CASE REPORT

# Satisfied Result of Modified Knapp Procedure for A Rare Case of Isolated Superior Rectus Muscle Rupture: A Case Report

**Lasmida Ruth A Simatupang [1], Gusti G Suardana[1]**
[1]Department of Ophthalmology, Faculty of Medicine, University of Indonesia
*E-mail: lasmida.ruth@gmail.com*

**ABSTRACT**

**Purpose:** To report a successful management of strabismus after isolated superior rectus muscle rupture with modified Knapp procedure.
**Case Description:** A 23-year-old patient with chief complain of having double vision since 6 days. He had history of falling and his right eye hit the floor. After that, he had double vision and his right eye could not move normally to the right and up gaze. Ophthalmology examination of right eye, uncorrected visual acuity was 6/12 and not improved with pinhole. He had 15 PD esotropia and right hypotropia on Hirschberg test. Right eye movement was restricted to to lateral, superotemporal and superonasal (-3 on abduction and elevation). The superior rectus muscle was barely visible at superior part of orbit. However, Computed Tomography scan showed there was not any enlargement of the extra ocular muscles. He had exploration surgery and intraoperatively the superior rectus muscle could not be identified. Surgeon decided to do modified Knapp procedure. On the third week and second month of follow up, patient did not have any complain of diplopia and no vertical and horizontal deviation.
**Conclusion**: Isolated superior rectus muscle rupture is a rare case. A thorough patient's history, ophthalmology and imaging technique are needed to establish the etiology. Modified Knapp procedure gave a satisfied result in this case to treat the esotropia and hypotropia.

**Keywords:** Knapp procedure, rectus muscle, isolated rupture

## INTRODUCTION

An isolated trauma to extraocular muscle without trauma to the globe is a rare condition and most commonly affects the medial and inferior rectus muscle. While trauma to superior rectus muscle rupture was rarely an isolated form but usually accompanied by trauma to levator palpebra superioris muscle. Diagnosis of extra ocular muscle rupture can be established by a thorough patient's history, ophthalmological examination and imaging examination. Diplopia and eye movement limitation were the most frequent complain. Ophthalmological examination include eye alignment, sensory and motoric examination, forced duction test and active forced generation test. Magnetic Resonance Imaging (MRI) is preferable due to its greater sensitivity in detecting muscle laceration or intramuscular injury.[1,2]

Extraocular muscle rupture was not the only cause of strabismus after trauma. Causes of eye deviation such as soft tissue swelling, orbital fractures with muscle

entrapment, cranial nerve palsy, orbital hematoma or damage to surrounding tissues causing mechanical restriction to eye movement should be considered. There are some approaches that can be done in managing this condition. After thorough examination, surgical exploration may be required first to identify the extra ocular rectus muscle. If the muscle has been identified, approaches can be done through medial wall approach, orbital wall approach or transnasal endoscopic retrieval. If muscle cannot be identified, transposition surgery of extra ocular muscle can be done as an alternative.

Case report will present a rare case of isolated superior rectus muscle rupture after a blunt trauma. Successful management of this case with extraocular muscle transposition surgery (modified Knapp procedure) was also a highlight because this procedure usually was performed for double elevator palsy cases.

## CASE DESCRIPTION

A 23-years-old patient came to the clinic on September 11$^{th}$, 2017 with chief complain of having double vision 6 days before admitted to clinic. He had slipped and fallen 6 days before coming to clinic. His head hit the floor causing trauma and bleeding in his right eye. After that, he had double vision while looking far and near. He also noticed that his right eye could not move normally to the right and up position.

Ophthalmology examination of right eye revealed uncorrected visual acuity was 6/12 and not improved with pinhole. On Hirschberg test, he had 15 Prism Diopter (PD) esotropia and right hypotropia. His right eye movement was restricted to all direction with mostly restricted to lateral, superotemporal and superonasal (-3 on abduction and elevation). There was minimal palpebral hematoma and excoriation in upper eyelid. Conjunctival laceration was found 8 mm from temporal limbus but sclera was intact. The superior rectus muscle was barely visible at superior part of orbit on slit lamp examination as shown in figure 1. There was subconjunctival bleeding in all quadrant. Other examination was within normal limit.

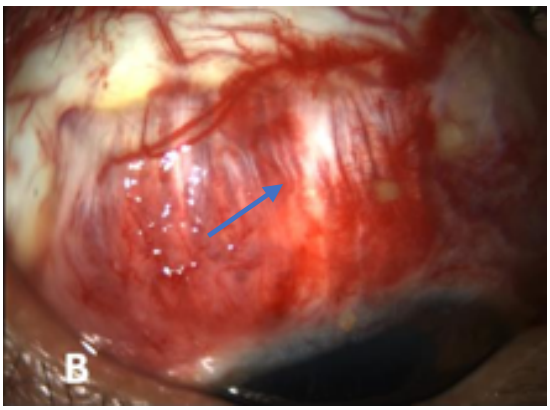


**Fig 1**. Superior rectus muscle was barely visible on examination (blue arrow)

Krimsky test showed 8 Prism Diopter (PD) esotropia and 25 PD hypotropia. Fusion was achieved with 8 PD esotropia and 30 PD hypotropia. Diplopia chart showed diplopia in all visual field. Patient's CT scan showed that there was not any enlargement of the extra ocular muscles, no sign of orbital wall fractures and no intra ocular foreign body was found.

