SCIENTIFIC CORRESPONDENCE

Visual results and complications of temporal incision phacoemulsification performed with the non-dominant left hand by junior ophthalmologists

T Kageyama, S Yaguchi, Y Metori, M Chida, K Koizumi, T Onishi, M Ayaki

Br J Ophthalmol 2002;**86**:1222–1224

Aims: To assess the results of temporal incision phacoemulsification and aspiration performed with dominant and non-dominant hand of ophthalmology trainees.
Methods: Retrospective analysis were made of 203 surgeries with dominant hand and 207 with non-dominant by five trainees at two institutions. Trainees sat at the patient's head, manipulating instruments with the dominant right hand for the right eye, and the non-dominant left hand for the left eye.
Results: Vitreous loss occurred in 12 (5.9%) of 203 dominant operated eyes and seven (3.4%) of 207 non-dominant operated eyes. The rate of endothelial cell loss was 6.1% (9.8%) in dominant and 7.4% (12.4%) in non-dominant. Mean ultrasound time were 1.81 (0.70) minutes in dominant and 1.78 (0.78) minutes in non-dominant. One trainee showed statistically significant excesses in incidence of vitreous loss in dominant operated eyes (8.7%, p=0.0270), and one showed statistically significant prolongation of the operation in non-dominant operated eyes (26.3 minutes, p=0.0315). In all other trainees, all parameters had no difference in both sides.
Conclusions: Ophthalmology trainees could successfully learn the technique with both hands. The authors consider that the skill of the non-dominant hand may be knowledge based and that surgeons avoid mistakes by mental efforts.

The temporal incision procedure of phacoemulsification and aspiration (PEA) is used by more than half of the cataract surgeons according to the latest ASCRS survey in 2000.[1] Surgeons are usually seated at the patient's side for the procedure; however, this requires repositioning of the surgeon's chair and surgical equipment if the next surgery is on the opposite side. Such a task greatly increases staff requirements in the operating room, risk of infection, and miscellaneous incidents. To avoid such repositioning, we developed a technique for performing phacoemulsification while seated at the patient's head. The incision is made and the phaco tip is manipulated with the surgeon's right hand for the right eye, and the left hand for the left. Concern arose about difficulty in learning this procedure because it demands skill of the non-dominant hand. We made a retrospective analysis of the results of our technique performed with dominant versus non-dominant hand, considering outcomes of PEA by ophthalmology trainees at two institutions.

PATIENTS AND METHODS

We reviewed the records of consecutive PEA procedures using the temporal incision technique performed by four trainees (A, B, C, D) in the division of ophthalmology at Showa University Fujigaoka Hospital (USFH) between June 1997 and June 2000, and one trainee (E) in ophthalmology at the Takatsu General Hospital (TGH) between October 1998 and June 2000. All surgeons were right handed and manipulated surgical instruments with the dominant right hand for the right eye and with the non-dominant left hand for the left eye.

Table 1 Numbers of cases, visual results, and intraoperative measurements

Trainee	Operation side	No of patients	Preoperative visual acuity*	p Value	Postoperative visual acuity*	p Value	Ultrasound time†	p Value	Mean duration of operative procedure†	p Value
A	R	45	0.35	0.175	0.95	0.081	1.46 (0.52)	0.8329	17.0 (6.7)	0.1724
	L	55	0.43		1.06		1.48 (0.56)		18.8 (5.8)	
B	R	46	0.45	0.500	0.91	0.855	1.69 (0.59)	0.7114	20.3 (6.0)	0.7005
	L	54	0.41		0.92		1.64 (0.60)		20.8 (5.3)	
C	R	29	0.46	0.100	0.94	0.960	2.44 (0.62)	0.5917	22.5 (3.7)	0.0315
	L	24	0.36		0.94		2.58 (1.06)		26.3 (6.8)	
D	R	34	0.40	0.461	0.88	0.642	1.88 (0.77)	0.7862	22.6 (4.0)	0.6673
	L	27	0.45		0.84		1.83 (0.65)		23.2 (5.5)	
E	R	49	0.51	0.492	1.05	0.764	–	–	20.5 (4.6)	0.9471
	L	47	0.48		1.07		–		20.4 (4.4)	

*Visual acuity is calculated as a geometric mean. †Values are represented as the mean (SD) in minutes.

