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ORIGINAL RESEARCH

Evaluation of the Efficiency of a Digital Workflow for Cataract Planning in Patients with Astigmatism

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Video abstract

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Purpose: To evaluate the efficiency and associated costs of a digital cataract workflow system and manual cataract workflow system for patients, with astigmatism presenting for cataract surgery in Brisbane, Australia.

Patients and Methods: Sixty patients with bilateral cataract requiring toric intraocular lenses (IOL) were sequentially assigned to a manual cataract workflow (n = 30) or digital workflow (n = 30) using EQ Workplace (SW v1.7.0) running on FORUM (SW v.4.2.1.66) (Carl Zeiss Meditec, Jena, Germany). Each step of preoperative data acquisition and analysis was timed. Steps in each workflow were divided into presurgical planning time and total workflow time, the latter including the time required to input toric data into CALLISTO eye (Carl Zeiss Meditec). Secondary outcomes included staff costs within each workflow.

Results: Median presurgical planning time using a digital workflow process was 6.51 ± 0.65 minutes, and using a manual workflow process, 12.32 ± 0.56 minutes ($p < 0.001$). Similarly, median total workflow time using a digital workflow process was 6.93 ± 0.57 minutes and using a manual workflow process, 13.49 ± 0.47 minutes ($p < 0.001$). Evaluating the staff remuneration during presurgical planning and the operating costs associated with running EQ Workplace, there was a cost-reduction of 35% per patient when using the digital cataract workflow process.

Conclusion: Using a digital cataract workflow process is more efficient and provides staff cost-savings compared to a manual workflow process when planning for toric IOL implantation.

Plain Language Summary: The prevalence of both cataracts and cataract surgery is known to be increasing in Australia and other economically developed countries. During cataract surgery, an individual's natural lens is removed, and an artificial lens (known as an intraocular lens or IOL) is inserted. Many patients elect to correct their astigmatism at the time of their cataract surgery by choosing to have a specific type of IOL, called a toric lens, implanted, which should reduce their dependence on spectacles following surgery. Ophthalmology clinics and clinical staff can spend significant time accurately planning and selecting a toric IOL in preparation for surgery. We evaluated the time spent on toric IOL planning in a digital workflow versus a manual workflow. There was a significant reduction in time (and therefore reduced staffing costs) with the digital workflow. Digital workflows offer improved efficiency and can be more cost-effective, both of which are important when meeting the increasing demands and rates of cataract surgery.

Keywords: cataract, astigmatism, workflow

Introduction

The prevalence of both cataracts and cataract surgery is known to be increasing,[1,2] and the cataract surgical rate in Australia and other economically developed countries ranges from 4000 to 10,000 per 1 million.[2] A recent National Eye Health Survey found the overall weighted prevalence of visually significant cataract was 2.7% in non-Indigenous Australians and 4.3% in Indigenous Australians;[3] thus, cataract remains a leading cause of visual impairment and blindness in Australia.[4,5] Patients presenting for cataract surgery often have increased expectations with respect to the

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visual and refractive outcomes following surgery. Preoperative astigmatism is generally correctable with the use of a toric intraocular lens (IOL).[6,7] As clinicians, we can now measure total corneal astigmatism and provide several different types of toric IOLs to achieve these demanding patient goals.[6–10] In Australia, Goggin estimated that the toric IOL implantation rate is approximately 30%.[11]

However, significant time or manpower is often involved in accurate calculations for toric IOL placement.[9] Extensive presurgical planning is necessary to ensure proper toric IOL selection;[9] and this includes individual eye calculations using advanced technology biometers, such as swept-source optical coherence tomography or by using an external toric calculator website. The latter of these processes involves manually transcribing biometric data from the biometer to the website. This can be time-consuming and a potentially inefficient use of staff time for busy practices. Additionally, manual transcribing may inadvertently lead to transcription errors and subsequently postsurgical refractive surprises. To mitigate transcription errors, some practices implement multiple check points across multiple staff members, which results in increased operating costs.

Brunner et al recently found that both diagnostic and surgical times were reduced when using a digital workflow process on one eye compared to a manual process on the fellow eye.[12] The purpose of this study was to assess if the incorporation of a digital workflow would reduce the time spent and costs associated with the preoperative processes necessary for toric IOL calculation when compared to a manual workflow process.

