Research Article

Evaluation of Autonomous Subjective Refraction Powered by Glasspop Algorithm versus Standard Subjective Refraction: A Comparative Study.

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Introduction

Since the 18th century, men invented spinning machines, steam locomotives, steal, and found petrol to economize their muscles.

In 1971, Gordon Earle Moore, by inventing the microprocessor, opened the door to a new kind of revolution, the automatic calculation to empower the human brain.

There, legendary innovators and entrepreneurs make it a general-purpose technology to tackle our daily lives problems.

What was the common denominator of all these successful innovations?

Founders always built something a lot of people want. And what they want are products that solve their daily problems.

Accessibility and affordability of healthcare will undoubtedly be one of our biggest challenges in the coming years.

Nowadays, the level of knowledge accumulated, and its growth velocity is impressive. The issue is not much about progress but about how we will deliver it for all.

For several years, algorithms are tested to replace the gold-standard subjective refraction (SSR). Semi-automated processes are trying to help assistant to perform refraction with relatively good accuracy and predictability.

However, nobody has ever tested a fully-automated system that allows a patient to make his refraction on its own.

Today, if we want to ensure everyone has access to high-quality eye care, we need to save time for every person in our practices.

Thanks to technology, one way is to transfer some of our current tasks to the patient.

The subject of this study is comparing SSR perform by an ophthalmologist or orthoptist versus the glasspop algorithm v1.6.1.8.

Method

A prospective randomized study was conducted for one month in two private ophthalmologic practices. All patients looking for a comprehensive eye exam with an SSR were included after information about the protocol and their enlightened consent registration.

Exclusion criteria were patients under 16 and over 65 years old. 59 patients were included (36 women; 23 men: median age: 33 years old). Two patients aged respectively 8 and 76 years old were wrongly included. We decided to keep them in an intended-to-treat analysis.

We performed a comprehensive eye exam with an SSR performed by a physician or an orthoptist on every patient included.

The same patient also made autonomous subjective refraction (ASR) using glasspop algorithm v1.6.1.8.

The same material and method were used for the measurement of the patient's previous prescription glasses (when he add one) and objective refraction, using standards fontofocometer (Nidek LM 1800 PD) and auto refractometer (Nidek ARK 1, TONOREF II or TONOREF III).

All SSR and ASR were made without cycloplegia.

All SSR were performed with a standard refractor (Nidek RT5100) by an ophthalmologist or an orthoptist. ASR was then conducted on a refractor Nidek TS610 with a plugged hardware module composed of a joystick and a button to allow the patients to answer the algorithm's different tests (Fig 1). Thanks to that, patients could make their subjective exam without any assistance. The patient used a tablet computer (Apple Ipad) to display instructions and give his age and level of satisfaction with his current eyeglasses.

With for input: age, objective refraction, previous eyeglasses and their level of satisfaction, the glasspop algorithm drove the ASR exam by conducting several selected tests as fogging and red-green tests.

The output obtained was visual acuity with current eyeglasses prescription, subjective refraction with monocular best-corrected visual acuity, an eyeglasses prescription proposal.

Figure 1: glasspop hardware module plugged on a Nidek TS610 refractor

Data analysis

SSR and ASR performances were compared on the subjective refraction results, using a Student test for related samples. Data used were mean spherical equivalent (MSE) and cylindrical vector coordinates vertical and obliques J0, J45 of subjective refraction.

Bland-Altman plots were used to look for a correlation.

Results are written in mean and standard deviation.

Results

Mean spherical equivalent (MSE) results are represented in **table 1**.

MSE were respectively -0,321 ± 1,826 for SSR and -0,329 ± 1,813 for ASR.

No statistically significant differences were found between the two procedures (p>0,05).

Results for vector coordinates are resumed in **Table 2 and 3**.

Regarding the J0 component, the mean result was -0,021± 0,239 for SSR and -0,017 ± 0,249 for ASR.

The Student t-test analysis does not show a statistically significant difference (p=0,901).

For the J45 component we found a mean of 0,039 ± 0,257 for SSR and 0,036 ± 0,259 for ASR(p=0,918).

Bland & Altman test analysis found a positive correlation between the two groups for both J0 and J45 components.

No statistically significant differences were found between the two procedures (p>0,05).

