

## BASIC SCIENCE ARTICLE

# Evaluating the effect of pulse energy on femtosecond laser trabeculotomy (FLT) outflow channels for glaucoma treatment in human cadaver eyes

Shangbang Luo PhD<sup>1,2</sup>  | Eric R. Mikula PhD<sup>2,3</sup>  | Reza Khazaeinezhad PhD<sup>3</sup> |  
Samantha M. Bradford PhD<sup>2</sup> | Fengyi Zhang MSc<sup>1,4</sup> | James V. Jester PhD<sup>1,2</sup> |  
Tibor Juhasz PhD<sup>1,2,3</sup>

<sup>1</sup>Department of Biomedical Engineering, University of California, Irvine, Irvine, California, USA

<sup>2</sup>Department of Ophthalmology, University of California, Irvine, Irvine, California, USA

<sup>3</sup>ViaLase Inc., Aliso Viejo, California, USA

<sup>4</sup>Beckman Laser Institute, University of California, Irvine, Irvine, California, USA

## Correspondence

Tibor Juhasz, University of California, Irvine, 843 Health Sciences Rd, Irvine, CA 92697-4390, USA.

Email: [tjuhasz@hs.uci.edu](mailto:tjuhasz@hs.uci.edu)

## Abstract

**Background and Objectives:** Femtosecond laser trabeculotomy (FLT) creates aqueous humor outflow channels through the trabecular meshwork (TM) and is an emerging noninvasive treatment for open-angle glaucoma. The purpose of this study is to investigate the effect of pulse energy on outflow channel creation during FLT.

**Materials and Methods:** An FLT laser (ViaLase Inc.) was used to create outflow channels through the TM (500  $\mu$ m wide by 200  $\mu$ m high) in human cadaver eyes using pulse energies of 10, 15, and 20  $\mu$ J. Following treatment, tissues were fixed in 4% paraformaldehyde. The channels were imaged using optical coherence tomography (OCT) and assessed as full thickness, partial thickness, or not observable.

**Results:** Pulse energies of 15 and 20  $\mu$ J had a 100% success rate in creating full-thickness FLT channels as imaged by OCT. A pulse energy of 10  $\mu$ J resulted in no channels ( $n = 6$ ), a partial-thickness channel ( $n = 2$ ), and a full-thickness FLT channel ( $n = 2$ ). There was a statistically significant difference in cutting widths between the 10 and 15  $\mu$ J groups ( $p < 0.0001$ ), as well as between the 10 and 20  $\mu$ J groups ( $p < 0.0001$ ). However, there was no statistically significant difference between the 15 and 20  $\mu$ J groups ( $p = 0.416$ ).

**Conclusions:** Fifteen microjoules is an adequate pulse energy to reliably create aqueous humor outflow channels during FLT in human cadaver eyes. OCT is a valuable tool when evaluating FLT.

## KEYWORDS

energy optimization, femtosecond laser trabeculotomy (FLT), glaucoma, human cadaver eyes, OCT, outflow channel, trabecular meshwork

## INTRODUCTION

Glaucoma is a disease characterized by the death of retinal ganglion cells, optic nerve head cupping, and is often associated with elevated intraocular pressure (IOP).<sup>1</sup> The only proven treatment for glaucoma is the reduction of IOP.<sup>2</sup> IOP is the result of a balance between aqueous humor secretion by the ciliary processes and the outflow of aqueous humor through the trabecular meshwork (TM) and Schlemm's canal (SC), and to a

lesser degree, the uveoscleral pathway. It is thought that most of the resistance to aqueous humor outflow is found in the juxtacanalicular region of the TM and inner wall of SC.<sup>3–6</sup> As such, numerous devices and procedures aim to bypass the resistance found in these tissues with the goal of lowering IOP.<sup>7–11</sup> Though these methods achieve an IOP reduction, they are all, except selective laser trabeculoplasty, invasive to a degree because they require opening the eye to either insert surgical instrumentation or an implant. Recently, femtosecond laser trabeculotomy

(FLT) has emerged as a noninvasive, non-incisional method to bypass aqueous humor outflow resistance.<sup>12–14</sup>

The use of a femtosecond laser for glaucoma treatment has several advantages. First, a tightly focused femtosecond laser beam enables photodisruption or laser-induced optical breakdown to occur only at a well-defined focal spot, resulting in localized and confined tissue removal.<sup>15</sup> Second, the pulse duration and plasma expansion time associated with femtosecond lasers are shorter than the local thermal diffusion time, leading to limited thermal damage.<sup>16</sup> Lastly, experimental studies on human ocular tissues have demonstrated that femtosecond lasers produce reduced shock wave and cavitation bubble effects compared to lasers with longer pulse durations, resulting in minimal localized tissue damage.<sup>15</sup> These favorable properties, coupled with the ability to noninvasively deliver the laser pulse and the precise scanning and delivery control enabled by modern computer systems, make femtosecond lasers an ideal technique for trabecular bypass surgery. Furthermore, the safety and efficacy of femtosecond laser have been demonstrated over the last 20 years for various procedures, including flap creation in corneal refractive surgery, capsulotomy, lens fragmentation, and corneal incisions during cataract surgery.<sup>17–20</sup>

The use of femtosecond lasers to perform trabeculotomy enables dynamic delivery of tightly focused laser pulses through the cornea, across the anterior chamber (AC), and to SC.<sup>12,13,21,22</sup> This innovative approach noninvasively establishes a conduit between the AC and SC, thus providing an unobstructed aqueous humor

