Modified Superior Oblique Intrasheath Tenectomy in a-pattern With Superior Oblique Overaction

Chunhua Sun
Tianjin Eye Hospital; Clinical College of Ophthalmology, Tianjin Medical University; Nankai University Affiliated Eye Hospital; Tianjin Key Laboratory of Ophthalmology and Visual Science
Ze Wang (wangzedoctor@sina.com)
Nanjing South East Eye Hospital
Bo Xia
Nanjing South East Eye Hospital

Research Article

Keywords: intrasheath tenectomy, superior oblique overaction, A-pattern, minimal incision, operating microscope, traction test

Posted Date: February 19th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-238576/v1

Version of Record: A version of this preprint was published at BMC Ophthalmology on April 21st, 2021. See the published version at https://doi.org/10.1186/s12886-021-01942-2.

Abstract

Background: To evaluate the effect of modified superior oblique intrasheath tenectomy (MSOIT) on superior oblique overaction (SOOA) with A-pattern.

Methods: We retrospectively reviewed the data of 66 patients (130 eyes) with SOOA and A-pattern underwent MSOIT at the nasal border of the superior rectus under an operating microscope between January 1, 2004 and December 31, 2018.. The preoperative and postoperative SOOA, objective torsion, ocular motility, and A-pattern deviation findings were compared. The correlation between the preoperative A-pattern deviation and the corrected deviation was analysed. All patients were followed up for more than 12 months.

Results: The superior oblique (SO) tendon fibres were resected, and the sheath was preserved in all patients. The average follow-up period was 33.45±29.88 (range: 12–122) months. The mean SOOA deviation improved from 2.95±0.54 to 0.34±0.55 ($P < 0.001$), while the A-pattern deviation difference between upgaze and downgaze improved from 23.15±7.64 prism dioptres (PD) to 3.50±2.90 PD ($P < 0.001$). The average objective fundus intorsion value improved from +2.96±0.58 to +0.38±0.60 ($P < 0.001$). The magnitude of correction in A-pattern was significantly correlated with the preoperative severity of A-pattern ($r = 0.812$, $P<0.001$).

Conclusions: MSOIT at the nasal border of the superior rectus (SR) under an operating microscope is safe and yields beneficial outcomes in patients with SOOA and A-pattern.

Background

Superior oblique overaction (SOOA) corresponds to excessive activity of the superior oblique muscle in directions including intorsion, depression, and abduction. Patients with SOOA may show abduction in downgaze, causing A-pattern. The superior oblique (SO) weakening procedures include tenotomy, tenectomy, recession, and split-tendon lengthening[1]. Tendon scarring due to split-tendon lengthening; a new insertion limiting SO depression due to recession; and uncontrolled effects caused by tenotomy are severe complications that increase the complexity of strabismus conditions [1,2,3,4,5]. The frenulum between the SO and superior rectus (SR) also limits the effects of disinsertion and suspension recession with a temporal approach [5,6]. Intrasheath tenotomy or tenectomy of the SO tendon is advantageous because it prevents SO paralysis to the greatest extent possible and achieves more predictable results because the cut ends remain within the sheath [7,8]. nder a microscope, minimal anatomical disruption, swelling and pain and good visualization have been achieved in rectus muscle surgery and oblique muscle recession [9]. Over the past 15 years, we have performed modified superior oblique intrasheath tenectomy (MSOIT) with a small incision under a surgical microscope and found that it is effective for treating A-pattern with SOOA.

Methods

Patients

Objective torsion was graded on a scale of 0–4 based on the fundus photographs [11]. Deviation was measured with an alternate prism and cover test while the patient fixated at a distance of 6 m in a 25° upgaze, the primary position, and a 25° downgaze. The difference in horizontal deviation between the upgaze and downgaze conditions was recorded for the A-pattern patients. All patients underwent assessment before surgery and were asked to undergo postoperative follow-up assessments at 1, 3, and 6 months and every 6 months thereafter. Adverse effects were recorded. The patients' data were analysed using SPSS 17.0 statistical software (SPSS Inc., Chicago, IL, USA), and comparisons were made between the preoperative and 12-month postoperative data. Wilcoxon's test was applied for statistical analysis. Spearman's correlation analysis was used to analyse the correlation between the preoperative A-pattern deviation and corrected deviation.