Materials and Methods

Study Design

This single-centre, prospective, randomized study enrolled 60 patients who presented with bilateral visually significant cataract and astigmatism, and who would be candidates for toric IOL insertion as calculated by the Barrett true-keratometry (TK) formula. Patients were excluded from study consideration if they presented with any ocular pathology that might affect preoperative biometric measurements, including (but not limited to) pseudoexfoliation syndrome, maculopathy, corneal pathology affecting optical zone (including irregular astigmatism), manifest glaucoma, prior ocular surgery (including laser vision correction), and diabetic retinopathy. Patients who were candidates for toric IOLs in powers greater than those stocked locally by the IOL manufacturer were also excluded.

This Low Negligible Risk study (HREC 2020-06-551) was approved by Bellberry Human Research Ethics Committee (Bellberry Ltd, Australia), and deemed exempt from clinical trial registry as the study is observational. All data was handled in accordance with the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (2007, incorporating all updates) and abided by the Declaration of Helsinki. Informed consent was obtained from all patients prior to proceeding with surgery.

Participants were sequentially allocated to one of two cohorts: the first 30 were assigned to undergo preoperative biometric assessments via a manual workflow, and the subsequent 30 patients underwent the same biometric assessments via a digital workflow using EQ Workplace (SW v1.7.0), running on the FORUM (SW v.4.2.1.66) platform (Carl Zeiss Meditec AG, Jena, Germany). EQ Workplace allows users to remotely plan for cataract surgery. Surgical plans incorporating IOL data and surgeon preferences are then imported from EQ Workplace into CALLISTO eye (Carl Zeiss Meditec) via a USB or EQ Mobile, an iOS software which allows secure remote management of all upcoming surgical plans. Figure 1 summarizes the steps followed in each workflow. Each step of each workflow was timed by one of four trained staff members (qualified optometrist or ophthalmic technician). Steps in each workflow were divided into presurgical planning time and total workflow time. All cataract surgery was performed by one surgeon (MR). Surgical time was not included in analyses.

All demographic data, including patient age and gender, preoperative biometric measures, preoperative uncorrected distance visual acuity (UDVA) and corrected distance visual acuity (CDVA), and preoperative refraction (including spherical power, cylinder power and axis) were obtained at the time of participant enrolment. Each participant underwent biometry measurements on the IOLMaster 700 (Carl Zeiss Meditec) and the Barrett TK toric formula within IOL Master 700 (for the manual workflow) or EQ Workplace (for the digital workflow) was used for all IOL calculations.. The specifications of the toric IOL required for each eye were recorded, including IOL spherical power, IOL cylinder power

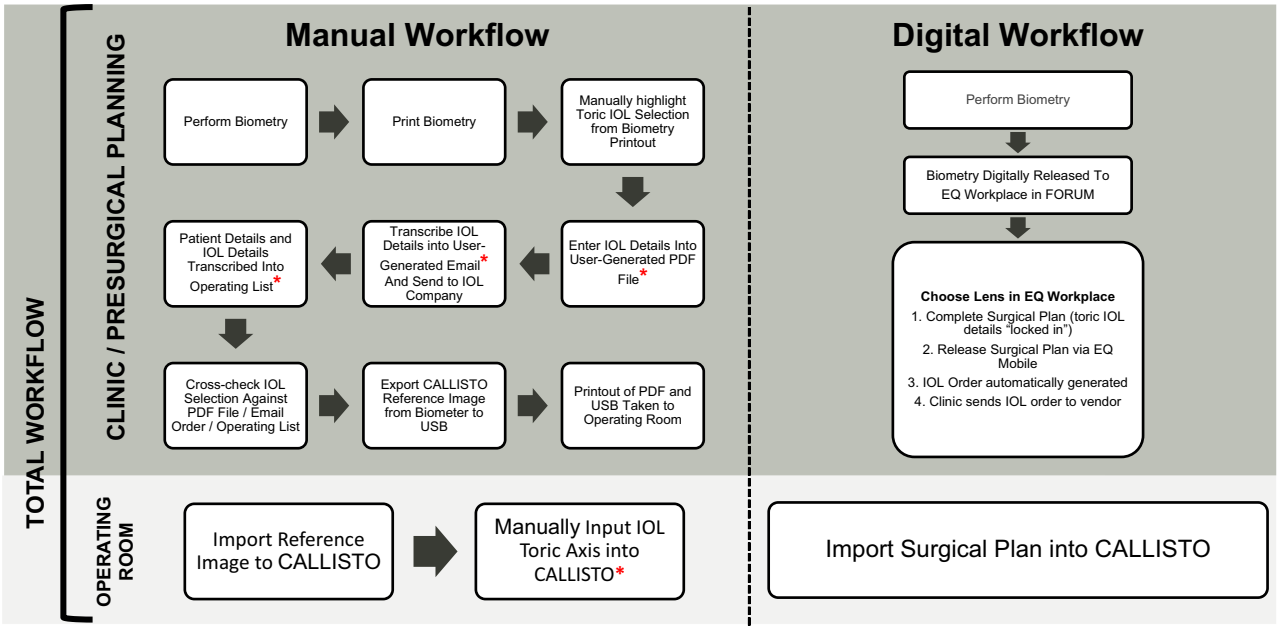

Figure 1 Flowchart summarising the steps followed in the manual and digital workflows. The asterisk (*) denotes specific steps in the manual workflow at which transcription errors could potentially occur.