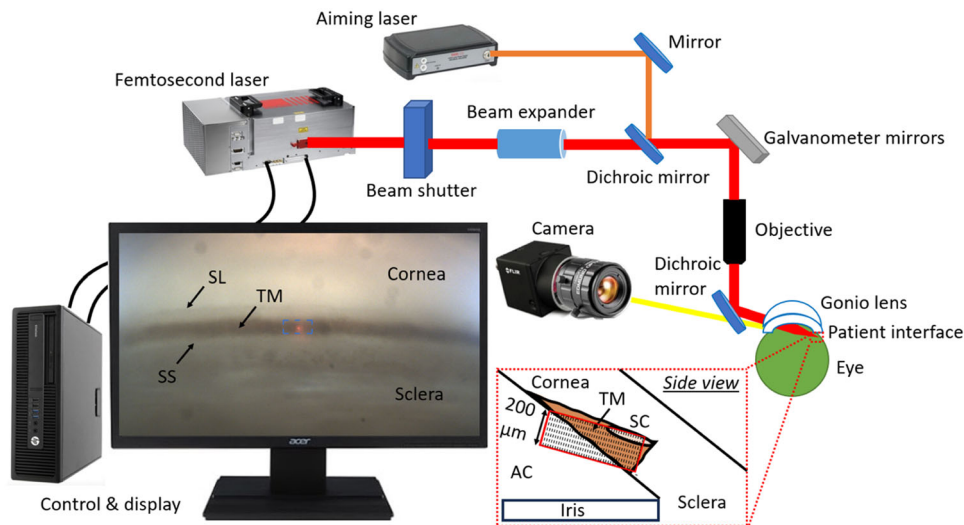
outflow channel. Though initial studies in cadaver eye perfusion models have shown promising IOP reductions, the optimal pulse energy required for successful FLT surgery needs to be investigated. In this study, we use optical coherence tomography (OCT) to investigate the influence of pulse energy on the creation of outflow channels within the TM during FLT surgery in human cadaver eyes.

## MATERIALS AND METHODS

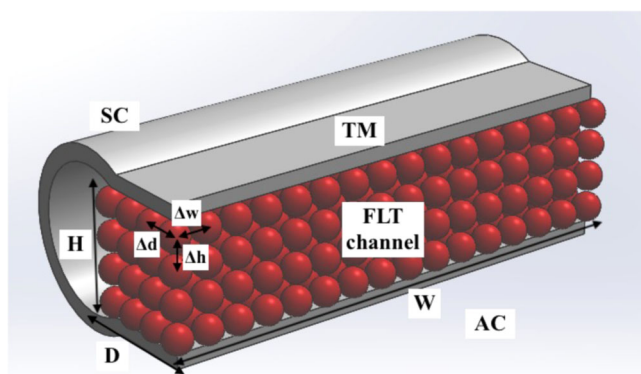
### FLT delivery system

The FLT system consists of several components, including a femtosecond laser, a gonioscopic camera, a low power HeNe aiming laser, and a series of optics, as depicted in Figure 1. For our experiments, we utilized a commercial amplified diode-pumped Ytterbium-based femtosecond laser (Origami-10XP Femtosecond Laser; NKT Photonics). This laser emits pulses with a duration of 400 fs, a wavelength of 1.03  $\mu\text{m}$ , and a pulse repetition frequency of 10 kHz.

The laser light passes through a beam expander (a)BeamExpander; Asphericon) to dilate the beam radius and fill the aperture of the objective. The beam scanning in the TM area is controlled by a pair of galvo-scanners, which determine the horizontal (*X*-axis) and vertical (*Y*-axis) directions. An objective lens focuses the laser beam through a custom gonioscopic lens into iridocorneal angle (spot size <10  $\mu\text{m}$ ). Additionally, a video camera is



**FIGURE 1** Components of the FLT surgical system. A commercial femtosecond laser is guided by a dual aiming beam, with the convergence of the dual beams indicating the focal point of the femtosecond laser on the TM. The gonio camera light passes through a dichroic mirror, transmitting through a custom-built gonio lens, a custom-built patient interface, and the transparent cornea, ultimately focusing on the TM at the iridocorneal angle of a human eye. A typical goniolens view of the enucleated eye was shown on the control and display module's monitor. In the close-up schematic, the FLT laser scans across the entire TM, starting from inside SC and extending into the AC. The scan pattern is designed with a width of 500  $\mu\text{m}$  and a height of 200  $\mu\text{m}$  (blue dotted box in the gonioscopic image). Note that the 500  $\mu\text{m}$  cutting width along the circumferential direction of the corneoscleral rim (perpendicular to the paper) is not depicted in the side view. AC, anterior chamber; FLT, femtosecond laser trabeculotomy; SC, Schlemm's canal; SL, Schwalbe's line; TM, trabecular meshwork.



**FIGURE 2** A schematic illustrating a femtosecond-created channel penetrating through the trabecular meshwork (TM), establishing a connection between the anterior chamber (AC) and Schlemm's canal (SC). The channel's geometry is determined by its width (W), height (H), and depth (D), while the laser spot, line, and layer separations are represented by  $\Delta w$ ,  $\Delta h$ , and  $\Delta d$ , respectively. The red spots indicate the focal points of the femtosecond laser arranged in a raster pattern, effectively photodisrupting the TM tissues. FLT, femtosecond laser trabeculotomy.

integrated into the system to facilitate real-time guidance by providing direct visualization of the iridocorneal angle structures. The femtosecond surgical beam is guided by a coaxial 5 mW, 632.8 nm HeNe dual aiming laser (Thorlabs Inc.). The convergence of the dual beams onto the TM serves as an indication of the focal plane of the femtosecond laser.

