

Comparison of two commercially available shade guide under three different light conditions with digital shade matching system: an in Vivo Study

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Abstract

Introduction: Accurate shade selection is the one of the most challenging aspects of dental restoration and aesthetic dentistry. Due to great variation in natural tooth colour, achieving a close shade match of an artificial restoration with natural dentition is a very complex process. In dentistry, tooth shape, size, position and colour of tooth is the determinant factor for aesthetics but among them colour is most important factor.

Purpose: Compare the reliability and accuracy of commercially available shade guide with digital shade matching device.

Material and Method: Tooth color was measured in 105 volunteers maxillary right and left central incisor teeth. L, C & H values and ΔE Value determined by visual method using vita classic and 3D master shade guide system under day, room and ambient light condition against digital shade matching system Vita Easyshade compact. ΔE was assessed. Anova, Bonferroni multiple comparison and t-test were used to compare the data.

Results: There was significant difference between vita classic, vita 3D master under different light condition and

vita Easyshade compact with respect to L, C & H Value where is p-value < 0.05. ΔE show a significant device difference where vita 3D master have highest mean 3.325 followed by vita Easyshade compact 3.113 and vita classic have least mean value 2.475.

Conclusion: Both in color matching with visual methods using shade guides and digital method using vita easy shade compact, it is more appropriate to use the same device since comparison between the values obtained with different devices is difficult. When we are talking about visual method using vita classic and vita 3D master there is no much difference in values. Both the shade guide showed excellent repeatability and so they can used in office to evaluate tooth color before and after the treatment.

Keywords: Aesthetic Dentistry, Shade Matching, Easy shade Compact, Rite Lite2, Dental shade guides.

Introduction

Woody Allen once wrote a humorous essay entitled ‘What if the impressionists were dentists’ [1] where the whole play deals with a parody on the life of the impressionist painter Vincent van Gosh as a dentist. Though this is

intended as a comical piece, in the field of aesthetic dentistry it has somewhat become a reality. Dentists are doctors of the mouth yet in the last three decades their final work is judged ever more by the level of their artistic talents. Not all dentists have the advantage of such innate skills, and increasing the level of predictability and evidence into the subjective field of esthetic is the solution for dental clinician today.

Present generation patients are highly aware and esthetically conscious of color and can be very demanding when it comes to the esthetics of restoring a tooth. They might not know the technicality of the procedure but they can definitely judge the look of the restoration and how close it matches the adjacent tooth. The esthetic makeup of a restoration includes both shape and color and the need to match the adjacent tooth. Shade matching is one of the most important and critical criteria in a successful and esthetically superior restoration.

As we move anteriorly the esthetic demands become greater. Patient demand is also higher for an exact replication of their restoration to their natural dentition especially if it is a single unit restoration. Practitioners are now seeking computer technology to contribute to their everyday procedures to eliminate the human errors. [2,3,4] A new alternative form for shade selecting is the VITA Easyshade system, a hand held device using electronic optical measurements. The manufacturer claims that their device is superior in reading and analyzing color thus giving a color match reading that will be more accurate than the human eye. This technology is assumed to be repeatable and accurate eliminating the human errors with visual matching. Clinical shade matching has always been conducted by the operator or the dental auxiliary personnel. Patient's feedback also play a major contributor in the color matching decision.[5]

The present study aims to evaluate the electronic color matching in comparison to the human eye in three different light condition. The reading from each subject is compared and to the shade selected by the trained operator using vita 3D shade guide and vita classic shade guide in three different light condition and the data collected to be analyzed and compared with vita easy shade guide.

Materials and Methods

2.1 Source of Data

The study will be conducted on patient to evaluate reliability and accuracy of visual method using commercially available shade guide against digital shade matching device

2.2 Method of Collection of Data

Shade matching will be done using vitapan classic shade guide and vita 3D master shade guide on patient maxillary 11 and 21 teeth number under three different light conditions.

Again on same subject shade matching done by using digital shade matching device (Vita Easyshade Compact).

The shade was measured in the central region of the tooth e.g. the best match to the middle third of the patients tooth, and this was referred to as the tooth's shade.

Data obtained from both the methods are compared.