Variable	Patients	Minimum	Maximum	Mean	SD
MSE SSR	117	-8,750	5,750	-0,321	1,826
MSE ASR	117	-8,750	5,750	-0,329	1,813
IC 95% : [-0,020; 0,037]					
P-value 0,558					
Alpha 0,050					

Table 1: Student's t-test for related samples SSR vs ASR

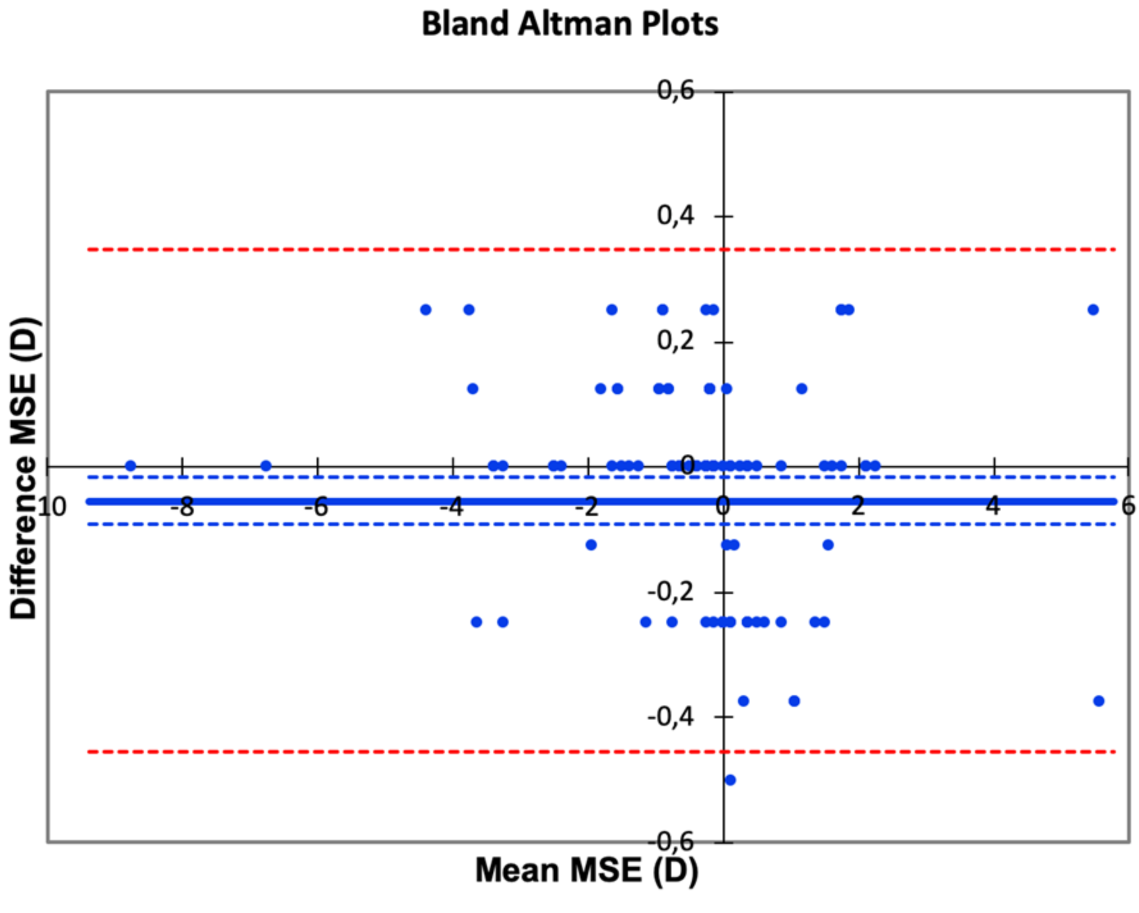

Figure 2: Bland-Altman plots between MSE of SSR and ASR.

The middle line indicates the mean difference (SSR-ASR), the two dashed red lines show the 95% limits of agreement

Variable	Patients	Minimum	Maximum	Mean	SD
J0 SSR	117	-1,220	0,875	-0,021	0,239
J0 ASR	117	-0,867	1,407	-0,017	0,249
IC 95% : [-0,067; 0,059]					
P-value 0,901					
Alpha 0,050					