Figure 2 provides a schematic diagram illustrating the creation of the femtosecond channel and its dimensional relationship to the structures in the iridocorneal angle. Photodisruption occurs within a confined region corresponding to the beam focus size. This process is repeated as the femtosecond laser focus is scanned in a continuous rectangular volume through the TM tissues, resulting in the creation of a patent femtosecond channel connecting the AC to SC. The dimensions of the channel are determined by the channel width (W) in the horizontal direction (X-axis), and the channel height (H) in the vertical direction (Y-axis).

## Human cadaver eye samples preparation

Six human cadaver eyes, which were not suitable for transplant, were obtained from the San Diego Eye Bank within 24 h postmortem. Careful dissection was performed to preserve the TM while removing other ocular components, including the posterior segment, vitreous, lens, iris, ciliary body, choroid, and uveal tissues (Figure 3A). Note that the TM is anchored posteriorly into the relatively stiff scleral spur, which provides a mechanical and physical boundary between the TM and ciliary body/iris. Thus in the ex vivo case, the removal of

these tissues should not have an appreciable effect on the mechanics of the TM or the photodisruptive ability of the femtosecond laser. Subsequently, the prepared eyes were stored in Optisol GS corneal transplant medium (Chiron Intraoptics) and refrigerated at 4°C (Figure 3B). The experimental procedures adhered to the principles outlined in the Declaration of Helsinki.

To assess morphology and viability, the cadaver eyes were examined under an optical microscope before being mounted on a custom sample holder. The eyes were then perfused with Dulbecco's modified Eagle's medium containing 5  $\mu\text{g/mL}$  amphotericin B and 100  $\mu\text{g/mL}$  streptomycin (MilliporeSigma) in a sterile tissue culture incubator (Sheldon Manufacturing Inc.) at 37°C, 5%  $\text{CO}_2$ , and 95% humidity for 30 min (Figure 3C). The corneal epithelium was removed due to irregularities in the surface quality. It should be noted that the perfusion system was strictly monitored to ensure the absence of bubbles or leakage, as these could impede the subsequent surgical procedure.

## Femtosecond laser channel creations in human cadaver eyes

The eye was subsequently placed on a movable mechanical stage/sample holder equipped with five degrees of freedom, including x, y, z translations, rotation, and tilting, within the FLT laser surgery system (Figure 3D). To optimize optical performance and provide a protective barrier, a custom-built patient interface was used between the laser system and the human cadaver eye, minimizing aberrations and reflective losses. Additionally, a drop of index-matching gel (GenTeal Gel; Novartis) was applied between the patient interface and the gonioscopic lens to reduce optical reflections at the interfaces. To ensure clear visualization of the TM and surrounding tissues at the iridocorneal angle, a drop of 20% dextran was directly applied to the eye to mitigate corneal edema.

Before commencing the surgical procedure, meticulous adjustments of the gonioscopic camera and sample holder were made to visualize the TM at the iridocorneal angle. Once the TM was visible, the dual aiming beams were aligned to overlap onto the TM surface, targeting the treatment laser. In this study, pulse energies of 10, 15, and 20  $\mu\text{J}$  were used, and channels with dimensions of  $W \times H = 500 \times 200 \mu\text{m}^2$  were created. When the laser shutter was opened, the femtosecond laser beam initiated photodisruption through the TM, starting from inside SC and moving out toward the AC, following a preprogrammed raster pattern controlled by the computer. The formation of an outflow channel took several seconds, depending on the laser scanning parameters and drainage geometry. Each eye received five channels at a particular energy.

After completing the surgical procedure, the surgical position was marked to facilitate subsequent OCT imaging. Following the treatments, the eyes were fixed in 4% paraformaldehyde (Mallinckrodt Baker Inc.) in phosphate-buffered saline (PBS) and dissected for post-surgery OCT imaging experiments.

## OCT imaging

In this study, we used a spectral domain OCT to evaluate the created channels. The imaging system operates at an A-line rate of 50 kHz and has a central wavelength of 890 nm, offering a theoretical axial resolution of 2.4  $\mu\text{m}$ .<sup>23</sup> The tissue sample was immersed in the PBS solution and carefully adjusted so that the OCT beam was scanned approximately perpendicular to the width of the surgical site.

