CASE REPORT

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Transluminal Nd:YAG laser embolysis – A reasonable method to reperfuse occluded branch retinal arteries

Transluminalno Nd:YAG lasersko razbijanje embolusa – razumna metoda za recirkulaciju okludiranih grana retinalnih arterija

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Abstract

Introduction. Central retinal artery occlusion (CRAO) and branch retinal artery occlusion (BRAO) result in partial or complete retinal ischemia and sudden loss of vision; at this moment, there is no effective therapy for CRAO and BRAO. Transluminal Nd:YAG laser embolysis (TYE) represents a therapeutic approach used for retinal vascular occlusive diseases. The main indication is branch retinal artery occlusion with visible embolus; for central retinal artery occlusion this tehnique is hardly applicable. The principle of this method consists of intravascular embolus breakage using the 1064 nm Nd:YAG laser, focused on the embolus surface. **Case report.** We presented 5 cases with BRAO, 3 with infero-temporal and 2 with supero-temporal BRAO, all of them treated with TYE, with variable results. All the patients had a visible embolus within the BRA, the laser applications being delivered directly to the embolus. **Conclusion.** Despite our short-term experience regarding this therapeutical approach, we can resume that the moment of emboli distruction, as close as possible to the onset of the occlusion, is decisive for regaining vision and that applying the procedure correctly is superior to observation in most cases. Worldwide experience with TYE is still limited, but the technique seems feasible also when treating CRAO caused by visible emboli on the optic disc surface. This most certainly calls for random trials for identifying precisely the role of TYE in treatment of retinal occlusion pathology, though the relatively small number of properly diagnosed cases affects this objective. In all cases, the risks of TYE must be weighed against the possibility of severe and permanent loss of vision secondary to retinal artery occlusions.

Key words:
laser therapy; lasers, solid-state; retinal artery occlusion; treatment outocme.

Apstrakt

Uvod. Okluzija centralne arterije retine kao i okluzija grana retinalnih arterija rezultiraju parcijalnom ili totalnom ishemijom retine, praćene iznenadnim gubitkom vida. U ovom trenutku, ne postoji uspešna terapija za ovu vrstu oboljenja. Transluminalno Nd:YAG lasersko razbijanje embolusa predstavlja terapeutski pristup okludiranim krvnim sudovima retine, najbolji rezultati se postižu kod okluzije grane arterije retine sa vidljivim embolusom unutar krvnog suda, dok je kod okluzije centralne arterije retine ova tehnika teško izvodljiva. Princip ove metode je u razbijanju intravaskularnog embolusa koristeći 1064 nm Nd:YAG laser, fokusiran na površinu embolusa. **Prikaz bolesnika**. U radu je prikazano pet bolesnika sa okluzijom grane arterije retine, tri sa okluzijom donje temporalne grane, dva sa okluzijom gornje temporalne grane. Svih pet je tretirano transluminarnim Nd:YAG laserom sa različitim rezultatima. Svi bolesnici imali su vidljiv embolus unutar arterije, tako da je laser usmeravan direktno na embolus. **Zaključak**. Uprkos našem kratkom i malobrojnom iskustvu sa ovim terapeutskim pristupom, može se zaključiti da je razbijanje embolusa, što je moguće tačnije i bliže mestu okluzije, neophodno za vraćanje vidne oštrine. Pravilno izvođenje ove laserske procedure superiornije je od praćenja stanja bolesnika. Svetska iskustva sa ovom metodom su još uvek skromna, pri čemu se ona može primeniti i kod okluzije centralne arterije retine sa vidljivim embolusom na površini papile očnog živca. Ova metoda sasvim sigurno zahteva jedno šire, veće ispitivanje da bi se odredila uloga razbijanja embolusa Nd:YAG laserom u lečenju okluzije krvnih sudova retine, mada relativno mali broj pravilno dijagnostikovanih slučajeva onemogućuje procenu uspešnosti. Kod svakog pojedinačnog slučaja okluzije, rizik od upotrebe ove metode mora biti procenjen u odnosu na mogućnost teškog i trajnog gubitka vidne oštrine.