2.3 Instruments

Vitapan Classic Shade guide

Vita 3D Master Shade Guide

Rite Lite-2 (By GC India)

Vita Easyshade Compact



Fig. 1: from left to right: Vita Classic, Vita 3D Master, Rite Lite & Vita Easyshade

2.4 Methodology

sterilized the shade guide and collaboration of instrument carried out before using Vita Easyshade Compact and protective shield is inserted on the tips. Then for each subject the shade selection done with vitapan classic shade guide under three light condition then the shade selection with 3D master shade guide and finally select the shade with vita Easyshade compact carried out. After collecting the data comparison & analysis of the data of vita classic & vita 3D master with vita Easyshade compact done.

2.5 Preparation of sample

Prior to selecting the shade ,thorough oral prophylaxis done for the patient.

2.6 Number of sample

For this study sample size selected 105 volunteers with 27 male and 78 female in 18 to 33 years age group.

2.7 Procedure

Before starting the shade selection, the participants were informed of the clinical procedure to which they would be subjected and written informed consent obtained to take part in the study. Research has been conducted in full accordance with ethical principles, including permission from institutional ethical committee, Navodaya Dental College & Hospital, Raichur, Karnataka, India.

Tooth color was measured in caries and fillings free maxillary anterior teeth. Total selected sample was 105. First measured tooth color with vita classic in the presence of day light, room light and ambient light (light environment created by rite lite2).



Fig. 2: Shade Selected in day light



Fig.3: Shade Selected in room light



Fig. 4: Shade Selected in ambient light



Fig. 5: Shade Selected in day light



Fig. 6: Shade Selected in room light



Fig. 7: Shade Selected in ambient light

Finally tooth shade measured with digital method using Vita Easyshade compact.



Fig. 8 : Shade Selection with Vita ES



Fig. 9: Shade obtained with Vita ES

Color data was exported into the CIE L*a*b* system for the color measuring process. To measure color with ES. ES was positioned and aligned correctly on the tooth (middle third of the buccal aspect of the tooth). All measurements were made by a single investigator, following the manufacturer's instruction. Before any measurement device were calibrated.

The parameter of each color sample were being examined: $\Delta L, \Delta C, \Delta H$ & ΔE .



Fig.10: Color difference metric values as Compared to the corresponding Vita Classic shade guide



Fig. 11: Color difference metric value as compared to the corresponding Vita 3D master shade guide

Observed these parameter individually for Vita Classic, Vita 3D master and for Vita Easyshade compact. There are three components of color: value (L) - the color brightness, Chroma(C) - saturation or intensity of color, hue (H) - Color itself or name of the color . ΔE is the color difference between two individual.

The obtained data were tested for normal distribution by descriptive statistics test. Quantitative variables were compared using one way ANOVA test. Multiple comparisons between groups done by Post Hoc Test

(Bonferroni) test. Qualitative data have been compared using t test. The level of $p < 0.05$ was considered statistically significant. Statistical analysis was done using the SPSS 11.0.

Results

3.1 Statistical Analysis

Descriptive statistics such as mean and SD was used. Comparison between three different groups was done by one-way ANOVA test followed by Bonferroni (post hoc) multiple comparison test. Comparison between three groups with respect to reliability & accuracy of shade selection was done by t-test. A p-value less than 0.05 was considered as significant.

Comparison of C value of vita classic, vita 3D master in three different light conditions (Rite Lite2) with Vita Easyshade compact.

Table 1: Descriptive Statistics:

	N	Mean	Std. Deviation
Vita Classic	105	1.824	1.245
Vita 3D Master	105	16.092	2.948
Vita Easy shade Compact	105	0.950	2.480
Total	315	6.289	7.332

Table 2: One way ANOVA

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15177.12	2	7588.562	1389.237	0.000
Within Groups	1704.267	312	5.462		
Total	16881.39	314			

There was significant difference between vita classic, vita 3D master and vita easyshade compact with respect to C Value where p-value is < 0.05 .