## Quantifying and visualizing the created channels by OCT

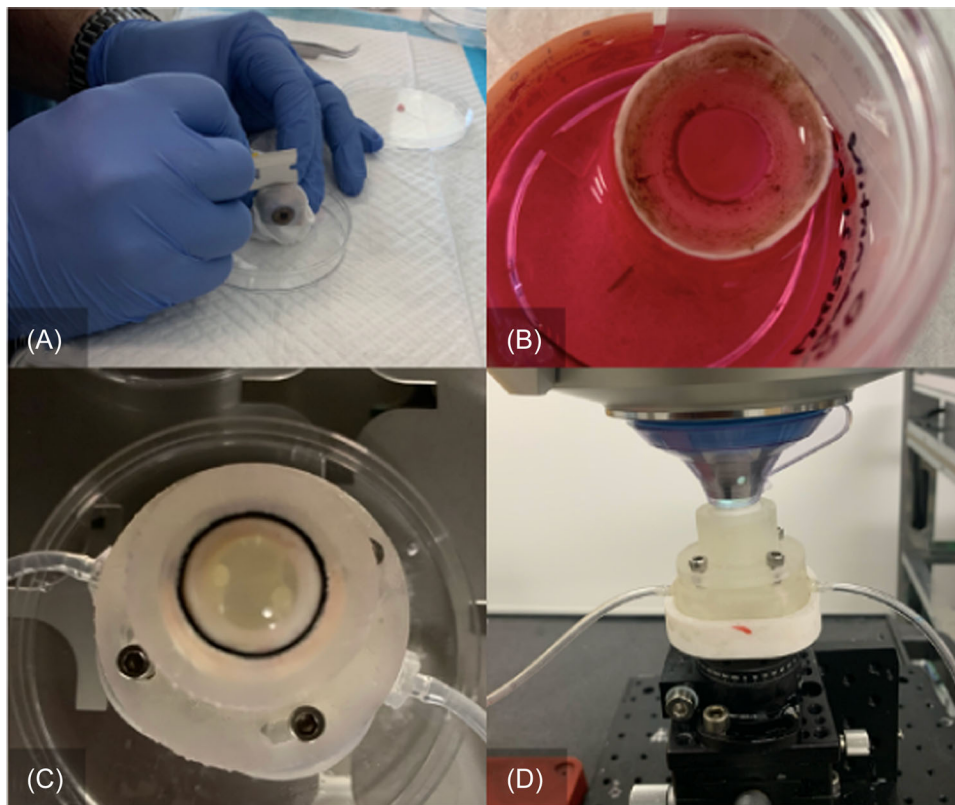
To assess the efficacy and precision of channel creation using the femtosecond beam, we conducted an evaluation of the OCT image stacks corresponding to the FLT channel (Figure 4D). The evaluation was performed by

analyzing the B-scan image slices individually (Figure 4). We defined a continuous cutting width ( $W_c$ ) of at least 200  $\mu\text{m}$  within the desired 500  $\mu\text{m}$  channel width as a complete drainage channel connecting to the SC, indicating a full-thickness cut. Any width below this threshold indicated either partial thickness cuts or the absence of observable outflow channels (refer to Figure 5).

Furthermore, the acquired image stacks were cropped to a volume size of  $V_{xyz} = 1 \times 1 \times 1 \text{ mm}^3$ , with the FLT outflow channel positioned at the center of the selected volumetric image. In the context of OCT imaging,  $z$  represents the depth direction,  $x$  corresponds to the fast scan direction, and  $y$  indicates the slow scan direction between B-scans. Subsequently, the image stacks were imported into FluoRender 2.25.2 software (Scientific Computing and Imaging Institute) for 3D rendering. To enhance the visual representation, the “Hot Effect” was applied along the depth in the software settings, facilitating the three-dimensional visualization.

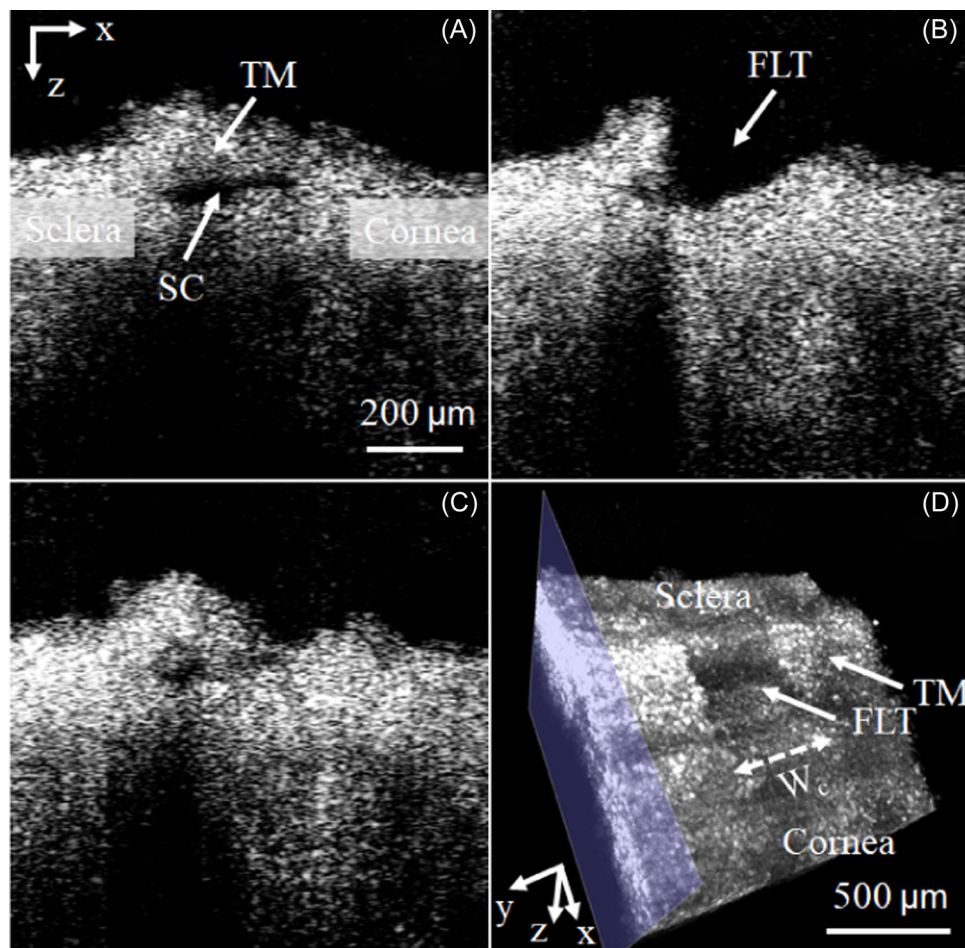
## Statistics

Unpaired  $t$ -tests using GraphPad Prism 10 (GraphPad Software) were conducted to examine potential significant differences in the cutting widths associated with



