

Tear Film Changes after Phacoemulsification

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Abstract

Background: Dry eye syndrome is a multifactorial disease of pre-corneal tear film that results in ocular discomfort, visual disturbance, and tear film instability, with potential damage to the ocular surface.

Aim of Study: Was to evaluate the incidence of dry eye in patients undergoing clear cornea phacoemulsification and evaluate the age as a risk factor associated with eye dryness after phacoemulsification surgery.

Patients and Methods: This was an observational prospective study conducted on 60 eyes with no dry eye signs or symptoms, who underwent clear corneal phacoemulsification for cataract, carried out at Ophthalmology Departments of Kalwoon Hospital and Faculty of Medicine, Al-Azhar University Hospitals (Al-Hussein and Sayed Galal Hospitals) during the period between January 2020 till January 2021.

Results: Our results indicated that values of Schirmer test and tear break-up time test changed following the operation. The tear film break-up time (TBUT) value had changed post-operatively on day 1 and day 7 remarkably. Statistically significant difference was observed between TBUT values on day 1 (6.08 ± 1.19) and day 7 (7.06 ± 1.2) when compared with preoperative value (11.1 ± 1), (p -value < 0.001). The Schirmer test value has changed post-operatively on day 1 and day 7 remarkably. Statistically significant difference was observed between Schirmer test value on day 1 (9.8 ± 1.4) and day 7 (12.08 ± 1.3) when compared with preoperative value (14.1 ± 2.2), (p -value < 0.001).

Conclusion: Our findings showed a gradual improvement in tear film break-up time and Schirmer's test results when the patients were reviewed at 1 month.

Key Words: Tear film – Phacoemulsification – Schirmer test – Tear film break-up time.

Introduction

THE tear film is a thin fluid layer that covers the outer mucosal surface of the eye. It is composed of three layers; superficial thin lipid layer, which is produced by the meibomian glands and its prin-

cipal function, is to retard tear evaporation and to assist in uniform tear spreading [1].

A middle thick aqueous layer, this layer is produced by the main lacrimal glands (reflex tearing), as well as by the accessory lacrimal glands of Krause and Wolfring (basic tearing). The amount and composition of this layer is critical for the health, maintenance and protection of the cells of the cornea and conjunctiva, also it has anti-adhesive and lubricant properties. This ensures that protein and debris generally do not adhere to the corneal surface [2].

An innermost hydrophilic mucin layer; is produced by both the conjunctival goblet cells and the ocular surface epithelium, the hydrophilic quality of the mucin allows the aqueous layer to spread over the corneal epithelium. The importance of mucin in tears has emphasized the realization that tears are not predominantly aqueous but are probably a type of mucin gel. A dysfunction of any of these three layers can result in dry eye disease [3].

Dry eye syndrome is a multifactorial disease of pre-corneal tear film that results in ocular discomfort, visual disturbance, and tear film instability, with potential damage to the ocular surface [4]. The diagnosis of dry eye is based on the clinical features and some diagnostic tests such as tear break-up time, tear meniscus height, and rose Bengal staining. The assessment of tear production by Schirmer I test (ST) is the most common test in the evaluation of dry eye. It measures the basal tear secretion and the function of the main lacrimal gland [5].

Clear cornea phacoemulsification has become one of the safest, most successful, and most frequently performed outpatient surgeries; however,

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as with other corneal surgeries, it may alter the ocular surface and disrupt normal tear function [6]. Post-operative dry eye has been implicated as the most important obstacle to patient's satisfaction despite an excellent visual recovery [7].

Factors that are responsible for development of dry eye after cataract surgeries include prolonged use of antibiotic-steroid eye drops, decrease tear film break-up time due to surface irregularity at the site of the incision, decrease mucin production from the conjunctiva secondary to incision placement, decrease corneal sensation due to surgical incision which disrupts the cornea-lacrimal gland loop leading to reduced tear secretion, poor tear film production and stability due to surgically induced ocular inflammation and exposure to light from the operating microscope [8].