Ključne reči:
lečenje laserom; laseri, kristalni; okluzija retinalne arterije; lečenje, ishod.

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Introduction

Branch retinal artery occlusion (BRAO) can be caused by fibrinoplatelet emboli, cholesterol emboli and calcific emboli, typically located on arteriolar bifurcations or areas of vascular stenosis. A rather frequent occurrence in retinal vascular pathology is temporal artery branch occlusion (superior or inferior) caused by emboli located at arterial branch's emergence from the optic nerve papilla. Blood flow blockage through the artery causes partial or complete retinal ischemia with sudden loss of visual acuity and visual field impairment. The ocular fundus exam reveals sectorial clouding of the retina and most of the times viewing the translumenal embolus is possible. The fluoresceine angiography (FAG) exam shows either a delay or complete absence of dye material filling the affected blood vessel. Histopathologically, retinal artery branch occlusion is characterized by intracellular oedema in the internal retinal layers with loss of cells (in several months) which extends from the nerve fiber layer to the inner nuclear layer. Medical literature still lacks a well-established treatment for such conditions, however there are a few published studies referring to dissolving or melting emboli with the aid of lasers. The first method which was used involved low power argon laser photocoagulation. Although the cholesterol emboli were successfully melted with the laser, no functional improvements have been made. Opremcak and Benner [1] introduced the idea of using photodisrupting Nd:YAG laser for selectively lysing an intravascular solid embolus without damaging vascular walls. The aforementioned authors presented in April 2002 two surprisingly efficient solved cases, both anatomically and functionally, through transluminal Nd:YAG laser embolysis (TYE). In both cases immediate clearing of the embolus was noted alongside full recovery of retinal blood flow and a relatively fast regain of visual function (1–2 weeks). There were also other authors reporting favorable results using TYE in some cases [2].

We have been applying this method since 2006 on around 20 cases until now. In this paper, we presented some of these cases, including technical features. We were among the first authors in Europe to publish results regarding TYE and some of our clinical cases were presented during the 2010 European VitreoRetinal Society (EVRS) Congress in Seville, Spain [3, 4]. We consider that TYE is a therapeutical approach which can be used in certain situations.

Worldwide experience with TYE is still reduced, but the technique seems feasible in treating branch retinal artery occlusion and also central retinal artery occlusion caused by visible emboli [5–7]. This most certainly calls for random trials for identifying precisely the role of TYE in treating retinal occlusions, though the relatively small number of properly diagnosed cases affects this objective.

Case 1

An-81-year old female patient was presented to another clinic with blurry vision and superior altitudinal visual field defect in her right eye. After thorough investigations including FAG and visual field (VF) testing, the diagnosis was inferior temporal artery branch occlusion with retinal oedema in the lower macular region, with a visible embolus at the point of emergence of the vessel from the papilla (Figure 1), and delayed filling of the affected inferior temporal artery by the fluorescein, with hypofluorescence in the surrounding inferior area (Figure 2). The visual acuity was good, 20/30 best corrected visual acuity (BCVA), due to a permeable optociliary vessel, and a superior arcuate scotoma was present (Figure 3).

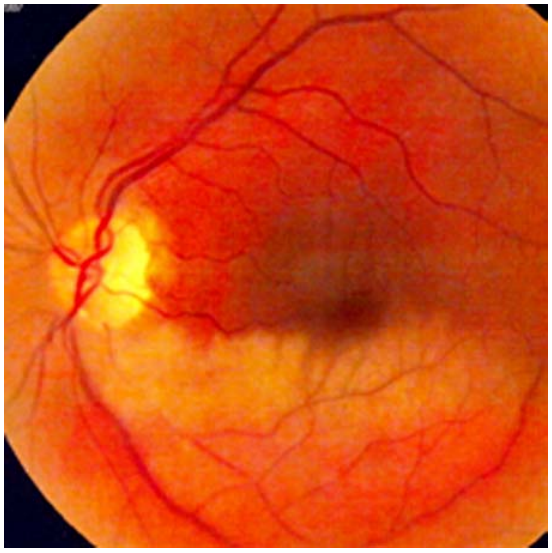

Fig. 1 – Colour retinography at presentation: inferior temporal artery branch occlusion, retinal oedema in the lower macular region, visible embolus at the point of emergence of the vessel from the papilla.