MSOIT procedure

The traction test was performed before and after the procedure with a simplification of Guyton's exaggerated traction test [12] (Figure 1). The globe was grasped and retro-placed using 0.5-mm toothed forceps at the 3 and 9 o'clock positions on the limbus. Then, the right eye was rotated counterclockwise, and the left eye was rotated clockwise. The eye was subjected to resistance but was not extorted by more than two clock hours. The operating microscope magnification was set to 4×. A super-nasal fornix incision was made 6-8 mm posterior to the limbus. Separate incisions in Tenon's capsule and the conjunctiva were completed at right angles to expose the sclera at the nasal border of the SR. The SR and Tenon's capsule were hooked and then moved inferior-temporally. A Desmarres retractor was placed at the posterior aspect of the incision and pulled backward to adequately visualize the triangular area formed by the SO and the nasal border of the SR. In cases in which exposure was limited, a set of custom-made deep retractors, similar to Desmarres retractor except with longer folds of 5 mm, 10 mm, 15 mm, and 20 mm, were applied progressively until the SO tendon was located. The SO tendon was identified by its pearly white glistening appearance, running perpendicular to the SR against the sclera (Figure 2a). The SO was elevated with the small hook (Figure 2b) and hooked by two ancistroid hooks to prevent slipping. In some cases, blood vessels were observed along the sheath (Figure 2c). A higher magnification (6× to 8×) was used for the subsequent procedures. A 6-8 mm incision in the long axis of the anterior aspect of the sheath was made to expose the tendon fibres, and the blood vessels were avoided. Six millimetres of tendon fibres were bluntly separated from the sheath (Figure 2d, 2e), and the naked tendon was resected in its sheath. With a special deep retractor (20 mm), we inspected and verified that no posterior tendon fibres remained. Following the procedure, only a small area of disturbance was visible in the fascial tissues (Figure 2f). To ensure that the tendon had been completely transected, the simplified forced extorsion traction test was repeated, additional extorsion of one to one-and-a-half clock hours was achieved, and the eyeball felt "softer".

Results

In all 130 eyes, the SO tendon and sheath were identified and operated on successfully without any adverse effects. The average follow-up period was 33.45±29.88 (range: 12–122) months. Only one eye suffered from mild inferior oblique overaction. Blood vessels were encountered along the sheath in some eyes [13]. The differences in SOOA severity, horizontal deviation , and intorsion were inconsistent; therefore, Wilcoxon's test was applied (Table 1). The magnitude of correction of A-pattern was significantly correlated with the preoperative severity of A-pattern (Figure 3, $r = 0.812$, $P<0.001$). None of the patients showed poorer results in these parameters at 12 months postoperatively.

Table 1 Results of superior oblique muscle intrasheath tenectomy

	Before operation	After operation	*Z*	*P*
†SOOA (+)	2.95±0.54	0.34±0.55	-10.12	0.000
Objective intorsion (+)	2.96±0.58	0.38±0.60	-10.01	0.000
§A pattern deviation (PD)	23.15 ± 7.64	3.50 ± 2.90	-7.07	0.000

†SOOA, superior oblique overaction

§ Difference in horizontal deviation between the upgaze and downgaze conditions in A-pattern

Discussion

The simplified forced torsion traction test

Guyton's exaggerated traction test is considered invaluable for assessing the tightness of the oblique [6]. Jung and Holmes proposed a new traction test in which the globe is maximally excyclorotated without retroplacement until the first instance of resistance is felt [14]. The authors reported a median maximum excyclorotation of 62.5 degrees after SO disinsertion in six eyes. In the current simplified forced torsion traction test, the eyeball is grasped and retro-pulsed, thereby stretching the oblique muscles and adding slack to the rectus muscles. Compared with the reported SO forced traction test [3,4,6,12,14] used in SO-weakening procedures, the present test is simpler to perform. It is practical to evaluate torsion traction tests by the number of hours required in an operation, especially for inexperienced surgeons. Residual SOOA is likely the most common complication of SO-weakening procedures, which results in a positive exaggerated forced duction test result [3]. If the tenectomy is completed, additional extorsion of one or one-and-a-half clock hours can be achieved; if not, the surgeon needs to inspect and verify whether the tendon fibres have been severed completely.