and intended toric IOL implant axis. (Authors' note: The remainder of patient care continued as per traditional clinic follow-up care post-surgery, with postoperative visits at 4–6 weeks after second eye surgery, where UDVA, CDVA, and refraction information were obtained; patients were also dilated with 1% tropicamide to assess the location of the IOL toric marker and to allow for comparison against the intended implant axis. These data points were not part of this study and will not be reported.)

Data Analysis

Descriptive statistics were calculated for all outcome variables and reported in median with interquartile range (IQR). Mann–Whitney *U*-tests were used to discriminate between the type of workflows (manual or digital) by age, preoperative data and toric IOL powers. Non-parametric clustered quantile regression was used to compare effective time required in the two workflows, with adjustment for clustering by eye. Secondary analyses included staff costs and/or savings. Statistical analysis was performed with StataCorp (v.17, StataCorp LLC) and Excel 365 for Windows (v.2205, Microsoft).

Results

A total of 120 eyes (60 patients) were analysed, divided evenly between the manual workflow (14 females and 16 males) and digital workflow (16 females and 14 males). Baseline spread of genders, preoperative UDVA, preoperative mean spherical equivalent (MSE) refractive error, preoperative CDVA, and preoperative biometric data between the two cohorts were similar. Patients were also recommended similar toric power IOLs. Table 1 shows the distribution of the preoperative data points.

The median presurgical planning time was 6.51 ± 0.65 minutes when using a digital workflow and 12.32 ± 0.56 minutes when using a manual workflow ($p < 0.001$; Figure 2a). The median total workflow time using a digital workflow was 6.93 ± 0.57 minutes compared to 13.49 ± 0.47 minutes when using the manual workflow ($p < 0.001$; see Figure 2b). Neither age nor gender impacted presurgical or total workflow time in either group.

Secondary Outcomes

To calculate the potential cost-savings associated with the digital workflow, the following equation was used:

Table 1 Distribution of Preoperative Data

	Manual Workflow (Median (IQR))	Digital Workflow (Median (IQR))	P value
Age (years)	73.5 (7.0)	76.0 (11.0)	0.193
Preoperative UDVA (logMAR)	0.65 (0.58)	0.54 (0.54)	0.264
Preoperative MSE (D)	0.88 (4.03)	0.56 (2.87)	0.808
Preoperative CDVA (logMAR)	0.22 (0.20)	0.22 (0.18)	0.468
Preoperative Biometric Data			
Axial Length (mm)	23.86 (1.20)	23.99 (1.60)	0.973
Anterior Chamber Depth (mm)	3.16 (0.39)	3.16 (0.47)	0.591
SE Corneal Power (D)	43.48 (2.08)	43.68 (2.07)	0.881
Corneal Astigmatism (D)	1.10 (0.77)	0.97 (0.61)	0.119
Total SE Corneal Power (D)	43.63 (2.22)	43.72 (1.90)	1.0
Total Corneal Astigmatism (D)	1.17 (0.71)	1.01 (0.67)	0.052
IOL Toric Power (D)	1.50 (0.75)	1.50 (0.75)	0.810

Abbreviations: IQR, interquartile range; UDVA, uncorrected distance visual acuity; logMAR, log of the Minimum Angle of Resolution; MSE, mean spherical equivalent; D, dioptre; CDVA, corrected distance visual acuity; SE, spherical equivalent; IOL, intraocular lens.

$$\left[\frac{(hourly\ wage \times\ time\ spent\ on\ manual\ steps)}{(hourly\ wage \times\ time\ spent\ on\ EQ\ steps)}\right] - annual\ subscription\ fees \times 100$$

Our clinic support staff currently earn AUD40.00 (USD26.00) per hour. The same support staff spend 15 hours/week on cataract-related processes. Thus, when using the above formula, the digital workflow equated to a cost-reduction of 35%; this can be extrapolated to an annual cost-savings of more than AUD 10,000 (USD 6,600).