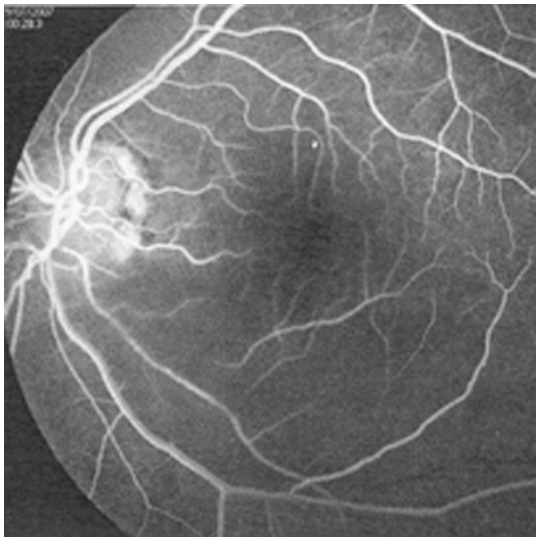

Fig. 2 – Fluoresceine angiography at presentation: delayed filling of the affected inferior temporal artery by the fluorescein, hypofluorescence in the surrounding inferior area.

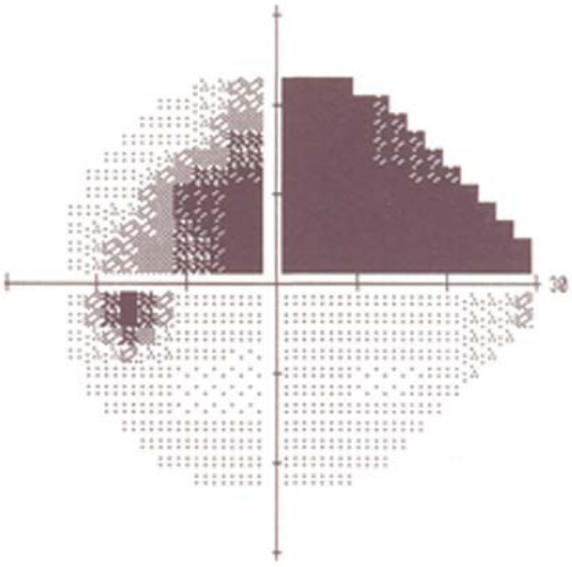

Fig. 3 – Visual field at presentation: superior arcuate scotoma.

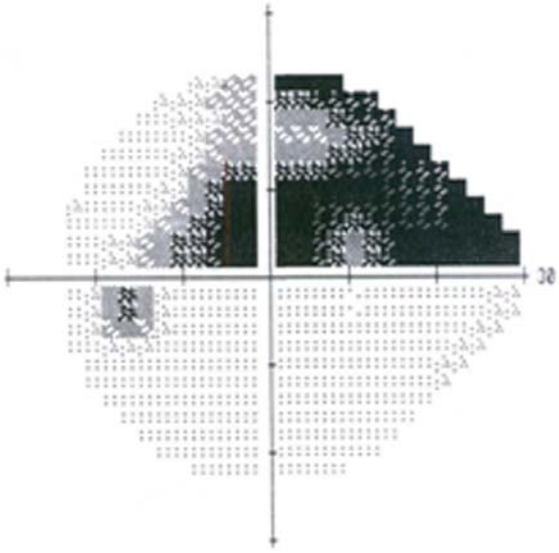

Fig. 5 – Visual field post-transluminal Nd:YAG laser embolysis (TYE): arcuate scotoma, slightly diminished in size.

