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# Effect of Intravitreal Liquid Silicone on Optic Nerve Function

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We recorded visual-evoked cortical potentials before and after pars plana vitrectomy and intravitreal liquid silicone filling in 30 patients (30 eyes) with complicated retinal detachments without vascular eye disease or glaucoma. The flash- and flicker-evoked cortical potentials increased in amplitude in all cases. Of 21 eyes followed up for more than 50 days, eight had a 30-Hz flicker response before and after surgery. Of 13 eyes with preoperatively reduced flicker-frequency responses, ten (77%) were improved after surgery. The visual-evoked cortical potential parameters did not deteriorate in any of the patients. We concluded that no toxic effect of intravitreal liquid silicone on the optic nerve could be shown by electrophysiologic methods.

THE TECHNIQUE OF liquid silicone filling as it is used to treat complicated retinal detachments has evolved over the last quarter century.<sup>1-6</sup> Today, vitrectomy and intravitreal silicone filling combined are used only when other therapeutic approaches are unlikely to be successful.<sup>3-7</sup> Silicone-related complications include cataract, keratopathy, and secondary glaucoma.<sup>2,8</sup> Some patients develop optic nerve atrophy after intravitreal liquid silicone filling.<sup>6</sup> Possible reasons include continuously increased intraocular pressure as a result of secondary neovascular glaucoma, angle closure, silicone emulsification, ischemic optic nerve disease, particularly in diabetic patients, and a toxic effect of liquid silicone. We, therefore, investigated the optic nerve function using visual-evoked cortical potentials before and after pars plana vitrectomy and intravitreal liquid silicone injection.

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## Patients and Methods

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Thirty-eight consecutive patients (38 eyes) with complicated retinal detachments including the macula without vascular eye disease or glaucoma were included in this study. They underwent pars plana vitrectomy and intravitreal silicone filling with purified silicone (viscosity, 5,000 centistokes). Before silicone surgery, intraocular pressure in all patients was normal. Eight patients were excluded from the study because of postoperative retinal reattachment or persisting secondary glaucoma. Five (17%) of the remaining patients had short-term postoperative increases in intraocular pressure that were treated successfully with 0.5% timolol and 0.1% dipivefrin eyedrops twice a day; they all remained in the study. The indications for silicone filling in the 30 patients remaining in the study were proliferative vitreoretinopathy in 20 cases, giant tears in six cases, and posterior retinal holes in four cases.

The electrophysiologic examinations included the recording of flash- and flicker-evoked cortical potentials before and after silicone surgery. Twenty-one patients were followed up for more than 50 days (mean  $\pm$  S.D., 179  $\pm$  103 days), and 13 of these patients were followed up for more than 150 days (238  $\pm$  64 days).

The examinations were performed with dilated pupils. The electrodes were placed in standard positions at the vertex and 2 cm above theinion. The ear served as the reference ground. A 100-diopter contact lens provided uniform retinal illumination. The light stimuli were of 10-msec duration, with a light intensity of 780 cd/m<sup>2</sup> in eyes with retinal detachment. Light stimuli were reduced by one logarithmic unit in eyes with attached retinas. First single flash stimuli were used, followed by flicker stimuli with the frequencies of 5, 10, 20, and 30 Hz (Fig. 1). Sixty-four responses were averaged with every stimulus.

We measured the amplitude of the flash-evoked cortical potential and the implicit time