**FIGURE 3** Sample preparation for FLT surgery. (A) Human donor eyes were obtained from the San Diego Eye Bank within 24 h postmortem. (B) An anterior segment with an intact trabecular meshwork (TM) was dissected and (C) carefully mounted on a custom ocular perfusion device within an incubator. (D) The eye was docked to the FLT surgical system via a custom-built patient interface between the two. FLT, femtosecond laser trabeculotomy.





**FIGURE 4** Representative OCT B-scan images at different slow-scanning locations and the 3D reconstructed image stack. As the sliding plane moves along the  $y$ -direction, the B-scan images show: (A) intact TM tissue, (B) a full-thickness cut creating an FLT channel connecting to Schlemm's canal, and (C) a partial-thickness cut in the TM tissue. The cutting width ( $W_c$ ), analyzed from individual B-scans along the  $y$ -axis, serves as an evaluation metric detailed in Figure 5. FLT, femtosecond laser trabeculotomy; OCT, optical coherence tomography; TM, trabecular meshwork.

different FLT pulse energies (10 vs. 15  $\mu\text{J}$ , 10 vs. 20  $\mu\text{J}$ , and 15 vs. 20  $\mu\text{J}$ ).

## RESULTS

### Representative outflow channels under a light microscope

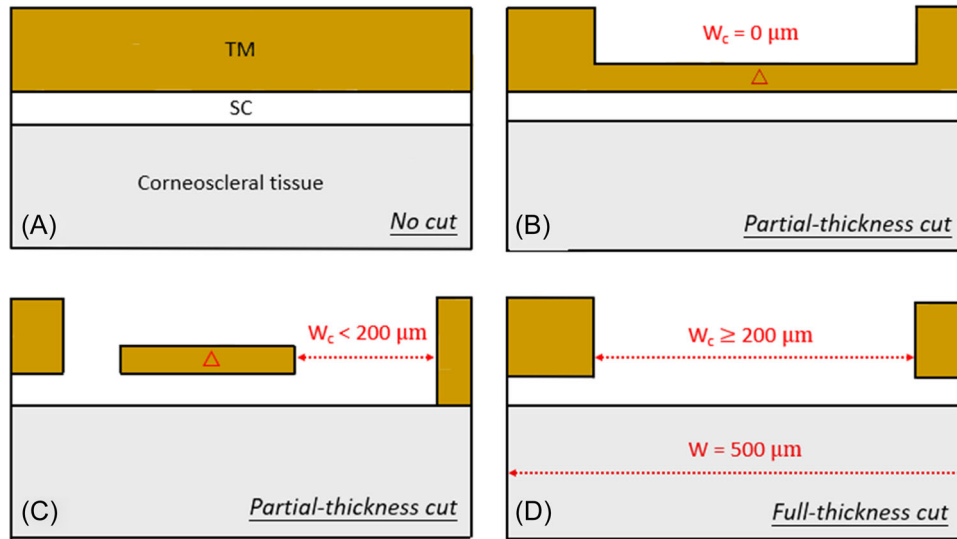
Images of outflow channels taken through an operating microscope are shown in Figure 6; channels are indicated by double arrows. These channels were created by irradiating the brownish TM with 15  $\mu\text{J}$  pulse energy using FLT surgery in a human donor eye. The corneoscleral shell was imaged at an angle, with the endothelium facing upward, allowing for the direct capture of the TM by the optical microscope. While these images nicely demonstrate the location of the outflow channels, a more detailed assessment is required to determine whether the channels were fully cut by the FLT surgery. This evaluation can be

achieved through a closer and deeper examination using a 3D OCT imaging modality, as reported below.

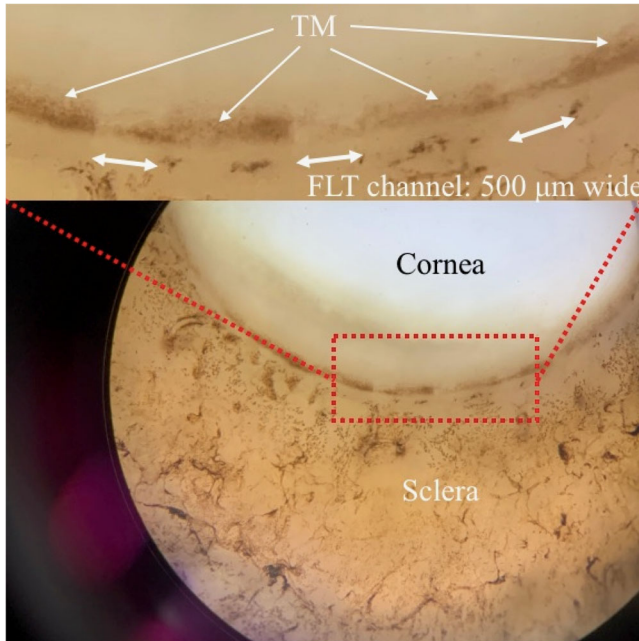
### OCT evaluation of femtosecond laser channel creations at varying pulse energies

Figure 7 shows sample OCT images of FLT outflow channels at different pulse energies. In this specific case, the representative FLT channel created at 10  $\mu\text{J}$  pulse energy was partially cut by the femtosecond laser, while the channels at 15 and 20  $\mu\text{J}$  cut through the entire TM into SC.