Minimal disturbance with visualizationunder a microscope

Both the complexity of the function and anatomical variation in the SO lead to challenges in isolating and manipulating the SO during the procedure [15,16]. Without visualization, SO tendon isolation can lead to injury of the vortex vein and orbital fat prolapse, a posterior Tenon's capsule tear, iatrogenic ptosis, the SR being mistaken for the SO, and failure to hook the SO tendon [17]. Excessively dissecting Tenon's capsule overlying the tendon may result in postoperative restricted globe elevation and even acquired Brown syndrome [16]. Parks and Helveston reported a preferred nasal-weakening procedure with a temporal conjunctival incision to keep the nasal intermuscular septum intact and reduce the risk for postoperative SO palsy or limited depression [15,18]. In the present study, the nasal approach was used, and a small incision with minimal disturbance was made under an operating microscope. Low-power magnification (4×) is required for SO tendon identification. Even on the downward rotated globe, the distance between the anterior border of the SO and the SR insertion varies and does not remain at 8 mm [17], which make it difficult to identify the SO. With a sufficient operating field and appropriate depth, this difficulty can be overcome by using different retractors with increasing lengths to 20 mm for individual patients. A sheath was detected to be enveloping the tendon (Figure 2d) in all cases, which is consistent with the findings of Helveston's study [19]. Blood vessels were noted along the sheath in some cases (Figure 2c) [13] and were preserved with intrasheath tenectomy under a microscope, which is inconsistent with the findings of previous reports [17]. With a higher magnification, at 6× to 8×, a small incision in the intermuscular septum and sheath was sufficient to explore the tendon fibres while keeping the deeper intermuscular septum intact (Figure 2d; 2e), thereby avoiding the surrounding adhesion.

Intrasheath tenectomy at the nasal border of the SR

SO tenotomy can also be performed from the temporal side of the SR, as the SO is easy to isolate [16], but the weakening effect is smaller than that with nasal tenotomy [3,4]. Wei et al. reported that bilateral SO posterior tenectomy is effective for treating mild and moderate SOOA-associated A-pattern [20]. The mean SOOA value decreased by 1.85, with a mean preoperative A-pattern deviation reduction of 12.75 PD, which were smaller than the values in the present study. The closer to the trochlea that tenotomy is performed, the more effective the procedure is [1,3,16], but the risk of iatrogenic SO palsy is higher [21]. Furthermore, the 'frenulum' between the SO and SR can hinder the SO weakening effect of temporal disinsertion or suspension recession [5]. Debert et al performed 6 mm bilateral SO transection with the complete width from its insertion without frenulum dissection [22]. The mean A-pattern collapse value was 18 PD, and the mean preoperative A-pattern deviation was 21 PD, which was similar to our result. However, four patients had postoperative vertical deviation. Heo et al performed 10 mm SO posterior tenectomy with dissection of the frenulum to the extent possible [23]. The mean A-pattern correction was 17.63 PD, which was similar to that in our study. However, 5 of 75 patients showed mild inferior oblique overaction. Parks and colleagues performed intrasheath tenotomy or tenectomy to achieve a sufficient weakening effect [15,17]. Helveston [8] also proposed that the fascia around the SO tendon should be left undisturbed to achieve more predictable results. Berke [7] performed intrasheath tenotomy or tenectomy of the SO tendon near the nasal border of the SR, where the sheath wrapping the tendon has many delicate areolar fibrillae. In the current study, MSOIT at the nasal border of the SR was performed for 130 eyes in 66 A-pattern patients with SOOA who were followed up for a mean of 33.45 months. Mild inferior oblique overaction occurred in only one eye. This treatment improved the mean A-pattern deviation by 19.65 PD, and the mean SOOA value improved by 2.95 (Table 1). The magnitude of correction of A-pattern was significantly correlated with the preoperative severity of A-pattern (Figure 3). The SO tendon was weakened with minimal sheath disturbance and the frenulum left intact. The preserved sheath was still connected to the two cut tendon edges in its original course, causing minimal disturbance to the fascia and allowing connections to form. Due to the temporal section and insertion being left intact, nasal transection resolved the case of SOOA, preserved important function and avoided SO palsy [3].

Limitations

The study included 66 patients with at least 12 months of follow-up data. Studies with larger sample sizes are needed.

Conclusion

MSOIT at the nasal border of the SR under an operating microscope is a feasible treatment for A-pattern caused by SOOA with minimal disturbance.

Abbreviations

MSOIT: modified superior oblique intrasheath tenectomy; SOOA: superior oblique overaction; SO: superior oblique; PD: prism diopters; SR: superior rectus.

Declarations

The study adhered to the tenets of the Declaration of Helsinki and was approved by the Human Subjects Ethics Subcommittee of the Tianjin Eye hospital.

