

Comparison of Wave Amplitude and Implicit Time and Comfort Level Using Dawson-Trick-Litzkow Electrode, Jet Electrode and Dencott Electrode in Standard Full-field Electroretinography in Normal Indonesian Adults, Age 19-49, in Cipto Mangunkusumo National General Hospital

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Objectives

To establish normal values of standard full-field electroretinography (ERG) and to compare the values and the comfort level using DTL, Dencott and ERG jet electrode in Indonesian adults.

Methods

Through convenient sampling 58 normal Indonesian subjects between 19 and 49 years old were selected. ERG amplitudes and implicit time values were measured according to recommendations by the International Society for Clinical Electrophysiology of Vision (ISCEV). Evaluations consisted of scotopic 0.01 ERG, scotopic 3.0 ERG, scotopic 3.0 OP ERG and photopic 3.0 flicker. After the examination, all subjects filled in a questionnaire about comfort levels, adopted from the visual analog scale.

Results

We observed a statistically significant difference in ERG normal values between electrodes with higher wave amplitudes and longer implicit times in Dencott and jet electrodes, compared to DTL electrodes. Jet and DTL electrodes are more comfortable than Dencott electrodes for Indonesian adults in standard full-field electroretinography.

Conclusion

DTL electrodes give the lowest wave amplitudes and the shortest implicit times and are the most comfortable electrode compared to Dencott and ERG jet electrodes, in standard full-field electroretinography in Indonesian adults.

Keywords: Standard full-field electroretinography, Dencott, Dawson-Trick-Litzkow DTL, ERG Jet electrode, comfort level, normal Indonesian adult

Electroretinography is a very important type of examination since it can be used to evaluate the retina function objectively and can calculate the results in numbers. Electroretinography may serve as baseline data and follow up measurement for therapy, as well as a means to predict the prognosis of patients if surgery is considered.^{1,2} The International Society for Clinical Electrophysiology of Vision (ISCEV) recommends that every centre should have its own normal set of data because the characteristics of patient vary widely.^{3,4} Nowadays, there is quite a wide variety of electrode types which can be used for the electroretinography examination, such as scleral electrodes, corneal electrodes and eyelid

electrodes. In this research we limited the comparison to Dencott electrodes as the example of scleral electrodes, Jet electrodes as the example of corneal electrodes and Dawson-Trick-Litzkow (DTL) electrodes as the example of eyelid electrodes. This research aims not only to establish the normal values of standard full-field electroretinography at our hospital for the Indonesian population, but also to compare the values and comfort levels of using the 3 types of electrode in Indonesian adults.

METHODS

All 58 subjects, ages between 19-49 years old, were selected through convenient sampling and their normal status of both eyes were established through a series of examinations of visual acuity, intraocular pressure, Humphrey visual field, anterior segment evaluation, fundus photography, Ishihara colour blind test and Pelli-Robson contrast sensitivity test, over the course of April-August 2016. Subjects were excluded if they had high myopia (≥ 6 dioptres), a history of intraocular surgery or laser treatment (photocoagulation), eye trauma, long-term drug usage or difficulty in pupil dilation. The electroretinography examination was performed based on ISCEV recommendations. The order of electrode usage was randomised per subject, but all of the examinations was done on the same day for each subject by the same operator. The questionnaire about comfort levels, adopting the visual analog scale of a 10 centimetre line, was given to the subjects after they had completed all examinations. The score was later measured by ruler in centimetres. This research has been approved by The Ethical Committee of the Faculty and The Hospital based on the Helsinki Declaration.

RESULTS

From the 58 subjects recruited, 43 were female, totaling 116 eyes. Pearson / Spearman correlation showed moderate to strong correlation between the three electrodes in all of the parameters measured, as given in the table below.

Table 1. Correlation between Electrodes

Parameter	Correlation (r)		
	Dencott vs Jet	Dencott vs DTL	Jet vs DTL
Implicit time of b wave Scotopic 0.01	0.626	0.609	0.650
Amplitude of b wave Scotopic 0.01	0.604	0.436	0.572
Implicit time of a wave Scotopic 3.0	0.737	0.476	0.487
Amplitude of a wave Scotopic 3.0	0.564	0.358	0.388
Implicit time of b wave Scotopic 3.0	0.615	0.582	0.641
Amplitude of b wave Scotopic 3.0	0.826	0.668	0.649
Implicit time of OP wave	0.382	0.300	0.392
Sum amplitude of OP wave	0.787	0.584	0.688

Implicit time of b wave Photopic Flicker	0.623	0.565	0.636
Amplitude of b wave Photopic Flicker	0.640	0.467	0.584

Normal values of standard full-field electroretinography in Indonesian adults, using Dencott electrodes, Jet electrodes and DTL electrodes, are shown in the tables below. The p-values were obtained from the paired t-test analysis.