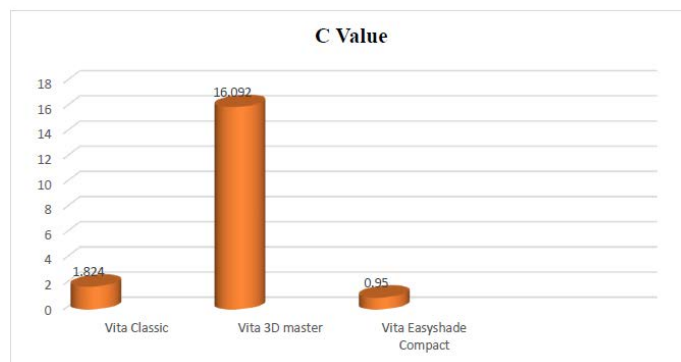
Table 3: Multiple Comparisons: Bonferroni test

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Vita Classic	Vita 3D Master	-14.26857*	.32256	.000	-15.0450	-13.4922
	Vita Easyshade Compact	.87333*	.32256	.021	.0969	1.6497
Vita 3D Master	Vita Classic	14.26857*	.32256	.000	13.4922	15.0450
	Vita Easyshade Compact	15.14190*	.32256	.000	14.3655	15.9183
Vita Easyshade Compact	Vita Classic	-.87333*	.32256	.021	-1.6497	-.0969
	Vita 3D Master	-15.14190*	.32256	.000	-15.9183	-14.3655

*The mean difference is significant at the 0.05 level.

- There was significant difference between Vita classic and Vita 3D master because p-value < 0.05 .
- There was significant difference between Vita classic and Vita Easyshade compact because p-value < 0.05 .
- There was significant difference between Vita 3D master & Vita Easyshade compact because p-value < 0.05 .

Graph 1:



From the above results, Vita 3D master had the highest mean of 16.092, Vita Classic had second highest mean of 1.824 and Vita Easy shade Compact had the least mean of 0.95. Thus Vita Easy shade compact, with respect to C value was found to be the better instrument for shade selection among the three instruments tested in this study. Comparison of L value of vita classic, vita 3D master in three different light conditions with vita Easy shade compact

Table 4: Descriptive Statistics

Day Light	N	Mean	Std. Deviation
Vita Classic	105	0.432	1.421
Vita 3D Master	105	79.943	2.210
Vita Easyshade Compact	105	0.461	2.906
Total	315	26.945	37.602

Table 5: One way ANOVA

ANOVA					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	442375.1	2	221187.6	43238.67	0.000
Within Groups	1596.037	312	5.115503		
Total	443971.2	314			

There was significant difference between vita classic, vita 3D master and vita Easyshade compact with respect to L Value where p-value is < 0.05

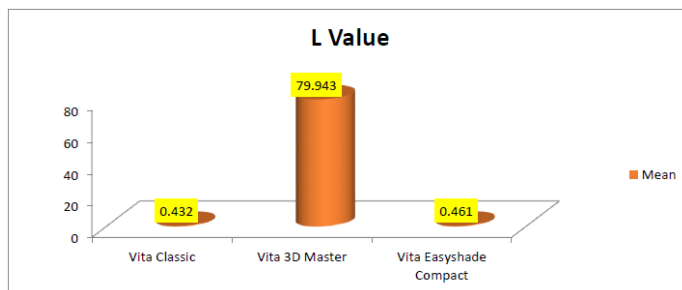
Table :6 Multiple Comparisons: Bonferroni test

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Vita Classic	Vita 3D Master	-.7951048*	.31215	.000	-80.2618	-78.7591
	Vita Easyshade Compact	-.02857	.31215	1.000	-.7799	.7228
Vita 3D Master	Vita Classic	79.51048*	.31215	.000	78.7591	80.2618
	Vita Easyshade Compact	79.48190*	.31215	.000	78.7306	80.2332
Vita Easyshade Compact	Vita Classic	.02857	.31215	1.000	-.7228	.7799
	Vita 3D Master	-79.48190*	.31215	.000	-80.2332	-78.7306

*The mean difference is significant at the 0.05 level

- There was significant difference between Vita classic and Vita 3D master because p-value < 0.05.
- There was significant difference between Vita classic and Vita Easyshade compact because p-value < 0.05.
- There was significant difference between Vita 3D master & Vita Easyshade compact because p-value < 0.05

Graph 2:



From the above results, Vita 3D Master had the highest mean of 79.943, Vita Easyshade had second highest mean of 0.461 and Vita Classic had the least mean of 0.432. Thus Vita 3D master shade guide, with respect to C value was found to be the better instrument for shade selection among the three instrument tested in this study.