The patient was referred to our clinic 10 days after the onset of symptoms, for the laser procedure, which was successfully completed, thus breaking the embolus and completely restoring blood flow (Figure 4). After resorbtion of

Fig. 4 – Colour retinography post-transluminal Nd:YAG laser embolysis (TYE): restored blood flow, juxtapapillary preretinal hemorrhage.

the small juxtapapillary preretinal hemorrhage induced by the TYE, another FAG exam was performed after 3 weeks, showing the absence of retinal oedema and restored blood flow. Subjectively, the patient's visual acuity was about the same and the arcuate scotoma slightly diminished in size without disappearing completely (Figure 5).

Obviously, because of the optocilliary artery and the long period of time between the start of the symptoms and the referral to laser, this case is not the best example about the utility of TYE, but this was the first case done using TYE and it gave us the courage to continue.

Case 2

A 66-year-old male patient, with a complex associated cardiovascular and hepatic pathology, was presented to another hospital's emergency room with sudden and dramatic loss of vision in his left eye (counting fingers) in the past 12 hours. He was diagnosed with inferior temporal artery branch occlusion with macular oedema affecting the foveola, with a visible white embolus at the vessel's emergence from the papilla and numerous other small agglutinated emboli scattered along the aforementioned arterial branch. The patient was referred to us for TYE, which was performed 2 days after the sudden loss of sight.

Three procedures (one every other day) were necessary in order to completely break the cholesterol emboli across the papillary area. Unfortunately our laser equipment does not have a video camera attached, because it is difficult to explain how the whole package of emboli was completely mobilized downstream the vessel after just one laser shot. We had to repeat the procedure three times because new emboli has arrised on the same place (on the optic disc surface). It is worth mentioning that despite the patient's systemic health problems, there was no hemorrhage during the procedures. After 4 weeks, the patient visual acuity was 20/20, with superior arcuate scotoma, normal aspect of the fundus and no visible oedema. Unfortunately, because of the emergency of the case, no VF or FAG exams were performed nor any other images were taken.

Case 3

A 73-year-old female patient was presented for an ophthalmological exam because of dramatic and sudden loss of sight in her right eye for approximately 3 days. Visual acuity of counting fingers was found and a superior temporal artery branch occlusion was diagnosed, with a visible embolus at the emergence of the blood vessel from the papilla. Fundus pictures were taken along with a 3D optical coherence tomography (OCT) revealing the macular oedema (Figure 6).

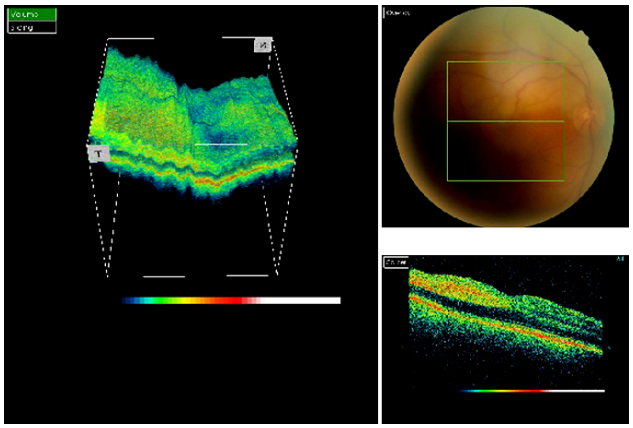

Fig. 6 – 3D optical coherence tomography (OCT) and colour retinography revealing the macular oedema.

The patient was referred to us for TYE procedure, seven days after the symptoms started. Two laser surgical attempts, a week apart, were needed for the complete embolysis. This was due mainly because of the patient's lack of cooperation, constantly moving her eyes and making it almost impossible for accurate targeting on the embolus surface; this also caused iatrogenic vessel perforation and subsequent hemorrhages.

Two weeks after the second procedure, normal blood flow was noticed, slight visual acuity improvements (20/200), retinal oedema remission and small hemorrhage in the posterior vitreous. In the images below, the presence of 4 small white emboli was presented, located at half disc diameter, inferior of the papilla, preretinal. Those emboli were pushed into the vitreous accompanied by a small blood jet, when we broke the initial embolus and the containing vessel (Figure 7).

Six weeks after the surgery, visual acuity improved up to 20/100, retinal oedema was noticeably reduced but not completely (Figure 8). The images below show an embolus fragment placed on the superior temporal artery at half disc diameter of the papilla, not completely obstructing the lumen. This is a risky location and we do not recommend laser in this situation because of the possibility of inducing retinal tears.