Discussion

This study found that using a digital workflow process was more efficient than a manual workflow process for toric IOL planning. Additionally, the time saved using the digital workflow process equates to an annual cost savings in our clinic of more than AUD 10,000 (USD 6,600).

Our study supports previous findings that a digital workflow in cataract surgery is beneficial. Brunner et al[12] compared a manual approach of biometry assessment, data export, IOL calculations, and surgery time to a digital cataract workflow with digital data transfer and found that the manual process took about 23 minutes compared to about

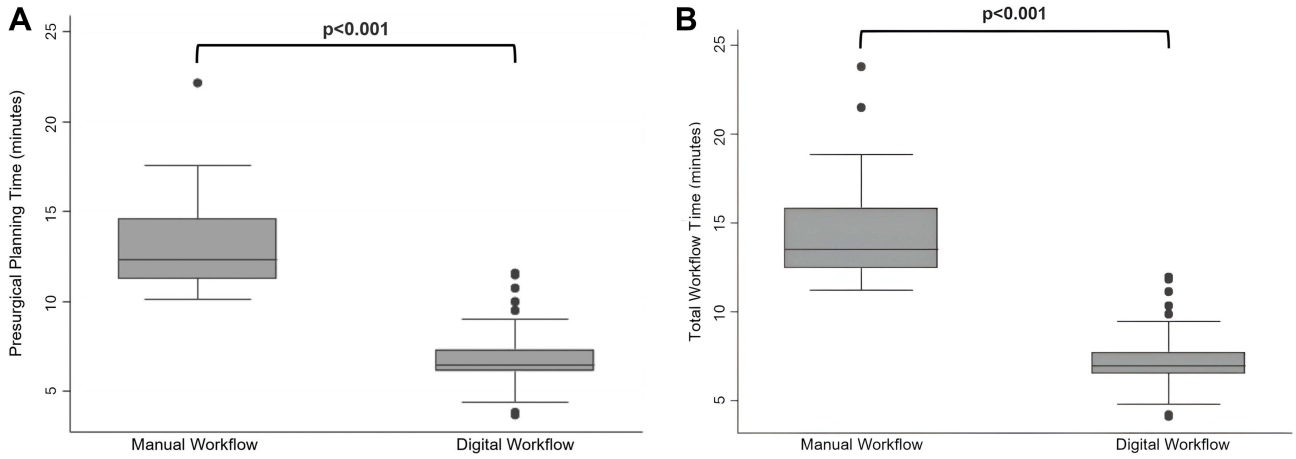

Figure 2 (**A**) Boxplot showing the difference in presurgical planning time between the manual workflow (12.32 ± 0.56 minutes) and digital workflow (6.51 ± 0.65 minutes). (**B**) Boxplot showing the difference in total workflow time between the manual workflow (13.49 ± 0.47 minutes) and digital workflow (6.93 ± 0.57 minutes).

19 minutes with the digital workflow ($p < 0.001$). In this study, we specifically focused on the processes involved in planning for the implantation of toric IOLs and did not include surgical time. Our results suggest that a digital workflow not only reduces time and cost, thereby allowing support staff to be more efficient and increasing clinic throughput, but it also invaluably offers increased peace of mind by lowering the risk of transcription and human error.

This study is not without limitations, including the possibility of inherent bias from sequential assignment of patients to each workflow, as opposed to adopting a randomised approach. However, any learning effects that could have confounded results would have existed within each workflow. Additionally, there were different toric IOLs chosen across the patient population. The majority of toric IOL models were the same in both groups, and as we did not evaluate the surgical time needed to implant the lens, but merely the time it took to prepare for the implantation, it is unlikely the choice of IOL would have impacted results. It was also not possible to compare the efficiency of the ZEISS Cataract Workflow against other digital cataract workflows—to the best of our knowledge, ZEISS Cataract Workflow was the only commercially available fully digital cataract solution in Australia at the time of the study. Overall, we feel that these limitations are more than offset by the real-world component of this study.

We believe the potential improvements in clinic staff efficiency and cost-savings associated with EQ Workplace offset the initial investment and subscription fees associated with running and maintaining the platform. Moreover, while outside the scope of this paper, we believe that the cost-savings of AUD 10,000 (USD 6,600) is conservative when considering the mitigation of transcription errors and the potential costs associated with surgically rectifying an incorrectly positioned IOL.

As the role of digital workflows is likely to increase, surgeons will continue to need secure and trustworthy processes that can meet the demands of increased cataract surgical rates and patient expectations. Future investigations comparing the refractive outcomes and toric axis alignment of a digital workflow against a manual workflow are warranted.

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