Table 2: Student's t-test for related samples SSR vs ASR

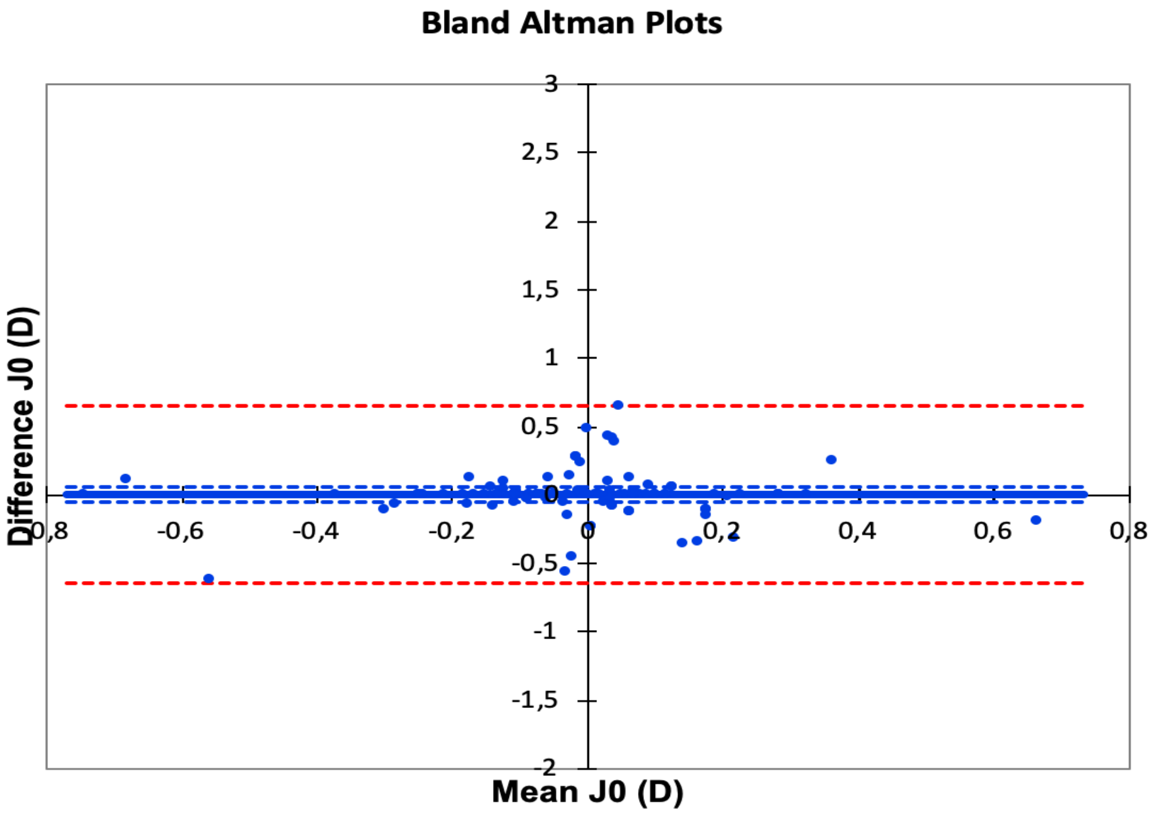

Figure 3: Bland-Altman plots between J0 of SSR and ASR.
The middle line indicates the mean difference (SSR-ASR), the two dashed red lines show the 95% limits of agreement

Variable	Patients	Minimum	Maximum	Mean	SD
J45 SSR	117	-0,839	0,858	0,039	0,257
J45 ASR	117	-0,476	1,079	0,036	0,259
IC 95% : [-0,063; 0,070]					
P-value 0,918					
Alpha 0,050					