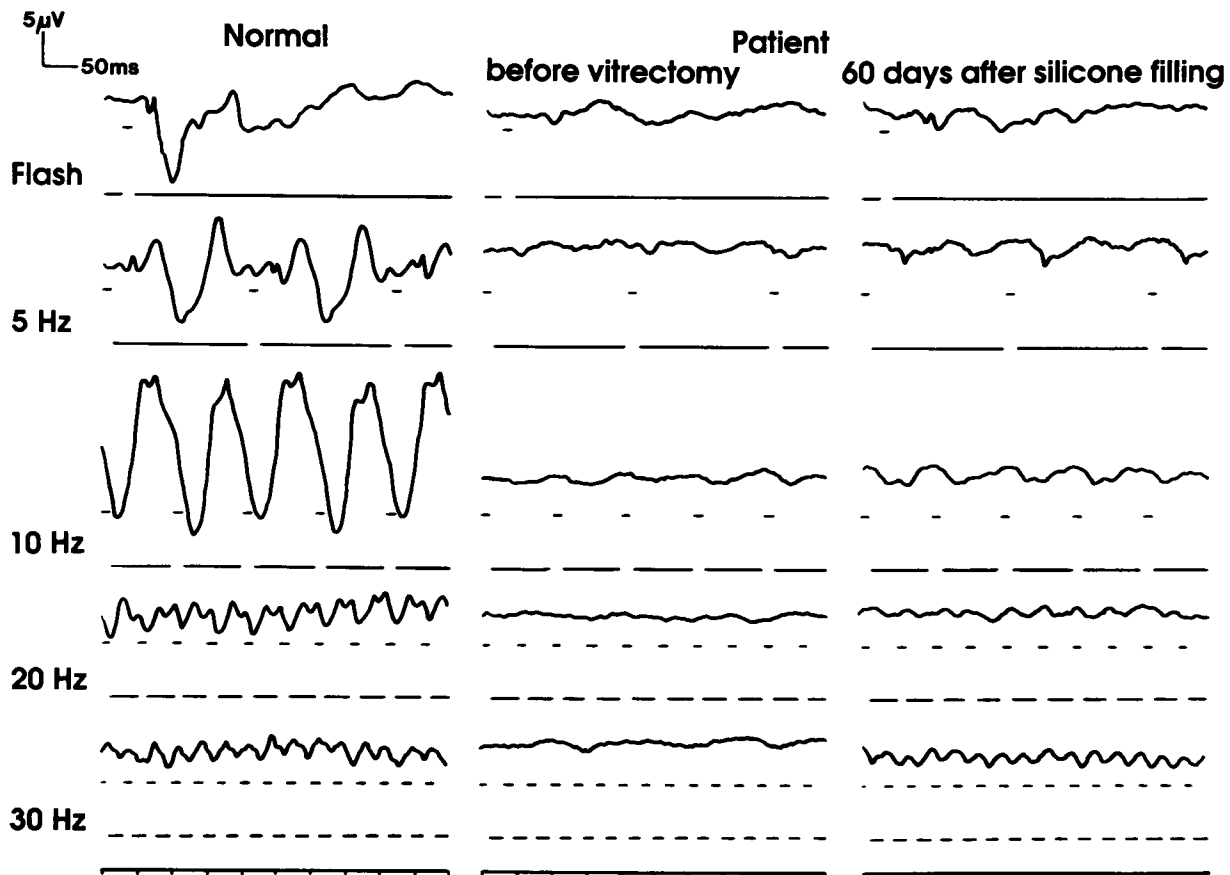


Fig. 1 (Kellner, Lucke, and Foerster). Flash- and flicker-evoked cortical potentials, stimulus duration 10 msec. Lower trace indicates the light stimuli. Upper trace is the average of 64 sweeps; positivity is recorded downward. Left column, Normal flash- and flicker-evoked cortical potential. Middle and right columns, Flash- and flicker-evoked cortical potentials before and after silicone filling because of proliferative vitreoretinopathy. Before surgery, the flicker responses were detectable up to 10 Hz with minimal amplitude; 60 days after surgery, the flicker-evoked cortical potential could be detected up to 30 Hz with increased amplitudes.

of the highest positive component, the P2-component. The amplitudes of the flicker-evoked cortical potentials were determined, and we estimated the highest frequency response. All normal fellow eyes responded to stimulus frequencies of up to 30 Hz (Table) or more. The high interindividual variance of the amplitudes of the flicker-evoked cortical potentials resulted in a wide normal range. Stimulus frequencies above 30 Hz were not analyzed because no significant data could be obtained at higher frequencies.

Of our 30 patients, 27 had a normal fellow eye. The visual-evoked cortical potentials of these eyes showed normal flicker responses at all frequencies tested.