Table 2. Normal Values of Standard Full-field Electroretinography in Indonesian Adults

Parameter	Dencott	Jet	DTL
Imp.time b wave Scotopic 0.01	77 \pm 7	76 \pm 6	74 \pm 5
Amp. b wave Scotopic 0.01	293 (133-544)	332 (109-576)*	281 (146-444)
Imp.time a wave Scotopic 3.0	25 \pm 1	25 \pm 1	26 \pm 1
Amp. a wave Scotopic 3.0	-258 (-445;-138)	-281 (-459;-132)*	-271 (-358;-184)
Imp.time b wave Scotopic 3.0	45 \pm 3	46 \pm 4	47 \pm 4
Amp. b wave Scotopic 3.0	482 (315-737)	509 (261-771)*	471 (202-720)
Imp.time OP wave	21 \pm 1	21 \pm 1	21 \pm 1
Sum amp. OP wave	345 (106-589)	338 (149-797)	281 (107-710)
Imp.time b wave PhotoFlicker	29 \pm 2	29 \pm 2	29 \pm 2
Amp. b wave PhotoFlicker	105 (44-236)	108 (44-264)	98 (37-188)

*) p value < 0.05 compared with Dencott

^) p value < 0.05 compared with Jet

The mean comfort level score using each electrode and the paired t-test comparison between them are shown in the tables below.

Table 3. Mean Comfort Level Score of Electrode

Electrodes	Mean Comfort Level Score
Dencott	5.21 \pm 2.5
ERG Jet	6.93 \pm 2.3
DTL	7.64 \pm 1.8

Table 4. Comparison of Comfort Level between Electrodes

Electrode Comparison	p value
Dencott -- ERG Jet	0.001
Dencott -- DTL	0.001
ERG Jet - DTL	0.064

There were no side effects or complications, such as eye infection or corneal abrasion, in any of the subjects during this research.

DISCUSSION

Standard full-field electroretinography is an important clinical tool that provides an objective quantitative measure of retinal function. Decreased a and b wave amplitudes and prolonged implicit time correlate to reductions in retinal function.¹ Because of the wide variety of patient characteristics, ISCEV recommends that every laboratory should have its own normal data using ISCEV protocols so that it becomes comparable all over the world.^{1,3,4} However, until this time, there has been no research done in Indonesia regarding this matter.

Correlation analysis shows moderate to strong correlation between all parameters in the 3 electrodes. This explains that the higher the values collected with Dencott electrodes, the higher the values will be collected with the two other electrodes. This result is similar to the research conducted in Japan by Kuze, et al.⁵

The electrode order was randomized to eliminate the possibility of bias of eye fatigue or electrode type. The recording conditions also specify 20 minutes of dark adaptation before recording dark-adapted electroretinography (scotopic), and 10 minutes of light adaptation before recording light-adapted electroretinography (photopic) according to ISCEV standards.⁶

This research shows that ERG jet electrodes give a higher amplitude than the other electrodes, with DTL giving the lowest. This happens because the DTL is quite far located from the centre of the cornea if compared with Dencott or Jet electrodes.⁷ However, the implicit times are not significantly different between electrodes, even though the material of each electrode is different. Silver, the material of DTL electrodes, has the highest conductivity of $6.8 \times 10^7 (\Omega\text{m})^{-1}$, while gold, the material of Jet electrodes, has conductivity of $4.3 \times 10^7 (\Omega\text{m})^{-1}$.⁸

In Malaysia and Iran adults the normal values of scotopic a and b wave amplitude is lower than in the Indonesian population when the recording is done by using DTL electrodes.^{9,10} Similar results are shown in research from Korea using Jet electrodes, which show lower results of wave amplitudes compared to the Indonesian population.¹¹ However, it proved difficult to compare this research's results with other

research, because the differences of electroretinography machines, as well as the electrodes, may contribute to a variety in results.

Race is known to be another factor that contributes to the difference of results. One research, comparing the Caucasian and Asian populations, showed that Caucasians tend to have a higher wave amplitude than Asians. The hypothesis of what cause this is said to be the ocular pigmentation, in which melanine serves as a resistant barrier for the electroretinography wave signal.¹²

The results from the questionnaires given to the subjects reveal that DTL electrodes give the most comfort of the three electrodes used: This is because of the position of the electrode, which is buried deep in the lower fornix, thus barely being in contact with the cornea. The electrode's position is stable as well, as the position is not necessarily affected by blinking of the eye. However, statistical analysis shows that there is no significant difference between DTL and Jet electrodes, which are shaped as contact lens touching the cornea.

The most ideal electrode is the one that give the highest amplitude, has low variability, and is well-tolerated by the patients (most comfortable). The study by Mohidin N, et al shows that corneal electrodes such as Jet electrode may give a high variability because it tends to easily slide during blinking.¹³ This makes the DTL as a non-corneal electrode a more favourable choice, as its variability is low due to its stable position.¹⁴ Dencott electrodes are the least favourable electrode due to their discomfort, caused by their bulky shape. However, its long legs make it stable, because once it is positioned well on the eye surface, it will not move even with rapid eye blinking.

CONCLUSION

There is a statistically significant difference in the wave amplitudes between Dencott, Jet and DTL electrodes. DTL and ERG jet electrodes are the most comfortable electrodes in standard full-field electroretinography for normal Indonesian adults.

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Questionnaire of Subject's Comfort Level Score

Comfort Level of Using Electrodes in Standard Full-field Electroretinography Examination

Please mark along the lines below to state how comfortable you were in using the electrodes in the electroretinography examination that was just done.

Electrode I



Very

Uncomfortable

0

Very



Comfortable

10

Electrode II



Very

Uncomfortable

0

Very



Comfortable

10

Electrode III



Very

Uncomfortable

0

Very



Comfortable

10