Comparison of H value of vita classic, vita 3D master in three different light condition with vita Easyshade compact

Table 7: Descriptive Statistics

Day Light	N	Mean	Std. Deviation
Vita Classic	105	-1.522	2.269
Vita 3D Master	105	91.574	1.893
Vita Easyshade Compact	105	2.885	2.567
Total	315	30.979	43.012

Table 8: One Way Anova

ANOVA					
Day Light	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	579325	2	289662.6	56714.77	0.000
Within Groups	1593.5	312	5.107358		
Total	580919	314			

There was significant difference between vita classic, vita 3D master and vita Easyshade compact with respect to H Value where p-value is < 0.05

Table 9: Multiple Comparisons: Bonferroni test

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Vita Classic	Vita 3D Master	-93.09619*	.31190	.000	-93.8469	-92.3455
	Vita Easyshade Compact	-4.40667*	.31190	.000	-5.1574	-3.6559
Vita 3D Master	Vita Classic	93.09619*	.31190	.000	92.3455	93.8469
	Vita Easyshade Compact	88.68952*	.31190	.000	87.9388	89.4403
Vita Easyshade Compact	Vita Classic	4.40667*	.31190	.000	3.6559	5.1574
	Vita 3D Master	-88.68952*	.31190	.000	-89.4403	-87.9388

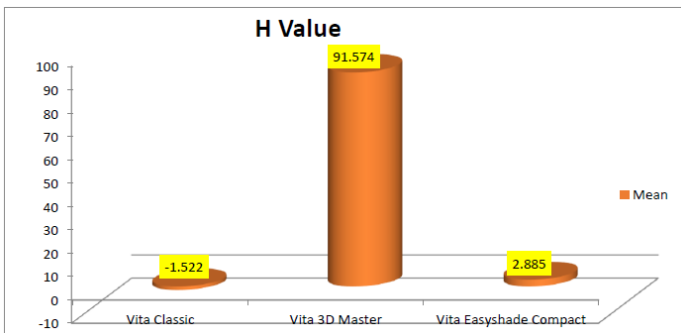
*The mean difference is significant at the 0.05 level

➤ There was significant difference between Vita classic and Vita 3D master because p-value < 0.05.

➤ There was significant difference between Vita classic and Vita Easyshade compact because p-value < 0.05.

➤ There was significant difference between Vita 3D master & Vita Easyshade compact because p-value < 0.05

Graph 3:



From the above results, Vita 3D Master had the highest mean of 91.574, Vita Easyshade compact had second highest mean of 2.885 and Vita Classic had the least mean of -1.522. Thus Vita Classic shade guide, with respect to H value was found to be the better instrument for shade selection among the three instrument tested in this study.

Comparison of ΔE

Table: 10

ΔE	N	Mean	Std. Deviation
Vita Classic	105	2.475	1.330
Vita 3D master	105	3.325	1.930
Vita Easyshade Compact	105	3.113	2.626

Graph 4:

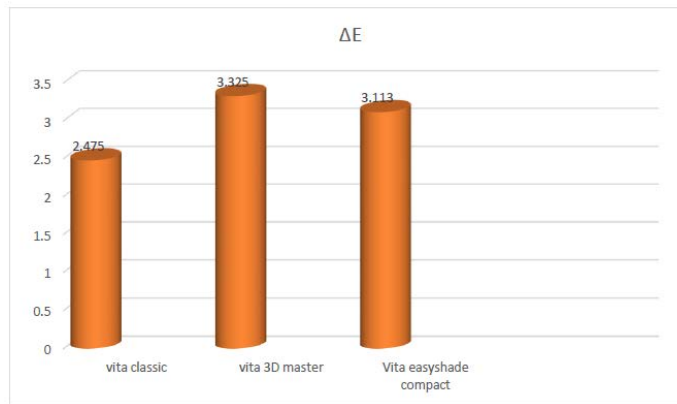


Table 11.

