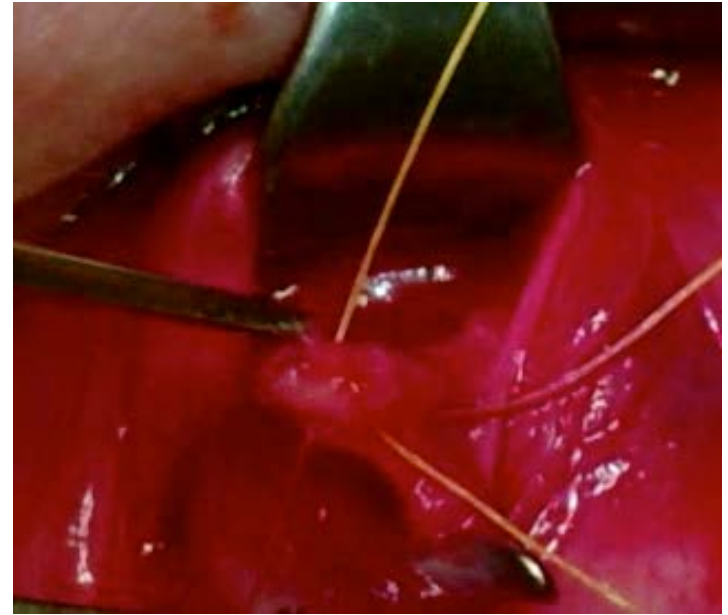
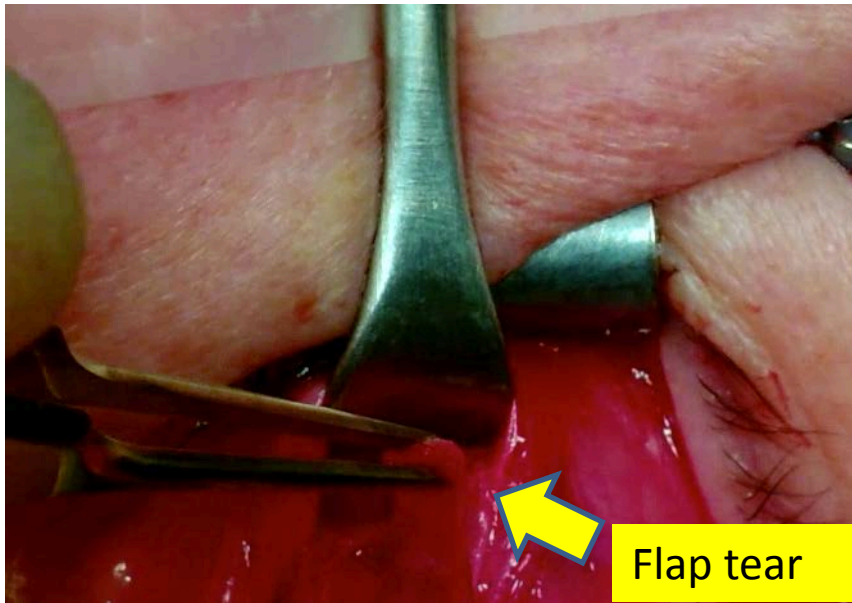


30/8/2016



Referred to Dr Ludwig (3 operations in 36 hours)

- Surgery 1
 - **Repair of flap tear on RIR and RMR**
- Surgery 2 - Persistent right hypertropia and new onset esotropia following repair of avulsion, right inferior medial rectus
 - **Residual flap tear of RIR found and repaired**, Tenon's capsule graft harvested from L superotemporal quadrant. **RLR inferior displacement found** – moved to anatomical position and secured to the sclera.
- Surgery 3: Persistent right hypertropia
 - **RIR resection 3.5mm**



Date	Range of single vision (deg) Up gaze	Down gaze	R gaze	L gaze	Measurements Primary; Motor fusion	Up gaze	Down gaze	After stretch
Sept 27	10	10	20	50	0 BD R1, BD L2 Can't see Fly	LH 20, ET 4	RH7	Same RH & ROS
Sept 29	10+	10+	25	40	0 800" stereo	LH 12	RH 8	RH6
Oct 4	20	10	30	5	0 BDR4, BDL2 50"	LH 12	RH8	RH8
Oct 10					0 BDR1, BDL3 20"		RH8	RH8
Oct 18 1 month	10	30	30	30	0 BDR1, BDL3 20"		RH 6	RH6
Nov 2	15	25	30	50	0 BDR2, BDL3 20"	LH 20+	RH3	No stretch
Dec 6	20	45	30	35	0 BDR2, BDL1 25"	LH 15	RH 1	"

3/11/2016





Before surgery



6/52 after surgery

Case 2

- 64 yo male
- R blunt trauma – fell onto a water tap 2/12 prior, since then bothered by vertical and torsional diplopia
- No orbital fracture, no globe injury, only lid oedema

Pre-operative measurements (* means single vision)

Eso deviation

Up right 10	Up 8	Up left 4
Right 6	Primary 6 *	Right 6
Down right 6	Downgaze 6	Down left 8