The mean  $\pm$  standard deviation cutting widths of the outflow channels through the TM were  $74 \pm 157$ ,  $403 \pm 89$ , and  $368 \pm 99 \mu\text{m}$  for the 10, 15, and 20  $\mu\text{J}$  energy groups, respectively. These results are summarized in Figure 8. Significantly different cutting widths were observed between the 10 and 15  $\mu\text{J}$  groups ( $p < 0.0001$ ), as well as between the 10 and 20  $\mu\text{J}$  groups



**FIGURE 5** Illustration of FLT outflow channel evaluation. The  $0 \mu\text{m}$  cutting width was considered when the TM is completely intact (A) or partially cut at any location along the circumferential direction (Y-axis) (B). A partial-thickness cut can also be defined as a maximum continuous cutting width ( $W_c$ ) below  $200 \mu\text{m}$  (C), while a full-thickness cut had a continuous cutting width of at least  $200 \mu\text{m}$  (D). Marks “Δ” in (B) and (C) indicate an incomplete cut through the TM, preventing connections to SC, and were excluded from the cutting width calculation. FLT, femtosecond laser trabeculotomy; SC, Schlemm's canal; TM, trabecular meshwork.



**FIGURE 6** Three representative  $500 \times 200 \mu\text{m}^2$  outflow channels (indicated by double arrows) created with  $15 \mu\text{J}$  energy through the brownish trabecular meshwork (TM), as observed under an optical microscope. FLT, femtosecond laser trabeculotomy.

( $p < 0.0001$ ). However, there was no significant difference between the  $15$  and  $20 \mu\text{J}$  groups ( $p = 0.416$ ).

Comprehensive data regarding all FLT channel creations are presented in Table 1. The results indicate that pulse energies of  $15$  and  $20 \mu\text{J}$  achieved a 100% success rate in creating full-thickness FLT channels with a continuous cutting width of at least  $200 \mu\text{m}$ , as

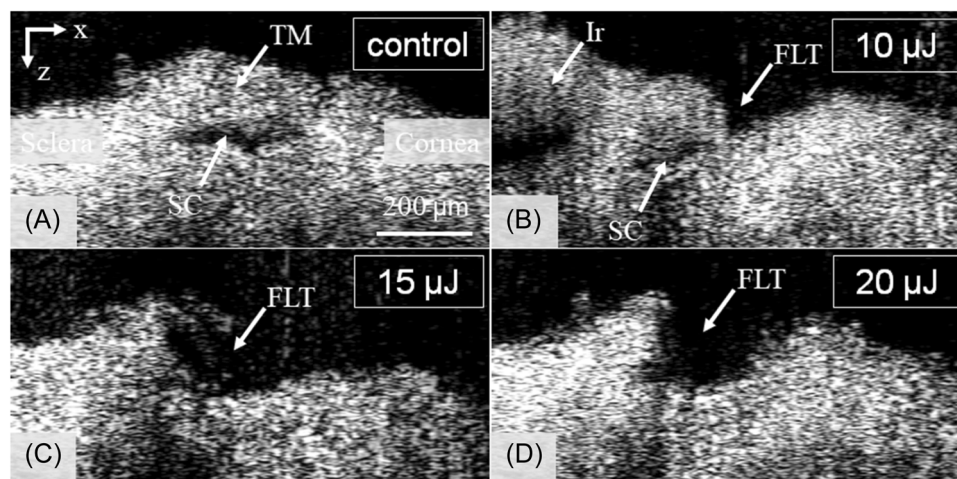
confirmed by OCT imaging. In contrast, the use of  $10 \mu\text{J}$  pulse energy resulted in the absence of channels in six cases, partial-thickness channels in two cases, and complete FLT channels in two cases.

### Three-dimensional OCT representation of the femtosecond laser outflow channels and iridocorneal angle structures

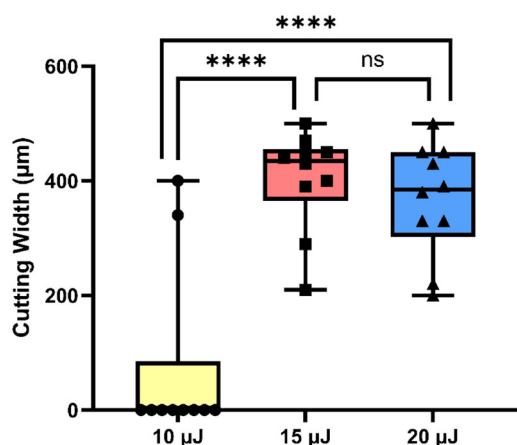
For a comprehensive understanding of the complete profile of the FLT channel at the iridocorneal angle, a three-dimensional visualization of a  $1 \times 1 \text{ mm}^2$  segment of the corneoscleral rim is provided in Figure 9. In this representation, the SC appeared as a patent tube (Figure 9A,B), accompanied by the overlaying TM tissue. Importantly, the OCT reconstruction clearly reveals a wedge-shaped channel created by the femtosecond laser. The TM is fully penetrated with sharp edges, resulting in direct exposure of SC to the aqueous humor in the AC.