ΔE	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
ΔE	-2.221	208	.027	-.63810	.28724	-1.20437	-.07182

Based on this study, vita 3D master have highest mean 3.325 followed by vita Easyshade compact 3.113 and vita classic have least mean value 2.475.

Discussion

Accurate shade matching is one of the most challenging aspects of dental restorations and aesthetic dentistry. Due to great variety of natural tooth color, achieving a close shade match of an artificial restoration with natural dentition is a complex process. Practitioners require an understanding of color, light and related characteristics of porcelain and resin, as well as the ability to clearly communicate instructions with laboratory technicians. Successful shade matching integrates a number of critical factors, including an individual’s perception of color, the light source in which shade is being determined, the color

of the surrounding walls and cabinets and the color of patients clothing and makeup.

A recent clinical survey by Diemah F.Alhekeir, Rana A. Al-Sarhan et al evaluating failure of porcelain laminate veneers reveals 43.48% of restoration failures are due to improper shade selection or color changes of prosthesis which points at majority of porcelain restoration failures till today are due to non-standardization of shade selection process, [6] necessitating evaluation of accuracy and reliability of commercially available shade guide systems. The present study designed to evaluate the accuracy and reliability of shades selected using most commonly used shade guide Vita Classic and Vita 3D Master shade guides under day light, room light & ambient light condition with digital Vita Easyshade Compact.

When one carefully studied natural teeth, he or she was soon be aware that color composition is determined by other factors hue, Chroma and value.10 These hue (H), Chroma(C) & Value or lightness (V/L) is very oldest colour system and it was created by Albert H. Munsell in 1905.[7]

Hue (H) is described with word we normally think of as describing color: red, purple, blue etc. is also a term which describes a dimension of color we readily experience when we look at color.

Value/Lightness (V/L) is the quantity of light reflected by an object compared to a pure white diffuser and a black absorber. It is the amount of light returned from an object. Munsell described value as a white to black gray scale. Bright objects have lower amount of gray and low value objects have larger amount of gray and will appear darker.

Chroma (C) is the saturation, intensity or strength of the hue. As Chroma is increased, the value is decreased; Chroma and value are inversely related. Higher numbers on Vita Classic shade Guide represents increased chroma.[8,9]

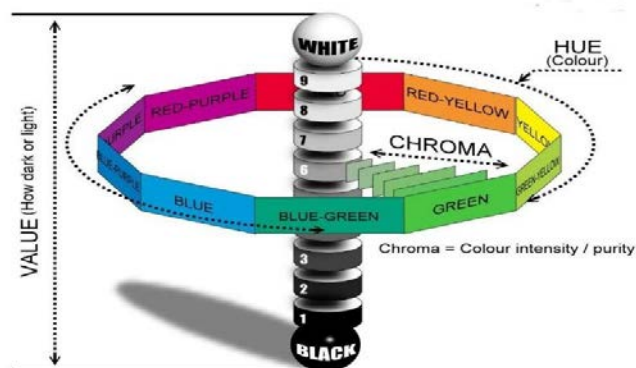


Fig .12: Munsell color system representing Hue, Value & Chroma

S.M.Burkinshaw observed that the science of color and colored material involves chemistry, Biology and physics. However the science of color differs from other areas of science in so far as a while quantities such as mass or volume are intrinsic properties of an object that are identical for all observers, the description of the color of an objects refers to a sensation experienced by a particular observer. In simple terms, the perception of the color of a reflected object depends upon the combination of three elements, namely a light source (illuminates the object), an object (absorbs or transmits the incident light to observer) and an observer (perceives the reflected light).[10]