Case 4

A 62-year-old female patient was referred to us, presenting a superior altitudinal scotoma and reduced visual acuity (20/120) for about 48 hours. The diagnosis was inferior temporal branch arterial occlusion (left eye) with a visible emboli at the edge of the papilla (Figure 9).

Fig. 7 – Colour retinography 2 weeks post transluminal Nd:Yag laser embolysis (TYE): small hemorrhage in the posterior vitreous; small white emboli, located at half disc diameter, inferior of the papilla, preretinal.

Fig. 8 – Colour retinography 6 weeks post transluminal Nd:YAG laser embolysis (TYE): reduced retinal oedema; embolus fragment placed on the superior temporal artery at half disc diameter of the papilla, not completely obstructing the lumen.

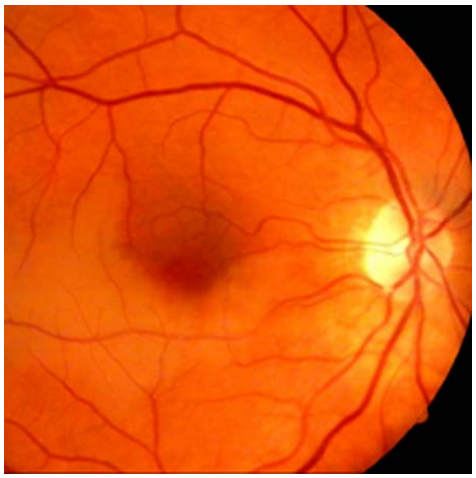

Fig. 9 – Colour retinography at presentation: inferior temporal branch arterial occlusion, visible emboli at the edge of the papilla.

TYE was performed thus destroying the embolus; blood flow and visual acuity up to 20/20 were restored while the visual field defect diminished considerably, being unnoticeable to the patient.

There was a cholesterol embolus and the laser procedure succeeded to break the embolus in smaller fragments inside the vessel, which went downstream.

The retinography performed 2 months after the laser procedure revealed: disappearance of the embolus from the inferior temporal quadrant of the optic disk and narrowing of the affected adjacent vessel (Figure 10).

Fig. 10 – Colour retinography 2 months post transluminal Nd:YAG laser embolysis (TYE): disappearance of the embolus from the inferior temporal quadrant of the optic disk and narrowing of the affected adjacent vessel

Case 5

A 76-year-old male patient, presenting an inferior altitudinal scotoma for about 4 days, came to us for a laser procedure, being diagnosed with superior temporal branch arterial occlusion on the left eye (Figure 11). Vision (BCVA) on the left eye was 20/30.

Fig. 11 – Colour retinography at presentation: superior temporal branch arterial occlusion, retinal oedema in the superior retinal sector.

TYE procedure was performed and blood flow was fully restored in the affected vessel (Figure 12) after 3 weeks; visual acuity recovered up to 20/20 and a substantial decrease in visual field defect was noticed. In this case the embolus was a little bit harder and a small haemorrhage was induced because of the laser impact inside the embolus against the vessel walls. There was not any extravasation of the embolus or fragments of it inside the vitreous cavity.

Fig. 12 – Colour retinography 3 weeks post transluminal Nd:YAG laser embolysis (TYE): fully restored blood flow in the affected vessel.

We summarized the cases in Table 1 below.

Discussion

Transluminal embolysis was performed with a photodisrupting Nd:YAG laser (1064 nm) manufactured by Nidek. The advantage of using this model is the possibility of focusing together the laser beam and the image of the slit-lamp perpendicularly on the center of the cornea, not just obliquely (there are also other laser equipment manufactured by different companies wich have this coaxial kind of focus); thus, using a specific laser contact lenses, it is possible to focus the target areas along the posterior pole. Throughout our cases we have used a Volk Centralis Direct contact lens, but also a three mirrors Goldman lens can be used. The focusing was performed perpendicularly on the embolus surface. The spot diameter was constant 50 µm in size and the power ranged from 0.8 mJ to 1.2 mJ. Firing was done “shot by shot”. In each session there were fired between 2 and 4 shots. Potential complications regarding this technique are: retinal or vitreous hemorrhage, retinal breaks, choroidal neovascularization, epiretinal membranes. In most of our cases we faced just minor preretinal hemorrhages that were completely reabsorbed after 10–14 days and, in some cases, vitreous hemorrhages that were reabsorbed after 4 weeks. In all the cases improvement of visual function was observed and full restoration of blood flow.