Table 3: Student's t-test for related samples SSR vs ASR

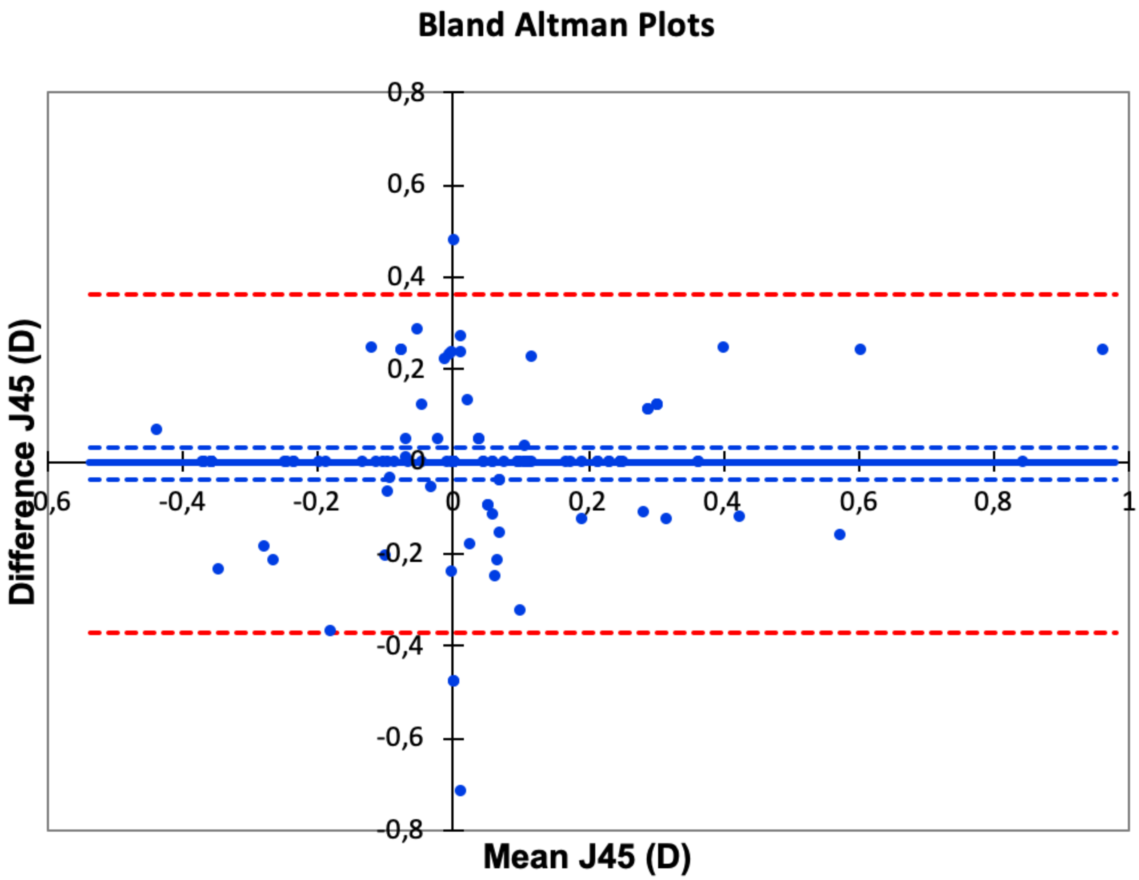

Figure 4: Bland-Altman plots between J45 of SSR and ASR.

The middle line indicates the mean difference (SSR-ASR), the two dashed red lines show the 95% limits of agreement

Discussion

We evaluated SSR results, representing today the gold-standard in refraction exam with the ASR powered by the glasspop algorithm v1.6.1.8 allowing a patient to conduct the exam on its own.

The results showed no statistically significant difference between the two processes regarding mean spherical equivalent and cylindrical vector coordinates vertical and oblique, respectively J0 and J45.

These first results are exciting because, as we know, most due to accommodation during the exam, subjective refraction could easily be wrong. *1-2-3-4-5*

To our knowledge, this is the first time a study is conducted to measure and compare the results of subjective refraction conducted by a patient alone without any assistance versus a regular exam.

For several years, new refractors with built-in software using wavefront technology are available on the market*6-7-8*. These technologies allow an assistant to perform subjective refraction with quite good results without a necessary medical background.

However, with all of these solutions, an assistant stays involved in the procedure. The patient is not alone, and so, it remains time and human resources consuming.

Additional experimentations are needed. First, to confirm our results regarding performances. Secondly, to see if this technology could be democratized.

It will be fascinating to test it on different organizations (primary care centers, hospitals, telemedicine) and other cultures (out of France and Europe).

Even if the product is intended to be used with patients from 16 to 65, we can notice that 100% of our patients, including two from 8 and 76 years old, managed to make the test without any assistance.

That is again a crucial point above the accuracy. Only simple and easy to use products can become general-purpose technology.

Conclusion

This study shows no statistically significant differences between SSR and ASR using the glasspop algorithm regarding MSE, J0 and J45.

To our knowledge, this is the only subjective refraction process made by a patient itself showing such results. The glasspop algorithm could be a real game-changer in ophthalmology's daily practice, allowing eye care professionals to save precious time for other tasks requiring a high level of expertise.

We live in a more and more crowded world. The improving living standards are the first factor that increases demand in healthcare.

Physicians need to see more patients.

One of the best ways to ensure affordable and accessible care for all will be to use technology to make sophisticated and expensive processes simple and affordable.

That means the measure and pre-analyze of the data will be done without the physician's presence. As we can see today, diabetic patients with continuous glucose monitor don't need to go to the laboratory to know their HBA1C and send it to their doctors.

Medicine has no internet yet. Practicians use it before (appointments) and after (EHR, Billing services) but not for the examination. The boom of cloud computing and artificial intelligence will help us create powerful software medical devices and improve them daily. For us, we are probably living in a fascinating period where the accessibility of healthcare practitioners could be powered in an unprecedented way.

Several deployments of the solution in France and abroad will help us in the coming days to both confirm our results and improve the process again.

An additional study enrolling more patients and a double comparison with SSR conducted by two operators on the same patient is already started.

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