Table 2 Intraoperative complications

Complication	Number of patients (%) in each group																
	Trainee A			Trainee B			Trainee C			Trainee D			Trainee E			Total	
	R	L	Total	R	L	Total	R	L	Total	R	L	Total	R	L	Total	R	L
Posterior capsule tear with vitreous loss	3 (6.7)	3 (5.5)	6 (6.0)	4 (8.7)	0 (0.0)	4 (4.0)	1 (3.4)	1 (4.2)	2 (3.8)	2 (5.9)	2 (7.4)	4 (6.6)	2 (4.1)	1 (2.1)	3 (3.1)	12 (5.9)	7 (3.4)
Posterior capsule tear without vitreous loss	0 (0.0)	1 (1.8)	1 (1.0)	3 (6.5)	0 (0.0)	3 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.9)	2 (7.4)	3 (4.9)	0 (0.0)	0 (0.0)	0 (0.0)	4 (2.0)	3 (1.4)
Slight wound burn	3 (6.7)	4 (7.3)	7 (7.0)	4 (8.7)	6 (11.1)	10 (10.0)	7 (24.1)	5 (20.8)	12 (22.6)	3 (8.8)	2 (7.4)	5 (8.2)	0 (0.0)	1 (2.1)	1 (1.0)	17 (8.4)	18 (8.7)
Iris damage	4 (8.9)	1 (1.8)	5 (5.0)	1 (2.2)	0 (0.0)	1 (1.0)	0 (0.0)	1 (4.2)	1 (1.9)	2 (5.9)	0 (0.0)	2 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	7 (3.4)	2 (1.0)
Total	10 (22.2)	9 (16.4)	19 (19.0)	12 (26.1)	6 (11.1)	18 (18.0)	8 (27.6)	7 (29.2)	15 (28.3)	8 (23.5)	6 (22.2)	14 (23.0)	2 (4.1)	2 (4.3)	4 (4.2)	40 (19.7)	30 (14.5)

A total of 410 eyes were included in the analysis; 314 (76.6%) eyes were operated on at USFH, and 96 (23.4%) eyes at TGH. Trainee A had 1 year's experience, and trainee B had 6 months of experience of conventional PEA procedure before training. Trainees C, D, and E had no experience of PEA.

We recorded the patient's age, postoperative follow up period, best corrected preoperative and postoperative visual acuity, surgical complications, ultrasound (US) time, and operative time. Using a specular microscope (SP-8000; Konan, Hyogo, Japan), corneal endothelial cell loss was assessed 3–6 months after the surgery. US time and endothelial cell loss were recorded only in cases at USFH. Student's *t* test and Fisher's exact probability test were used for statistical analysis.

RESULTS

Patients ranged from 16 to 93 years in age, with a mean of 73. Postoperative follow up ranged from 1 to 30 months, with a mean of 6.0 months. As shown in Table 1, 203 right eyes and 207 left eyes were operated.

Posterior capsule tear occurred in 26 (6.3%) eyes, 16 (7.9%) in the right and 10 (4.8%) in the left (Table 2). Vitreous loss occurred in 19 (4.6%) eyes, 12 (5.9%) in the right and seven (3.4%) in the left. No statistically significant difference in the incidence of vitreous loss was noted between both sides ($p=0.2231$). The highest incidence (8.7%) of vitreous loss among them was noted in right eyes operated on by trainee B. He only showed statistically significant excesses in the dominant right hand ($p=0.0270$).

Iris damage occurred in seven (3.4%) right eyes and two (1.0%) left eyes. Wound burn occurred in 17 (8.4%) right eyes and in 18 (8.7%) left eyes. Mean US time was 1.8 (SD 0.7) minutes for the right eyes and 1.8 (0.8) minutes for the left ($p=0.7526$). Postoperative corneal endothelial cell counts were performed in 243 eyes operated at USFH (Table 3). Overall, endothelial cell loss was 6.8% (11.2%), 6.1% (9.8%) in the right and 7.4% (12.4%) in the left ($p=0.3723$). In each parameter, no trainee showed statistically significant difference between both sides.

Mean operative time was significantly greater in the left (26.3 minutes) than the right (22.5 minutes) in trainee C ($p=0.0315$), and others showed no difference. One hundred and eighty seven (92.1%) right eyes and 187 (90.3%) left eyes attained best corrected visual acuity of 0.5 or better.

DISCUSSION

The first aim of this study was to determine whether the surgical results are different between operation sides and the second was to analyse human factors in learning surgical procedures from the psychological point of view. There is a great deal of literature on human factor contribution to nuclear power plants, etc, but only a few in surgery, particularly in ophthalmology.[2 3] Our incidence of complications was, in either right or left hand surgery, comparable to that of other reports of conventional superior incision procedure by trainees.[4–7] Overall, there was no statistically significant difference in the incidence of intraoperative complications and visual results between both sides.