## DISCUSSION

In this study, we employed OCT to assess the impact of pulse energy on the creation of outflow channels during FLT surgery in human cadaver eyes. Our aim was to determine the optimized energy level for the surgical procedure. Overall, the present study demonstrated that pulse energy significantly influenced the creation of outflow channels during FLT surgery in human cadaver eyes, resulting in variations such as full thickness, partial



**FIGURE 7** Sample OCT images of FLT outflow channels at varying pulse energies (A). Control (B). At 10  $\mu\text{J}$  energy, a partial-thickness outflow channel is observed, while both 15 and 20  $\mu\text{J}$  energies result in full-thickness channels (C, D). FLT, femtosecond laser trabeculotomy; OCT, optical coherence tomography; SC, Schlemm's canal; TM, trabecular meshwork.



**FIGURE 8** Statistics of the cutting width in the trabecular meshwork (TM) at different pulse energies. A significant difference in cutting width was observed both between 10 and 15  $\mu\text{J}$  and between 10 and 20  $\mu\text{J}$  (\*\*\*\* $p < 0.0001$ ). However, there was no significant difference in the cutting width of the TM between 15 and 20  $\mu\text{J}$  (ns, not significant:  $p > 0.05$ ). A pulse energy of 15  $\mu\text{J}$  is determined to be optimal for femtosecond laser trabeculotomy (FLT).

thickness, or absence of observable channels, as observed through spectral domain OCT imaging (see Table 1 and Figure 7). By evaluating the OCT images, we have determined that a pulse energy of 15  $\mu\text{J}$  reliably achieves the creation of outflow channels by photodisrupting the TM tissues in human cadaver eyes. Conversely, lower energy levels, such as 10  $\mu\text{J}$ , do not guarantee the attainment of full thickness cutting through the TM tissues. Typically, using the least amount of energy to accomplish a surgery is considered optimal. Any amount of energy over the minimum necessary, though it may not be damaging, is unneeded. These findings have potential implications for guiding the choice of pulse energy in the clinical setting.

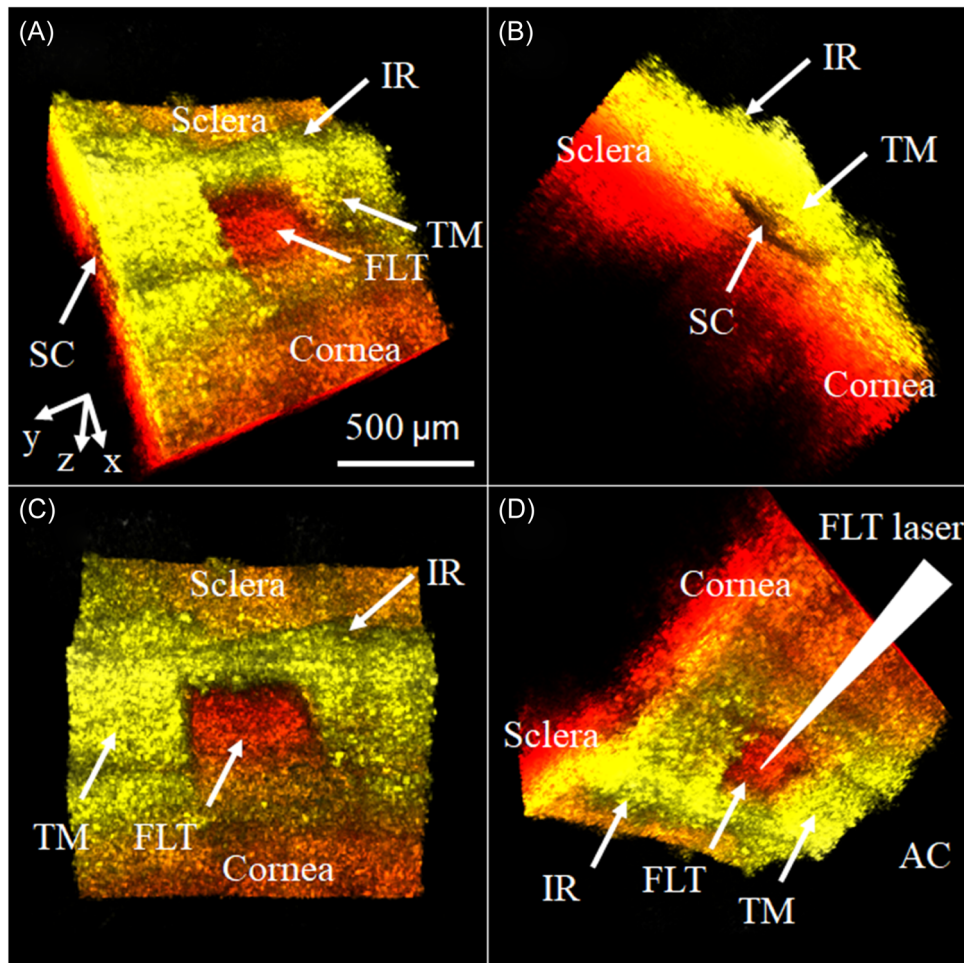
**TABLE 1** OCT evaluation of FLT channels created at different pulse energies.