The aim of present study was to evaluate the incidence of dry eye in patients undergoing clear cornea phacoemulsification and evaluate the age as a risk factor associated with eye dryness after phacoemulsification surgery.

Patients and Methods

This was a observational prospective study conducted on 60 eyes with no dry eye signs or symptoms, who underwent clear corneal phacoemulsification for cataract, carried out at Ophthalmology Departments of Kalwoon Hospital and Faculty of Medicine, Al-Azhar University Hospitals (Al-Hussein and Sayed Galal Hospitals).

Inclusion criteria:

Both genders, and patients having unilateral or bilateral cataract.

Exclusion criteria:

Pre-existing glaucoma, disorders of lids, conjunctiva, cornea, sclera and nasolacrimal pathway, chemical burns, radiation, previous history of ocular trauma, surgery or laser, use of contact lenses, patients on chronic ocular medications, history of drug intake which interfere with tear film stability, patients with ocular manifestations of systemic disease as Sjogren's syndrome, rheumatoid arthritis and other autoimmune disorders, patients with intraoperative complications like posterior capsule rupture, inability to implant intraocular lens (IOL) in bag; postoperative complications like toxic anterior segment syndrome or endophthalmitis, and patients who reject enrollment in the study.

All subjects involved in the current study were informed about the nature and details of the current work and a written consent was obtained from each participant. The study was approved by the local Ethics Committee, Faculty of Medicine, Al-Azhar University.

All patients were subjected to the following:

i- History and clinical examination: History taking including history of ocular disorders and detailed systemic examination were performed for study patients. Every patient was subjected to detailed pre-operative assessment with a slit lamp biomicroscopy. Tear film function was assessed one day before operation by Schirmer test-1 (ST-I) and tear film break-up time (TBUT) and data were collected.

ii- Phacoemulsification technique: All patients underwent clear cornea phacoemulsification. The procedure was performed by 3 surgeons using standard preoperative, intraoperative, and postoperative techniques and regimens. All the patient's pupil were dilated with tropicamide 1%. Benoxinate HCl 0.4% eye drops was used as topical anesthesia before sterilization of the eye. A standard phacoemulsification technique and foldable posterior chamber intraocular lens was implanted in the capsular bag through clear corneal incision. A 2.8 to 3.2mm superior clear corneal incision was performed using a calibrated knife. Capsulorhexis, hydrodis section, and nucleus rotation were performed.

A phacoemulsification tip was used to emulsify the lens nucleus then irrigation aspiration of residual cortical matter, and inside the capsular bag a foldable intraocular lens (IOL) was implanted. The viscoelastic material was removed; the incision was hydrated using a 30 G cannula.

iii- Postoperative topical eye treatment: All the patients received Ofloxacin 0.3% ED (6 times per day during 1st week, then 3 times per day during 2nd week, then stopped). Prednisolone acetate 1 % ED (6 times per day during 1st week, then 3 times per day during 2nd week, then 3 times per day during 3rd week, then twice daily during 4th week then stopped).

iv- Assessment of Tear film function: Tear film function was assessed by Schirmer test-1 (ST-I) and tear film break-up time (TBUT). Data were collected preoperatively and at 1 day, 1 week, 1 month postoperatively. All the tests were performed pre-operatively and post-operatively by the same observer. All the tests were done at a 10-min (at

least) interval to minimize reflex tearing secondary to the previous one.

Statistical analysis:

Data were analyzed using Statistical Program for Social Science (SPSS) version 24. Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage. Independent-samples *t*-test of significance was used when comparing between two means. Mann-Whitney U test was used when comparing between two means for abnormal distributed data. A one-way analysis of variance (ANOVA) when comparing between more than two means. Chi-square test was used when comparing between non-parametric data. Pearson's correlation coefficient (*r*) test was used for correlating data. Post Hoc test was used for multiple comparisons between different variables. *p*-value <0.05 was considered significant.