Vertical deviation RH

Up right 18	Up 16	Up left 16
Right 26	Primary RH 24*	Right 22
Down right 26	Downgaze 24	Down left 22

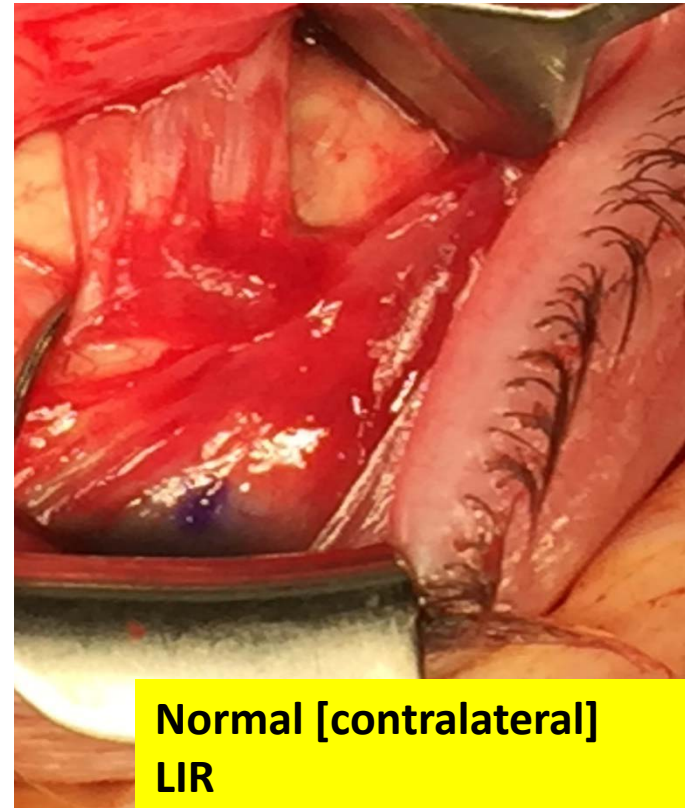
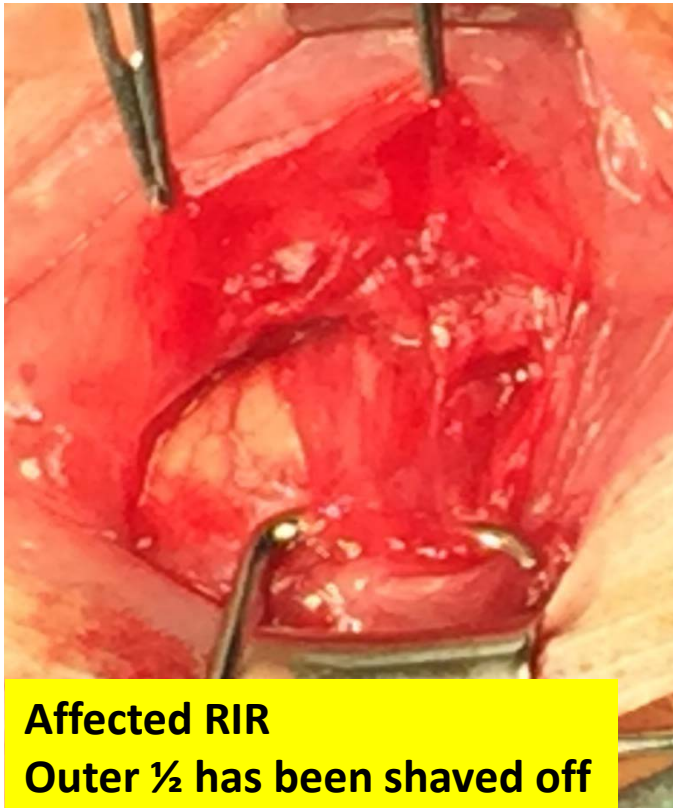
Subjective incyclotorsion

PP 6
Downgaze 5
Upgaze <5

Surgery

- **Findings:**

- Thin RIR first 12mm from insertion; not explored beyond conjunctivo-palpebral head
- LIR normal
- Tight RSR
- Conjunctival scarring around /nasal to RIR





- **Surgery:**

- Mersilene to RIR 12mm from insertion; RIR folded to 5mm from insertion
- RSR recess 5mm, adj, draped from ~3mm temporal to centre of original insertion, 5/0 vicryl
- LIR nasal edge Faden 6/0 Mersilene, 6mm behind insertion
- Holmes' dots: no net torsional effect

Case 2

Post-operative measurements

Large range of single vision with good stereopsis

Post-op	Range of SV upgaze	Range of SV downgaze	R gaze	L gaze	Motor fusion	Primary
7 days	40	40	30	40	400"	0
5 weeks	40	30	40	30	40"	0

Summary

- Flap tear hypothesis first published in 2001 – not widely accepted by ophthalmologists
- 2016 – MRI imaging confirming flap tear diagnosis
- Is it necessary to repair the flap tear?
- How soon to do repair?
- Technique?

Literature

- Ludwig, Irene H., and Mark S. Brown. "Strabismus due to flap tear of a rectus muscle." *Transactions of the American Ophthalmological Society* 99 (2001): 53.
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