	10 $\mu\text{J}$		15 $\mu\text{J}$		20 $\mu\text{J}$	
	Cutting width ( $\mu\text{m}$ )	Result	Cutting width ( $\mu\text{m}$ )	Result	Cutting width ( $\mu\text{m}$ )	Result
CH #01	0	No	390	Full	450	Full
CH #02	0	No	440	Full	330	Full
CH #03	0	No	470	Full	380	Full
CH #04	0	Partial	450	Full	200	Full
CH #05	340	Full	400	Full	330	Full
CH #06	400	Full	430	Full	450	Full
CH #07	0	No	500	Full	390	Full
CH #08	0	No	450	Full	430	Full
CH #09	0	Partial	290	Full	500	Full
CH #10	0	No	210	Full	220	Full

Abbreviations: FLT, femtosecond laser trabeculotomy; OCT, optical coherence tomography.

Previous groups had explored using femtosecond laser to noninvasively bypass aqueous outflow resistance with limited success. Researchers have employed 800 nm femtosecond laser pulses focused directly through air onto the exposed TM within a 4 mm excised strip of the porcine corneoscleral rim.<sup>24</sup> Histological analysis revealed successful photodisruption of the TM, including the juxtacanalicular tissue, using moderate pulse energies of 7–14  $\mu\text{J}$  and short exposure times ranging from 0.5 to 2 s. While this study successfully removed TM with a femtosecond laser, it was not conducted in a clinically relevant manner through the intact cornea. The same group also investigated the feasibility of photodisrupting





**FIGURE 9** A representative 3D image stack of the iridocorneal angle, oriented from different perspectives, illustrates a wedge-shaped FLT outflow channel cut through the trabecular meshwork (TM) and extending into Schlemm's canal (SC). This channel was created using a pulse energy of 20  $\mu\text{J}$ , effectively establishing a direct connection between SC and the aqueous fluid in the anterior chamber (AC). The FLT channel and nearby structures were observed from (A) an approximately 45-degree view, (B) a side view, and (C) a top view. The relationship between the angle structures and the FLT surgical laser is depicted in (D). FLT, femtosecond laser trabeculotomy; IR, iris root.

the TM using femtosecond laser pulses focused through a gonioscopic lens with significantly higher energies of 60–480  $\mu\text{J}$ .<sup>25</sup> However, histological results indicated that they were unable to reach the innermost layer of the TM known as the juxtacanalicular tissue and the inner wall of SC, which are believed to contribute to the greatest resistance to aqueous outflow.<sup>3,26</sup> This failure may be attributed to the lack of necessary optimization of the focal spot size of the femtosecond laser beam propagating through the gonioscopic contact lens, cornea, and AC, as well as the absence of proper visualization of the iridocorneal angle structures.

Researchers have used two-photon or histological imaging to evaluate the femtosecond laser created channels.<sup>24,25,27</sup> However, both imaging techniques necessitate tissue sectioning and face challenges in determining the continuous and overall cutting profile of the entire FLT channel. OCT has demonstrated its capability for three-dimensional imaging of the entire femtosecond-created channels in human cadaver eye

tissues.<sup>12</sup> Moreover, our previous experience utilizing a custom-built spectral domain OCT to provide detailed visualization of the iridocorneal angle structures,<sup>28,29</sup> supports the suitability of OCT for this investigation. As discussed in this study, OCT has been employed as an effective tool to evaluate the impact of pulse energy on the generation of outflow channels during FLT surgery in human cadaver eyes. Furthermore, OCT has successfully aided in determining the optimal energy level for the FLT procedure. A three-dimensional OCT reconstruction clearly depicted the location of the outflow channel within the TM, thus establishing a direct connection between SC to aqueous fluid in the AC (see Figure 9). This raises a possibility that OCT can be translated for evaluations of the clinical laser surgery for the treatment of glaucoma. Further investigation of OCT imaging follow-ups is needed to assess the long-term outcomes after surgery.<sup>14</sup>

It is important to discuss the acceptance criteria defined in this study for a “full channel,” which was defined as a channel with a continuous cutting width of



at least 200  $\mu\text{m}$  fully penetrating the TM into SC. Since the channel width defined in the experiment is 500  $\mu\text{m}$ , one would reasonably expect that the success criteria would be closer to 500  $\mu\text{m}$ . The criteria of 200  $\mu\text{m}$  or greater is borne from prior laboratory experience in passing femtosecond pulse obliquely through the cadaver cornea, across the AC, and to the TM.<sup>30,31</sup> Though we employed strict acceptance criteria and handling procedures regarding the donor cadaver tissue, there still exists uncontrollable variability in the quality of the corneas, specifically the viability of the endothelium and surface quality of the cornea. Endothelial function directly affects corneal clarity and edema. Additionally, cadaver corneoscleral rims are subject to wrinkling on the posterior corneal surface. The consequence of these defects is variability in the quality of the trabeculotomy in the tissue. Taking into consideration the variability of these tissues, one would not expect full-width cuts all the time, as shown by the data in Table 1. For example, in living tissue, the corneas could be expected to be clearer than cadaver corneas and therefore may achieve more complete cuts in lower energies.

## CONCLUSIONS

In conclusion, this study successfully demonstrated the capability of our FLT system, utilizing a pulse energy of 15  $\mu\text{J}$ , to effectively photodisrupt the TM tissues. This resulted in the creation of a full-thickness outflow channel, establishing a vital connection between the AC and SC. Confirmation of this outcome was achieved through a comprehensive analysis of high-resolution OCT images. These findings underscore the effectiveness of utilizing OCT as a valuable tool for evaluating the creation of FLT outflow channels in the treatment of glaucoma.

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## ORCID

Shangbang Luo  <http://orcid.org/0000-0003-0111-9460>

Eric R. Mikula  <http://orcid.org/0000-0003-2015-8713>

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