Consent for publication

Informed consent was obtained from all patients in this study.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The author(s) declare(s) that they have no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements

Not applicable.

Author contributions

C.S. drafted the manuscript, analysed the data, and revised the manuscript. Z.W. designed the study, supervised the procedure, collected and analysed the data, and helped revise the manuscript. B.X. helped conduct the study and collect the data. All authors reviewed and approved the final manuscript.

References

1. Wright KW, Spiegel PH, Thompson L, editors. Handbook of Pediatric Strabismus and Amblyopia, 2nd ed, New York: Springer; 2006, p. 284–322.
2. Vempali VM, Lee JP. Results of superior oblique posterior tenotomy. J AAPOS 1998;2:147–50
3. Wright KW, Strube YNJ. Superior oblique tendon weakening procedures. In: Wright KW, Strube YNJ, editors. Color Atlas of Strabismus Surgery: Strategies and Techniques, 4th ed, New York: Springer; 2015, p. 161–170.
4. Coats DK, Olitsky SE. Strabismus surgery. In: Lambert S, Lyons C, editors. Taylor & Hoyt's Pediatric Ophthalmology and Strabismus, 5th ed, New York: Elsevier Medicine; 2017, p. 876–904.
5. Iizuka M, Kushner B. Surgical implications of the superior oblique frenulum. J AAPOS. 2008;12(1):27-32. doi: 10.1016/j.jaapos.2007.06.017. PMID: 17720568
6. Kushner BJ. Strabismus: Practical Pearls, You Won't Find in Textbooks. New York: Springer; 2017, p. 97–114, 153–192, 221-231.
7. Berke RN. Tenotomy of the superior oblique muscle for hypertropia; preliminary report. Arch Ophthal. 1947;38(5):605-44. doi: 10.1001/archopht.1947.00900010622003. PMID: 20273126.
8. Helveston EM. Surgical Management of Strabismus. 5th ed. Turnhout, Belgium: Wayenborgh Publishing; 2005, p. 15–58, 109–114.
9. Mojon DS. Review: minimally invasive strabismus surgery. Eye (Lond). 2015;29(2):225-33. doi: 10.1038/eye.2014.281. PMID: 25431106; PMCID: PMC4330290.
10. Scott WE, Kraft SP. Classification and surgical treatment of superior oblique palsies: I. Unilateral superior oblique palsies. Trans New Orleans Acad Ophthalmol. 1986;34:15-38. PMID: 3726951.
11. Suh DW, Guyton DL, Hunter DG. An adjustable superior oblique tendon spacer with the use of nonabsorbable suture. J AAPOS. 2001;5(3):164-71. doi: 10.1067/mpa.2001.114190. PMID: 11404743.
12. Guyton DL. Exaggerated traction test for the oblique muscles. Ophthalmology. 1981;88(10):1035-40. doi: 10.1016/s0161-6420(81)80033-4. PMID: 7335306.

13. Wang Z, Sun C. Blood vessel on the superior oblique muscle sheath. J Pediatr Ophthalmol Strabismus. 2013;50(2):128. doi: 10.3928/01913913-20110825-02. PMID: 23495857.
14. Jung JH, Holmes JM. Quantitative Intraoperative Torsional Forced Duction Test. Ophthalmology. 2015;122(9):1932-8. doi: 10.1016/j.ophtha.2015.05.025. PMID: 26130329; PMCID: PMC4549184.
15. Parks MM, Helveston EM. Direct visualization of the superior oblique tendon. Arch Ophthalmol. 1970;84(4):491-4. doi: 10.1001/archopht.1970.00990040493018. PMID: 5492457.
16. Coats DK, Olitsky SE. Strabismus surgery and its complications. New York: Springer; 2007, p. 3–19, 119–129.
17. Parks MM. Doyne Memorial Lecture, 1977. The superior oblique tendon. Trans Ophthalmol Soc U K. 1977 Jul;97(2):288-304. PMID: 345531.
18. Parks MM. Superior oblique tendon surgery. In: Atlas of Strabismus Surgery. Philadelphia: Harper Row, Inc, 1983; pp 33-37, 189–208.
19. Helveston EM, Merriam WW, Ellis FD, et al. The trochlea. A study of the anatomy and physiology. Ophthalmology. 1982;89(2):124-33. doi: 10.1016/s0161-6420(82)34835-6. PMID: 7070784.
20. Wei Y, Dong, L-Y, Zhao P, Kang X. The efficacy of superior oblique posterior tenectomy in the treatment of A-pattern exotropia without ocular intorsion: A retrospective study. BMC Ophthalmol 2020;20:32 http//doi.org/10.1186/s12886-019-1298-4. PMID: 31964376; PMCID: PMC6975027.
21. Biglan AW. Pattern strabismus. In: Rosenbaum A, Santiago A, editors. Clinical Strabismus Management, Philadelphia: W.B. Saunders; 1999, p. 202–216.
22. Debert I, Darcie ALF, Polati M. Bilateral superior oblique temporal tenectomy for the treatment of A-pattern strabismus. J AAPOS. 2020;24(4):222.e1-222.e4. doi: 10.1016/j.jaapos.2020.04.012. PMID: 32861855.
23. Heo H, Lee KH, Ahn JK, Kim DH, Park YG, Park SW. Effect of 10-mm superior oblique posterior tenectomy combined with frenulum dissection in A-pattern with superior oblique overaction. Am J Ophthalmol. 2009;148(5):794-9. doi: 10.1016/j.ajo.2009.06.016. PMID: 19665106.