TABLE  
NORMAL AMPLITUDES OF FLICKER-EVOKED  
CORTICAL POTENTIALS

STIMULUS FREQUENCY* (Hz)	MEAN $\pm$ 2 S.D. AMPLITUDE ( $\mu$ V)
Flash	22 $\pm$ 16
5	17 $\pm$ 8
10	17 $\pm$ 10
20	8 $\pm$ 5
30	6 $\pm$ 4.5
40	3.2 $\pm$ 3
50	1.5 $\pm$ 2

\*Stimulus frequencies above 30 Hz gave no statistically significant data.

## Results

Preoperatively, because of retinal detachment, all eyes had reduced amplitudes of the visual-evoked cortical potentials compared with the normal fellow eyes at all stimulus conditions. However, the reduced amplitudes were still within the low-normal range. Early and late flash-evoked cortical potential subcomponents representing rhythmic response characteristics had markedly reduced amplitudes. The implicit time of the P2-component was not different in eyes with retinal detachment compared to the normal fellow eyes. Flicker-evoked cortical potentials were found up to stimulus frequencies of 10 Hz in seven eyes, up to 20 Hz in 11 eyes, and up to 30 Hz in 12 eyes.

The postoperative amplitudes of the visual-evoked cortical potentials, after the retina was reattached, were increased from their preoperative values. The single flash-evoked cortical potential had more subcomponents than before vitrectomy. The implicit time of the P2-component did not change significantly. Figure 1 shows the flicker-evoked cortical potentials of a normal subject (left) and a typical patient before (middle) and 60 days after surgery (right).

The maximal frequency response did not decrease after surgery in any of the 30 study eyes. The results of the flicker-evoked cortical potentials in 21 eyes with a follow-up of more than 50 days are shown in Figure 2. Eight eyes had a 30-Hz flicker response preoperatively (the

highest flicker frequency tested) and had the same response at every follow-up examination. Ten of the remaining 13 eyes (77%) had an increased frequency response after silicone filling. In six of these ten eyes, this occurred immediately after surgery. No change occurred after surgery in three eyes with preoperatively reduced frequency responses.

Of the 13 eyes that were followed up for more than 150 days, five had a 30-Hz flicker stimulus response before surgery and at the last follow-up examination. Seven of the remaining eight eyes had flicker responses at higher frequencies at their last follow-up examination compared to preoperatively (Fig. 3).

One eye each underwent silicone removal after 158, 194, and 257 days. The amplitudes of the visual-evoked cortical potential did not change after compared to immediately before silicone removal. The frequency response was unchanged as well: two eyes had 30-Hz flicker responses and one eye 20-Hz flicker responses before and after silicone removal.

Ophthalmoscopically, we found no increasing excavation or paleness of the optic nerve head in any of the eyes during the study.

## Discussion

Histologic and electrophysiologic findings in human and animal eyes having undergone silicone surgery have been contradictory and different conclusions regarding liquid silicone toxicity have been made.<sup>9-15</sup> In enucleated eyes after silicone surgery, vacuole formation has

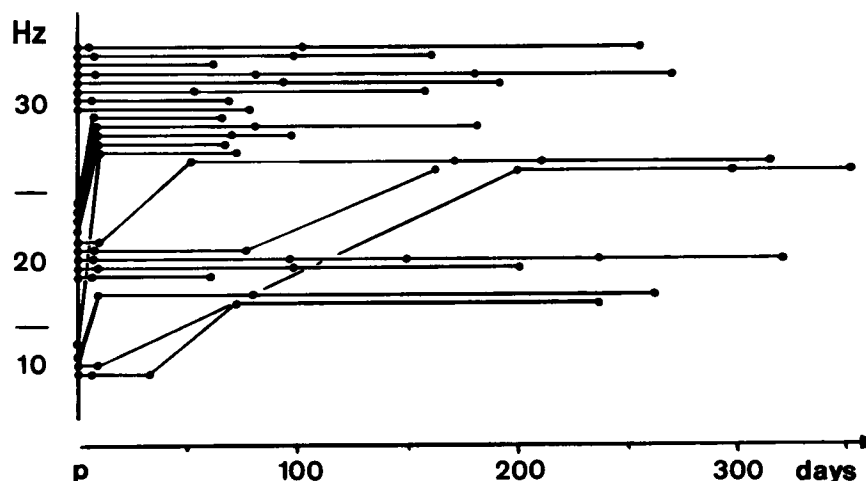


Fig. 2 (Kellner, Lucke, and Foerster). Flicker-evoked cortical potentials. Frequency responses at the preoperative (p) and postoperative follow-up examinations. Dots indicate the highest frequency response at a given examination. Each line represents one eye ( $n = 21$ ).