The absolute therapeutic role of TYE in BRAO is debatable as it is known that over 70% of cases lean towards resolution, but the efficiency of the technique remains unquestionable speaking about the speed of emboli distruction and the recovery

Table 1

Centralized patient data

Parameters	Case				
	1	2	3	4	5
Occlusion type	Infero-temp BRAO	Infero-temp BRAO	Supero-temp BRAO	Infero-temp BRAO	Supero-temp BRAO
Embolus type	Calcific	Cholesterol and fibrinoplatelet	Calcific	Cholesterol	Cholesterol
Location	Optic disc	Optic disc	Optic disc	Optic disc	Optic disc
Macular edema	Yes-partial	Yes	Yes	Yes – partial	No visible
Arcuate retinal edema	Yes	Yes	Yes	Yes	Yes
Time of the TYE	10 days	2 days	7 days	2 days	4 days
Type of dislodging	Intra- and extravascular	Intravascular	Extravascular	Intravascular	Intravascular
Haemorrhages	Yes	No	Yes	No	Yes (very small)
VA preop.	20/30	CF	CF	20/120	20/30
VA postop.	20/30	20/20	20/100	20/20	20/20
Visual field defect	Diminished, but present	Very diminished, but present	Still present	Very diminished	Very diminished

TYE – transluminal Nd:YAG laser embolysis; BRAO – branch retinal artery occlusion; VA – visual acuity; CF – finger counting.

of blood flow. Despite a set of inherent riscs of any surgical intervention, speaking about TYE, the moment of emboli distruction as close as possible to the onset of occlusion is decisive for regaining visual function and, most probably, applying the procedure correctly is superior to observation.

We emphasize the importance of individualized analysis of any BRAO patient in deciding the treatment or not. For a successful TYE, the embolus have to be visible on the optic disc surface. We do not recommend laser treatment of emboli localized outside the optic disc, because of the retinal tears risks.

Any kind of arterial emboli can be treated in this way, but the TYE effect differs according with the embolus type. For hard emboli, like calcific ones, by using a YAG laser we can sometimes get a true extravasation of embolus, like in case 1. In such cases because of the high density of embolus the blood jet will pump up the full embolus or fragments of it in the vitreous cavity. For softer emboli, like fibrinoplatelet or cholesterol ones, the laser impacts usually dislodged them downstream the vessel in smaller fragments, if the power is set properly and the focus is done correctly. In this situation there is a true intravascular procedure by external approach. Obviously the sooner is the better, but even in prolonged occlusions (8–10 days) with persistent macular edema probably embolysis can help. We cannot prove yet the benefits of late TYE. It is very difficult to decide if the retina lesions are for good after one week of BRAO or there are still some viable retinal cells able to survive if the reflow will be set up again. Anyway "do no harm" is mandatory in judging each case, so when potential complications overwhelm the potential benefits of TYE, the surgeon has to adopt a conservatory approach.

Conclusion

Despite our short-term experience with this therapeutical approach, we can resume that the moment of emboli distruction, as close as possible to the onset of the occlusion is decisive for regaining vision and that applying the procedure correctly is superior to observation in most cases. Worldwide experience with TYE is still limited, but the technique seems feasible also when treating CRAO caused by visible emboli on the optic disc surface. This most certainly calls for random trials for identifying precisely the role of TYE in treatment of retinal occlusion pathology, though the relatively small number of properly diagnosed cases affects this objective. In all cases, the risks of TYE must be weighed against the possibility of severe and permanent loss of vision secondary to retinal artery occlusions.

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