Figures

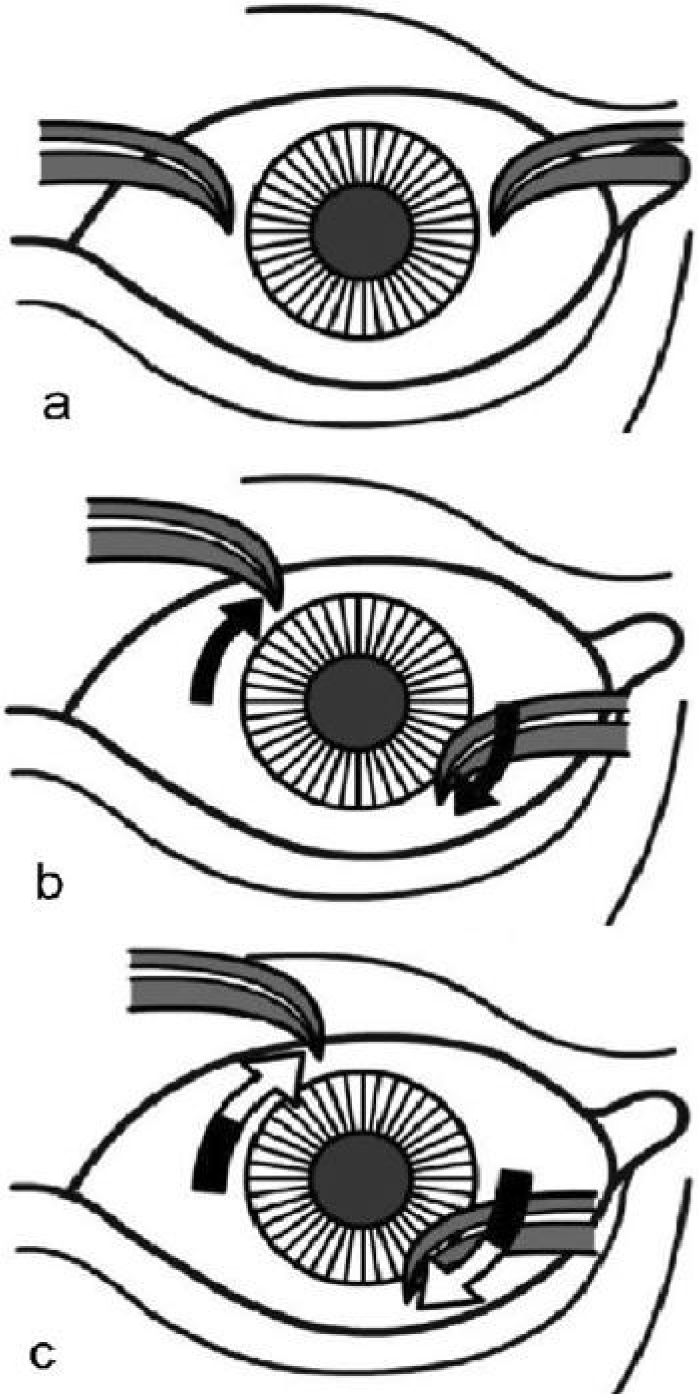

Figure 1

Simplified forced extorsion traction test. a: The left eye is grasped and retroplaced at the 3 and 9 o'clock positions on the limbus. b: The eye is rotated clockwise. In the case of superior oblique overaction (SOOA), the forceps, located at the 3 o'clock position, could not be extorted to the 5 o'clock position before surgery. c: After surgery, eye extorsion of an additional one to one-and-a-half clock hours could be obtained.