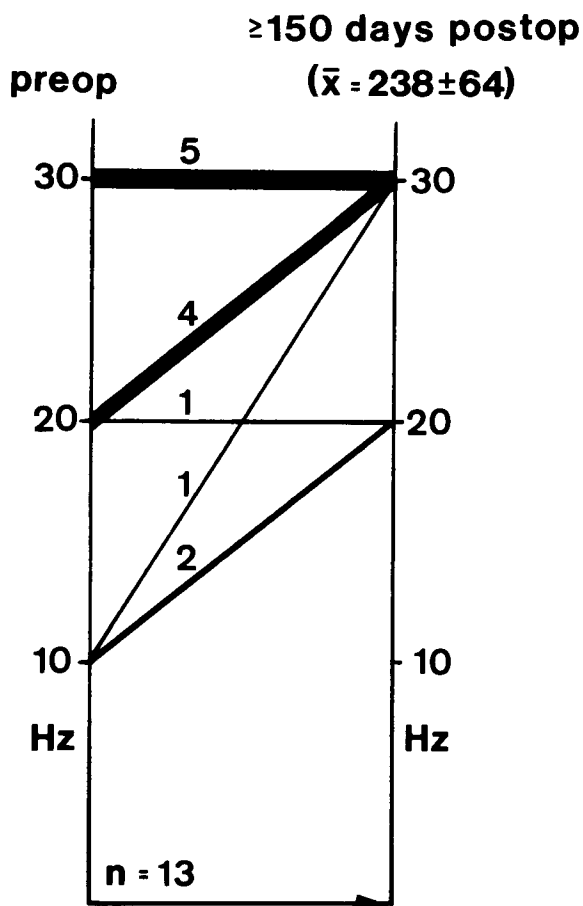


Fig. 3 (Kellner, Lucke, and Foerster). Flicker-evoked cortical potential. Highest frequency response preoperatively and at the last examination in eyes followed up for more than 150 days. Horizontal lines indicate unchanged frequency responses, oblique lines indicate changes.

been seen in the retina, the optic nerve, and even beyond the lamina cribrosa.<sup>11,16</sup> In animal experiments, vacuole formation and destruction of ganglion cells following silicone injection have been described.<sup>9,17</sup>

Pattern-evoked cortical potentials would be the most accurate method to determine optic nerve function. However, good visual acuity is necessary for this test. Because of the retinal detachments in our patients, visual acuity was insufficient to record pattern-evoked cortical potentials. However, a flash-evoked cortical potential alone does not provide reliable information about optic nerve function.<sup>18</sup> We therefore used flicker-evoked cortical potentials as an indicator of the transmission properties of the optic nerve.<sup>19,20</sup>

In our patients there was no deterioration of the transmission properties of the optic nerve during the silicone filling and after silicone removal within an observation period of up to 348 days. In most cases, optic nerve transmission was improved. Flicker responses were unaltered or appeared at higher stimulus frequencies over time.

We believe that the optic atrophy found in some patients undergoing silicone surgery can usually be attributed to increased intraocular pressure or vascular ischemic damage. There is no clinical or histologic<sup>12,15,21-23</sup> evidence to support the contention of a toxic effect of liquid silicone on the optic nerve. The swelling of the nerve fiber layer and the vacuolization and degeneration of ganglion cells described by some investigators<sup>9,17,24</sup> could not be reproduced by others and were judged as "results of procedures other than silicone injection."<sup>12</sup>

The histologic finding of silicone vacuoles in the optic nerve head of enucleated human eyes<sup>11,16</sup> was probably the result of long-standing severe disease, with retinal detachment and secondary glaucoma.<sup>14</sup> Therefore, these results cannot be compared with those of eyes operated on successfully.

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