Results

Table (1): Demographic description of studied patients.

	Studied patients (N = 60)	
<i>Age (years):</i>		
Mean ±SD	58.9±9.6	
Min - Max	45-75	
<i>Sex:</i>		
Male	34	56.7%
Female	26	43.3%

Table (2): Results of Schirmer and TBUT before and after Phacoemulsification.

	1 Day before (N=60)	1 Day After (N=60)	7 Days After (N=60)	30 Days After (N=60)	<i>p</i> - value
<i>Schirmer</i> (in mm):					
Mean	14.1	9.8	12.08	13.8	<0.001
±SD	±2.2	±1.4	±1.3	±1.5	HS
Range	10-20	7-12	10-17	10-18	
<i>TBUT</i> (in sec.):					
Mean	11.1	6.08	7.06	8.8	<0.001
±SD	±1.09	±1.19	±1.2	±1.3	HS
Range	10-14	4-9	5-10	6-11	

F: F-value of one way ANOVA.

Table (3): Post-Hoc test for multiple comparisons of Schirmer and TBUT results.

		LSD	<i>p</i> - value
<i>Schirmer</i> (in mm):			
1 Day preoperatively	1 Day Postoperatively	4.3	<0.001 HS
	7 Days Postoperatively	2.03	<0.001 HS
	30 Days Postoperatively	0.28	0.353 NS
1 Day postoperatively	1 Day preoperatively	-4.3	<0.001 HS
	7 Days Postoperatively	-2.3	<0.001 HS
	30 Days Postoperatively	-4.08	<0.001 HS
7 Days postoperatively	1 Day preoperatively	-2.03	<0.001 HS
	1 Day Postoperatively	2.3	<0.001 HS
	30 Days Postoperatively	-1.75	<0.001 HS
30 Days postoperatively	1 Day preoperatively	-0.2	0.353 NS
	1 Day Postoperatively	4.08	<0.001 HS
	7 Days Postoperatively	1.75	<0.001 HS
<i>TBUT</i> (in sec.):			
1 Day preoperatively	1 Day Postoperatively	5.05	<0.001 HS
	7 Days Postoperatively	4.06	<0.001 HS
	30 Days Postoperatively	2.3	<0.001 HS
1 Day postoperatively	1 Day preoperatively	-5.05	<0.001 HS
	7 Days Postoperatively	-0.98	<0.001 HS
	30 Days Postoperatively	-2.7	<0.001 HS
7 Days postoperatively	1 Day preoperatively	-4.06	<0.001 HS
	1 Day Postoperatively	0.98	<0.001 HS
	30 Days Postoperatively	-1.76	<0.001 HS
30 Days postoperatively	1 Day preoperatively	-2.3	<0.001 HS
	1 Day Postoperatively	2.75	<0.001 HS
	7 Days Postoperatively	1.76	<0.001 HS

LSD: Least significant difference.

Table (4): Correlation study between age and Schirmer test.

Variables	(<i>r</i>)	<i>p</i> -value
Age vs Schirmer 1 day preoperatively	-0.36	0.004 S
Age vs Schirmer 1 day postoperatively	-0.39	0.002 S
Age vs Schirmer 7 days postoperatively	-0.32	0.012 S
Age vs Schirmer 30 day postoperatively	-0.3	0.019 S

(*r*): Pearson correlation coefficient.

S : *p*-value <0.05 is considered significant.

Table (5): Correlation study between age and TBUT test.

Variables	(<i>r</i>)	<i>p</i> -value
Age vs TBUT 1 day preoperatively	-0.28	0.03 S
Age vs TBUT 1 day postoperatively	-0.49	<0.001 HS
Age vs TBUT 7 days postoperatively	-0.52	<0.001 HS
Age vs TBUT 30 day postoperatively	-0.63	<0.001 HS

(*r*) : Pearson correlation coefficient.

S : *p*-value <0.05 is considered significant.