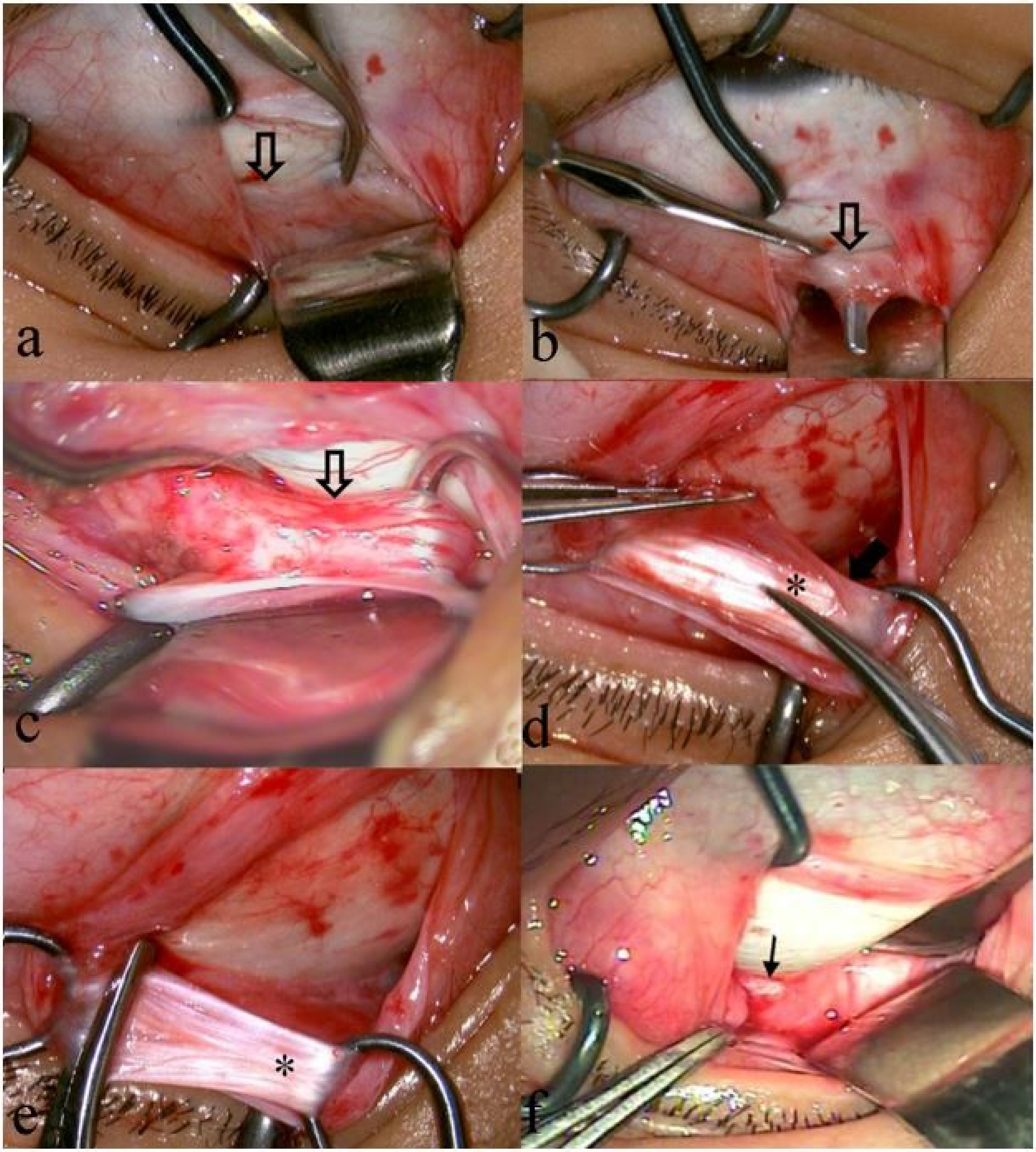

Figure 2

a: The SO was identified by its pearly white glistening appearance against the sclera. b: The SO was elevated with small hook. c: Two ancistroid hooks were used to fix the SO muscle at the two borders. Blood vessels were detected along the sheath in some cases. d: Solid arrow: The SO tendon is bluntly isolated from the sheath. e: The naked SO tendon is held with two ancistroid hooks at the two borders. The temporal border of the naked tendon is clamped. Hollow arrow: SO; solid arrow: SO sheath; stars: SO tendon; thin arrow: small area of disturbance of the fascial tissues.