The patient was planned to undergo exploration surgery of rectus muscle. Forced duction test was performed intraoperatively and no restriction was noticed. Medial and lateral rectus were identified. They were intact but with adhesion to conjunctiva, tenon and muscle. Superior rectus muscle could not be identified on its insertion location (8 mm from limbus). It was thought that the muscle was covered with granuloma. Proximal stump of superior rectus muscle could not be identified. Then it was decided to do Knapp procedure (modified) surgery.

Knapp procedure steps described as followed. Lateral rectus muscle was identified, cleaned and transected into half as long as 12 mm. The half superior part of the lateral rectus muscle then sutured to predicted location of superior rectus muscle insertion (8 mm from limbus).

Then, the same procedure was made for the medial rectus muscle. The muscle was identified, cleaned and transected into half as long as 12 mm. The half superior part of the medial rectus muscle then sutured to predicted location of superior rectus muscle insertion (8 mm from limbus). Then, the conjunctiva was sutured with vicryl 8.0. The operation was finished.

**Fig 2.** Patient's first visit to the clinic on September 11th, 2017 showed esotropia and right hypotropia

During follow up three weeks after surgery, patient felt better with no more diplopia in primary position. He only felt diplopia when he saw to inferior but it did not bother him. Ophthalmological status revealed that he was orthoporia in primary position and no shifting for cover and uncover test. His visual acuity was 6/7.5. There was still some eye movement restriction (-2 on duction to superior, supero-nasal and supero-temporal). He was planned to have follow up in one month.

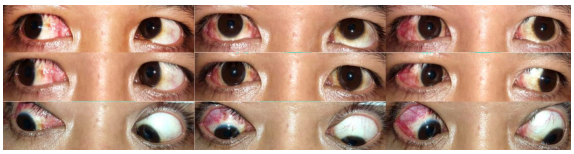

**Fig 3.** Follow up three weeks after surgery

During follow up two months after surgery, patient had no major complain. He only felt diplopia when he saw to inferior that was less than before, but it did not bother him. Ophthalmological status revealed that he was orthoporia in primary position and no shifting for cover and uncover test. His visual acuity was 6/6. There was still some eye movement restriction (-2 on duction to superior, supero-nasal and supero-temporal). He was planned to have follow up in four months.

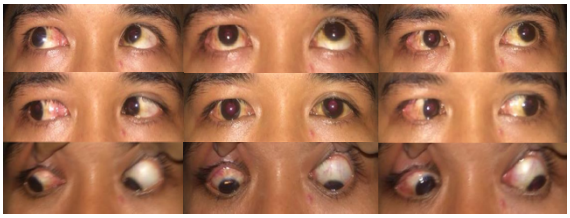

**Fig 4.** Follow up two months after surgery

## DISCUSSION

This case reports a 23-years-old male with chief complain of double vision after having trauma. He noticed that he could not move his right eye to the right and superior position. Strabismus and double vision is not an uncommon complain after orbital trauma. There are some conditions that cause this complain such as acute soft tissue swelling, orbital fractures with muscle entrapment, partial or complete loss of extraocular muscle (EOM), cranial nerve palsy, orbital hematoma or damage to surrounding tissues causing mechanical restriction to eye motion. A thorough patient's history, ophthalmology examination and imaging are needed to make a proper diagnosis and treatment.[1-3]

Isolated rectus muscle rupture after trauma was a rare case. Ophthalmologist must exclude other causes that is more possible to cause strabismus and double vision after orbital/head trauma. In this case, based on history, ophthalmology examination and CT scan, orbital fracture with muscle entrapment and hematoma were excluded. All rectus muscles were well identified through CT scan. But, there was conjunctival laceration and superior rectus muscle was barely visible on superior part of the orbit. So, suspicious of lacerated or detached rectus muscle was still considered as the etiology because CT scan was not really sensitive to detect soft tissue abnormalities, as in this case extraocular muscles. A Magnetic Resonance Imaging (MRI) has superiority in detecting muscle contour irregularity from a lacerated muscle. Lin KY et al in their publication stated that there were

some reports that demonstrate muscle changes missed on the initial CT such as muscle disinsertion, that were later detected on MRI. In general, CT scan is the primary imaging modality in orbital trauma because it was sensitive to detect orbital fracture, soft tissue entrapment, shorter scanning time and not a contraindication if metal foreign body suspected. In this case, CT scan was performed to evaluate the whole eye condition following trauma and also MRI took more time to be performed.[4]