Interestingly, the overall rate of complications was lower in non-dominant operated eyes (14.5%) compared to dominant operated eyes (19.7%), although this was not significant. The possible explanation for this counterintuitive result is as follows. The nature of human error is classified under three types within the generic error modelling system (GEMS)—skill based (SB) slips and lapses, ruled based (RB) mistakes, and knowledge based (KB) mistakes.[8] Errors at the SB level occur during routine actions in a familiar environment and are attributed mainly to monitoring failures. On the other hand, RB and KB mistakes occur during problem solving activity. RB level is a pattern matching and rule applying procedure, and the rules are established by previous experiences. RB mistakes

Table 3 Corneal endothelial cell density in the surgically treated eye*

Trainee	Eye	Preoperative	Postoperative (3–6 months)	Endothelial cell loss (%)	Sample size (No of patient)	p Value
A	R	2751 (213)	2629 (202)	4.3 (4.4)	37	0.685
A	L	2786 (181)	2654 (248)	4.8 (5.8)	47	
B	R	2775 (247)	2549 (442)	8.1 (14.3)	35	0.656
B	L	2742 (186)	2576 (439)	6.6 (14.0)	36	
C	R	2730 (213)	2612 (158)	4.1 (4.9)	24	0.159
C	L	2828 (225)	2644 (234)	6.4 (5.7)	19	
D	R	2751 (410)	2889 (186)	8.2 (10.5)	26	0.110
D	L	2522 (467)	2432 (601)	15.8 (20.2)	19	

*Values are represented as the mean (SD) (/mm^2).

could arise from the misapplication of good rules and/or application of bad rules. KB level is effortful online processing activity, and KB mistakes occur in new or unfamiliar situations where the solution to a problem has to be analysed and solved directly at the time without utilising any pre-package or pre-formulated solution.[8]

When we assess the human factor in learning PEA along the GEMS, the main mechanism of intraoperative complications with the dominant hand may be classified as RB mistakes, and they proceed to the SB level later. For instance, the trainee damages the posterior capsule because he/she misreads the fact that the nucleus will not rotate after incomplete hydrodissection (the application of bad rules), or aspirates posterior capsule during PEA of the hard nucleus, failing to modify the adequate vacuum level (misapplication of good rules). After initial training, he/she may make SB mistakes such as vitreous loss due to failure of execution or monitoring of implementation.

On the other hand, the mechanism of intraoperative complications in the non-dominant hand is likely to be a different, KB, mistake. It happens when the individual has "run out" of applicable problem solving routines and is forced to resort to attentional processing within the conscious workspace.[8] Actually, all of the instrument manipulation is the performance at the KB level for the non-dominant hand—that is, inserting instruments into the anterior chamber, holding the nucleus with phaco tip, delivery of intraocular lens, etc. Considering KB techniques require concentrated and powerful mental efforts, it may be acceptable that the complication rate with the non-dominant hand was substantially lower than that with dominant hand, although it seems counterintuitive.

In conclusion, the present study demonstrated ophthalmology trainees who lacked experience in PEA successfully learned temporal incision PEA with excellent surgical results even when they used non-dominant hands, although this study has limitations; it was retrospective and at only two study centres. The non-dominant hand can achieve satisfactory surgical skills, probably through the surgeon avoiding knowledge based mistakes by their mental efforts.

Authors' affiliations
T Kageyama, S Yaguchi, Y Metori, M Chida, K Koizumi, T Onishi, M Ayaki, Department of Ophthalmology, Showa University School of Medicine, Fujigaoka Hospital, 1-30 Fujigaoka, Aoba-ku, Yokohama, 227-8501, Japan

Correspondence to: Dr Kageyama

Accepted for publication 25 May 2002

REFERENCES

1 **Leaming DV**. Practice style and preferences of ASCRS members—2000 survey. *J Cataract Refract Surg* 2001;**27**:948–55.
2 **Reason JT**. The Chernobyl errors. *Bull Br Psychol Soc* 1987;**40**:201–6.
3 **Rasmussen J**. Human errors: a taxonomy for describing human malfunction in industrial installations. *J Occupational Accidents* 1982;**4**:311–35.
4 **Allinson RW**, Metrikin DC, Fante RG. Incidence of vitreous loss among third-year residents performing phacoemulsification. *Ophthalmology* 1992;**99**:726–30.
5 **Cruz OA**, Wallace GW, Gay CA, *et al*. Visual results and complications of phacoemulsification with intraocular lens implantation performed by ophthalmology residents. *Ophthalmology* 1992;**99**:448–52.
6 **Corey RP**, Olson RJ. Surgical outcomes of cataract extractions performed by residents using phacoemulsification. *J Cataract Refract Surg* 1998;**24**:66–72.
7 **Hayashi K**, Nakao F, Hayashi F. Corneal endothelial cell loss after phacoemulsification using nuclear cracking procedures. *J Cataract Refract Surg* 1994;**20**:44–7.
8 **Reason J**. *Human error*. Cambridge: Cambridge University Press, 1990:53–96.

Visual results and complications of temporal incision phacoemulsification performed with the non-dominant left hand by junior ophthalmologists

T Kageyama, S Yaguchi, Y Metori, M Chida, K Koizumi, T Onishi and M Ayaki

Br J Ophthalmol 2002 86: 1222-1224
doi: 10.1136/bjo.86.11.1222