HS : *p*-value <0.001 is considered highly significant.

Discussion

As regard description of age & sex, the mean age of all studied patients was 58.9 ± 9.6 years with minimum age of 45 years and maximum age of 75 years. There were 34 males (56.7%) and 26 females (43.3%).

Our results indicated that values of Schirmer test and tear break-up time test changed following the operation compared with data collected before the surgery.

The TBUT value changes post-operatively at day 1 and day 7 remarkably. Statistically significant difference was observed between TBUT value on day 1 (6.08 ± 1.19) and day 7 (7.06 ± 1.2) when compared with pre-operative value (11.1 ± 1), (p -value < 0.001).

The Schirmer test value changes post-operatively on day 1 and day 7 remarkably. Statistically significant difference was observed between TBUT value on day 1 (9.8 ± 1.4) and day 7 (12.08 ± 1.3) when compared with pre-operative value (14.1 ± 2.2), (p -value < 0.001).

According to TBUT and Schirmer tests we found that the incidence of dry eye in patients undergoing clear cornea phacoemulsification was 29.6% (29 eye) at 1st day postoperatively, 16.6% (10 eyes) at 7 days after operation and 5% (3 eyes) at 30 days postoperatively.

Our findings showed a gradual improvement in tear film break-up time and Schirmer's test results when the patients were reviewed at 1 month. No significant differences were found on Schirmer test values between baseline measurements at 1 day preoperative and 30 days postoperative, 14.1 ± 2.2 mm and 13.8 ± 1.5 mm, respectively (p -value = 0.353). TBUT values showed a similar finding of initial postoperative decline up to 7 days and then a gradual rise. However, there was a significant difference of tear BUT test between baseline measurements at 1 day preoperatively and 30 days postoperatively, 11.1 ± 1 sec and 8.8 ± 1.3 sec, respectively (p -value < 0.001).

The results of current study were supported by Ishrat et al., [4] in which One hundred eyes of 96 patients, including 35 (36.5%) men and 61 (63.5%) women, were enrolled. The mean age was 63.1 (± 8.3) years with a range of 46-85 years. The majority of women (48, 78.7%) were postmenopausal. In the enrolled eyes, the preoperative mean TBUT was 15.82sec (± 2.99 , range 11-22sec). The preoperative mean score for the ST-1 was 24.33

± 5.44 mm at five minutes, (range 15-35mm). Dry eyes were found in 42% eyes ($p < 0.001$) at 1 week follow-up. 15% and 9% of the eyes were dry at 1 month and 3 months after the surgery, respectively. There were significant differences in the TBUT values at 1 week, at 1 month and at 3 months postoperatively. There was a significant decrease in the TBUT values in the early postoperative period at one week as compared to preoperative findings (8.7 ± 0.48 sec vs. 15.8 ± 0.31 seconds $p < 0.001$). The significant difference was also noticeable at 1 month follow-up (11.2 ± 0.39 seconds vs. 15.8 ± 0.31 seconds $p < 0.001$). However, this difference became non-significant at 3 months as further improvement in TBUT occurred 4.3 ± 0.37 sec vs. 15.8 ± 0.31 sec $p = 0.089$. Overall, there was a decrease in the ST-1 scores during early postoperative period at one week in all patients as compared to the preoperative finding (15.2 ± 0.64 mm vs 24.5 ± 0.59 mm $p < 0.001$). The significant difference was also noticeable at 1 month follow-up (19.7 ± 0.60 mm $p < 0.001$) and at 3 months (21.8 ± 0.64 mm $p < 0.001$).

Cho and Kim [9] carried out study on 70 eyes of 35 patients to investigate changes in dry eye symptoms and diagnostic test values after cataract surgery. They observed the aggravation of dry eye symptoms and diagnostic test results after cataract surgery as compared to preoperative measurements. They concluded that TBUT affected in the early postoperative period after cataract surgery which is consistent with the present study.