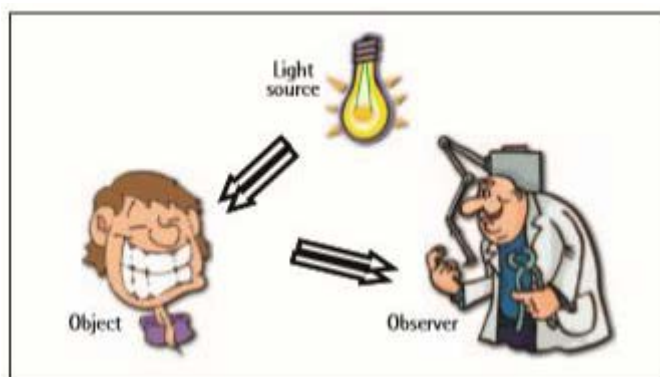


Fig. 13 : Three component of color

As per results of this study, light source play a major role during shade selection with visual methods. In the present study shade selection was carried out in day light and selected shade was verified under room light and ambient

light. S.Wesland and W.Luo found that colorimeters, spectrophotometers and even camera systems can allow computation of $L^*a^*b^*$ value. Color difference can be measured in terms of CIELAB color difference value or ΔE . According to results of Seghi et al under ideal viewing condition, ΔE values less than 1 are perceivable and value greater than 2 are discernable. Whereas Khokhar et al. have suggested that a ΔE of 3.3 is acceptable in dentistry.[11]

In the present study vita classic shows $\Delta E=2.475$ in three different light condition whereas Vita 3D master shows $\Delta E= 3.325$ in three different light condition. Which indicate that vita classic shade guide is more reliable compared to vita 3D master shade guide under the three different light condition.

Seungyee Kim Pusateri et al did a study on 4 different digital shade guide system (Spectroshade based on spectrophotometer by MHT Optic Research AG,Switzerland; ShadeVision based on digital camera with colorimeter by X-Rite,America; Vita Easyshade based on spectrophotometer by Vita Zahnfabrik,Germany & ShadeScan based on digital camera with colorimeter by Cynovad,Canada) and they found that Vita easy shade is only color measurement instrument that had both reliability and accuracy value greater than 90%.[13]

As per Seungyee Kim et al study, in the present study vita Easyshade compact used as a standard instrument and compared another two visual shade guide in three different light condition with Vita Easyshade compact. There was significant difference between vita classic, vita 3D master under different light condition and vita Easyshade compact with respect to L, C & H Value where is p-value < 0.05 . ΔE show a significant device difference where vita 3D master have highest mean 3.325 followed by vita Easyshade compact 3.113 and vita classic have least mean value 2.475. Based on data obtained we can say that vita

classic is more accurate in three different light condition compare to 3D master shade guide.

The null hypothesis that they present no difference in their color measuring within device or shade system they accepted, but the results allow to reject the null hypothesis that they present no difference in their color or shade system in their devices.[14]

In present study the value ratio compared with lowest value tab was 0.1 to 1.9 and the Chroma ratio compared with lowest Chroma was 0.0 to 3.3 for Vita classic shade guide in three different light condition whereas value ratio for 3D master shade tab was 68.0 to 82.9 and the Chroma ratio was 10.6 to 18.1 in three different light conditions.

Based on the result of present study, there was significant interaction between each pair of three color coordinates for all of the investigated color parameters ($p<.001$). These results indicate that all of the color parameter, such as the value, Chroma, and hue are influenced differently by the combination of the designations of hue, value and Chroma of each shade tabs in different light conditions, which indicate that the color parameters are not arranged in same intervals by the shade designation. A systematically arranged shade guide should aid in selection of the correct shade tooth shade and in avoiding the need for shade correction.[15]

As with natural teeth, the color of shade varies by thickness of dentine & enamel. As in the present study shade selected only on healthy central incisors, further studies on the color measurement of various teeth by location should be carried out. As this was an in vivo study, the clinical relevance of these results requires much clinical trials with various types of restorations like porcelain fused with metal, composite metal, lithium disilicate,zirconia etc.

Conclusion

There was no variation in both the reliability and accuracy of shade matching visual devices using Vita Classic and Vita 3D master in day light, room light & ambient light conditions tested in present study. Both devices (vita classic and vita 3D master) comparison had similar, high reliability indicating predictable shade value from repeated measurement. However there was marked variability in the accuracy of the devices and difference in the accuracy of were found with most device comparison. The reliability & accuracy are useful in comparing these devices in vivo, and may predict the perfection in a clinical study.

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