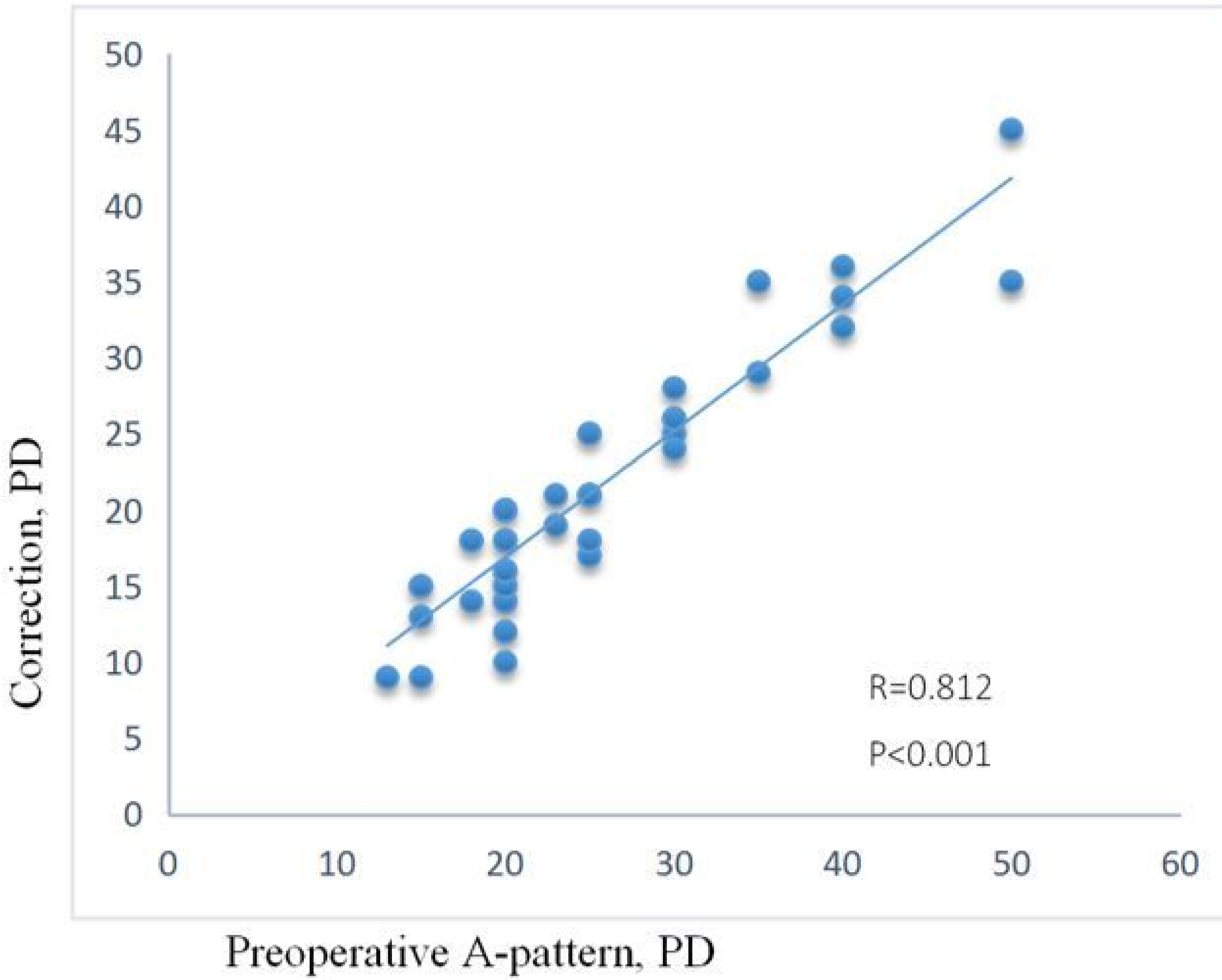

Figure 3

Scatterplot of preoperative A-pattern deviation and correction. PD, prism diopters.