Gharaee et al., [10] found no statistically significant difference between the results of preoperative and postoperative ST-1. However, similar to our study, TBUT values differed between preoperative and postoperative examinations.

Oh et al., [11] found a marked decrease in TBUT in the early postoperative period in patients who had undergone phacoemulsification surgery but ST-1 was within normal range. In addition, at 1 and 3 months postoperatively, the authors noticed that TBUT and ST-1 values showed improvement, although they still remained lower than the baseline.

The results of current study were supported by Cetinkaya et al., [12] in which 192 eyes of 96 patients (30 males, 66 females) who had undergone phacoemulsification surgery were enrolled. Their mean age was 68.46 ± 8.14 standard deviation (SD) (range 56-83) years. Thirty of them (31%) were males and 66 (69%) were females. The mean postoperative 1st day, 1st week and 1st month (BUT) values were significantly lower than preoperative BUT value ($p < 0.001$, $p < 0.001$, $p < 0.001$), however

3rd month, 6th month, 1st year and 2nd year values were not significantly different from preoperative value ($p=0.441$, $p=0.078$, $p=0.145$, $p=0.125$). The mean postoperative 1st day, 1st week and 1st month Schirmer Test 1 (ST1) values were significantly lower than preoperative ST1 value ($p<0.001$, $p<0.001$, $p<0.001$), however 3rd month, 6th month, 1st year and 2nd year values were not significantly different from preoperative value ($p=0.748$, $p=0.439$, $p=0.091$, $p=0.214$).

Khanal et al., [13] investigated post phacoemulsification changes in cornea sensitivity and tear physiology in 18 patients. They found that deterioration in corneal sensitivity and tear physiology is seen immediately after phacoemulsification and the tear functions recovered within 1-month. We also found a similar behavior where TBUT and ST values started recovering after 1-month.

A prospective observational study in which 100 eyes of 100 patients without preoperative dry eye were enrolled. Schirmer's Test I and tear break-up time were performed preoperatively and at 5 days, 10 days, 1-month, and 2 months after phacoemulsification surgery. most of the patients were >55 years of age with average of 60.80 ± 5.94 years (range: 46-70). Preoperatively, the mean ST-I was 17.56 ± 6.88 mm. Postoperatively, it progressively decreased when assessed on day 5 and day 10, after which however, a gradual rising was seen up to last follow-up of 2 months. The preoperative mean TBUT was 16.11 ± 2.55 sec which also followed a similar trend of initial postoperative decline up to 1-month and then there is was a gradual rise [7].

In agreement with our study, Mark et al., [6] a single-center, prospective, non-randomized study involving forty-nine (49) eyes of forty-four (44) patients without preoperative dry eye, who underwent clear cornea phacoemulsification for age-related cataract. Fluorescein tear break-up time (FTBUT) and Schirmer tests with and without anesthesia were measured before surgery and 1 week, 1 month, and 3 months after surgery. Preoperative FTBUT (14.01 ± 0.56 seconds) decreased at 1 week (3.97 ± 0.21 seconds; $p<0.001$) and at 1 month (5.82 ± 0.32 seconds; $p<0.001$) after the surgery and gradually improved by 3 months (8.26 ± 0.54 seconds; $p<0.001$) after surgery. Preoperative Schirmer test without anesthesia (18.78 ± 1.17 mm) decreased at 1 week (14.02 ± 1.52 mm; $p<0.001$) and subsequently recovered by 3 months (16.31 ± 1.34 mm; $p>0.05$). Temporary reduction in physiologic tear levels seen one week postsurgery gradually returned to near-normal baseline levels by the third postoperative month.

Kohli et al., [14] noted aggravation of both the signs and symptoms of dry eye in immediate post-operative period after phacoemulsification. The sharp deterioration was followed by a recovering trend towards the end of sixth week. This trend is similar to that reported by our study.