A surgery for extra ocular muscles exploration was planned for the patient. The surgery was done two weeks after he had trauma. The timing for strabismus surgery after orbital trauma can be delayed up to 6 months in the absence of a fracture as spontaneous improvement of the strabismus and diplopia may result.[2] But, that would be an inappropriate time approach in the case of a lacerated or ruptured muscle. Attempt to repair the muscle should be done at the earliest time, as waiting months would cause the antagonist to contract, further retraction of the lost muscle and scar formation would also occur, which may make finding the muscle difficult and therefore treating diplopia more challenging. So, in this case, the timing for surgery was already appropriate.[3]

In case of trauma, rectus muscle can be lost or torn. Plager and Parks characterized a "lost" muscle by the absence of any attachment of the muscle or its capsule to the sclera. MacEwen defined a torn or snapped muscle as one in which the muscle belly has ruptured across its width, posterior to the muscle insertion, while the insertion to the globe remains intact. The tearing usually occurs at the junction between muscle and tendon. In this case, intraoperatively, superior rectus muscle could not be identified on its insertion location (8 mm from limbus). Proximal stump of superior rectus muscle could not be identified. But medial and lateral rectus were well identified with adhesion to conjunctiva and tenon. So, in this case the superior rectus muscle was lost. [5-8]

Losing a muscle not only results in a cosmetic problem of squinting but can cause constant diplopia in adults which may be compensated by an abnormal head posture. The goal of the management is to make a good alignment so the patient would be diplopia free in primary gaze. Repair and management of complete loss muscle was based upon individual cases. Chen et al stated, the 3 most important steps involved with these surgeries are: (1) identification of the muscle's posterior border, (2) exposure of the muscle fibers, and (3) suture of the posterior border to the anterior border of the muscle. Lost muscle can be found using a traditional conjunctival approach, using either an external orbitotomy or an endoscopic trans-nasal method.[1-2]

Any muscle lost preoperatively should if possible be retrieved during that operation as this provides the best possible chance of a good outcome. Direct end-to-end muscle anastomosis is performed when both the proximal and distal muscle segments can be located and securely sutured together in a muscle-to-muscle anastomosis. If there was large gaps between the posterior and the anterior borders, a ''hang-back'' suture technique, sometimes combined with recession of the ipsilateral antagonist, is considered. When the lacerated muscle is transected posteriorly, it is hard to locate the posterior border through standard anterior approach. A transposition procedure of adjacent muscles is performed as an alternative. As in this report, operator decided to do Knapp procedure (modified) because the superior rectus muscle could not be identified.[2,6,9]

Knapp procedure was a transposition surgery first introduced by Phillip Knapp in 1969 to treat severe cases of hypotropia for double-elevator palsy. In this procedure, the entire tendons of the medial and lateral rectus muscle are transplanted to the corners of the insertion of the superior rectus muscle. Another case of

isolated superior rectus muscle treated with Knapp procedure with satisfactory result have been also reported by Javed et al. Transposition surgery is based on changing the location of the muscle insertion so the muscle pulls the eye in a different direction (i.e., changes the vector of force). The key for successful surgery is symmetrical transposition to avoid induced vertical or horizontal deviations.

Knapp procedure in this case was a modified procedure because it did not take an entire tendon to be transected but only the half superior part or split-tendon (Figure 5). This modified procedure was preferred because there was also horizontal deviation in this patient, allowing the correction of horizontal deviation with the untouched inferior half. This procedure also has the advantage of leaving the anterior ciliary arteries intact, reducing the risk of anterior segment ischemia. [11-17]

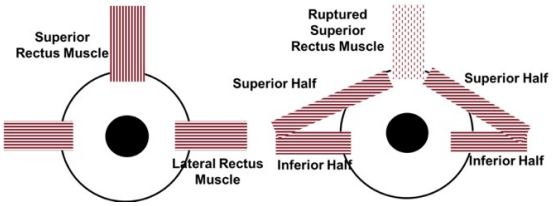


**Fig 5.** Modified Knapp Procedure

Follow up after three weeks and two months surgery, patient felt satisfied with the result. He did not have diplopia in primary position, only slight diplopia when he looked down. His ophthalmology examination showed visual acuity was 6/6, orthophoria in primary position and no shifting in cover/uncover test on primary position.

## CONCLUSION

This case reported a-23 years-old male with chief complain of diplopia and restricted eye movement after blunt trauma. He had 15 PD esotropia (ET) and right hypotropia. He was then diagnosed of having isolated superior rectus muscle of right eye. Patient underwent operation of muscle exploration. Intraoperatively, the rectus muscle could not be identified. So, the operator decided to do transposition surgery of horizontal rectus muscle (modified Knapp procedure). This revealed a satisfied result with orthophoria in primary position, minimal diplopia in downward gaze, and no more shifting on cover and uncover test.

## ACKNOWLEDGEMENTS

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