In agreement with our study, Zaky et al., [15] demonstrated that phacoemulsification had effects on the tear film status mainly immediately after the operation and Schirmer test 1 and tear break-up time test changed following the operation compared with data collected before the surgery. They also noted a similar change where Schirmer test 1, and tear break-up time values started returning to normal level after 1-month. Before the surgery, Schirmer test 1 was about 17.4 ± 6.11 mm. After phacoemulsification, it decreased markedly when measured on day 7, and then a gradual increase was recorded 9.23 ± 6.26 mm, 10.40 ± 7.50 mm, and 12.30 ± 5.49 mm at 7 days, 1 month and 2 month respectively. Before the surgery, tear break-up time was 15 ± 2.5 sec which decreased up to 1 month and then showed a gradual improvement.

Dodia et al., [16] in their study evaluated prospectively 272 patients undergone for phacoemulsification cataract surgery and assessed tear film status by tear film break up time (TBUT) and Schirmer's test on the pre-operative day, on the 1st, 7th and 45th post-operative day. The mean age was 60.03 years with 36-75 years range. More than half (54.4%) of the patients belongs to age group of 51-65 years. On the 45th post-operative day, 42 (15.4%) patients reported altered TBUT and Schirmer's I test (SIT) value had indicated dry eye. Statistically significant difference was observed between TBUT and SIT value on day 1 and 7 when compared with pre-operative value. Maximum change in value was reported in both sexes above 65 years for 1st and 7th post-operative day. Similar findings were reported for TBUT value also.

The results of current study were supported by Al Saad et al., [17] which enrolled forty eyes of forty patients who underwent phacoemulsification. All patients were evaluated preoperatively and up to 6 weeks postoperatively. Tear BUT and Schirmer test were measured at one, three, and six weeks postoperatively. The average age was 64.9 ± 9.73 years. There was a significant decrease in Schirmer test and tear BUT test at one week and three weeks postoperative by compared to the baseline (p -value less than 0.05). However, at 6 weeks, the values became insignificant when compared to the preoperative values (p -value more than 0.05).

In disagreement with our study, Ram et al., [18] reported no differences in dry eye between before and after phacoemulsification in 23 patients when the TBUT and Schirmer I test with anesthesia were performed. The reason for the discrepancy may be due to its small sample size, retrospective study design and type of Schirmer test.

The current study observed a statistically significant positive correlation between old age and changes of tear film after phacoemulsification.

In accordance with our results, Kohli et al., [14], Prospective study included 50 eyes with no dry eye signs or symptoms, who underwent clear corneal phacoemulsification for senile cataract. The average age was 60.60 ± 8.42 years (42-74 years). 20 (40%) patients were <60 years of age, 30 (60.0%) were >60 years of age. The percentage of patients below the age of 60 years with SI-T score <10mm and TBUT <10sec at second post-operative week was 45 %, 50 % respectively. On the contrary, the percentage of patients above the age of 60 years with SI-T score <10mm and TBUT <10sec at second post-operative week was 76.7% and 93.3% respectively.

In agreement with our study, Dodia et al., [16] evaluated prospectively 272 patients undergone phacoemulsification surgery and reported that higher age is additional risk factor for the dry eye after phacoemulsification surgery.

Conclusion:

Cataract surgery is capable of triggering dry eye symptoms and affecting dry eye test values.

The observed changes in tear physiology were temporary, and a gradual recovery to near normal tear function level was observed one month after the surgery.

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تغيرات طبقة الدموع بعد إزالة المياه البيضاء بالموجات فوق الصوتية

خلفية: البحث متلازمة العين الجافة هي مرض متعدد العوامل يصيب الغشاء المسيل للدموع قبل القرنية وينتج عنه انزعاج في العين واضطراب بصرى وعدم استقرار الغشاء الدمعى، مع احتمال تلف سطح العين.

الهدف من البحث: تقييم حدوث جفاف العين في المرضى الذين يخضعون لاستحلاب العدسة القرنية النقية وتقييم العمر كعامل خطر مرتبط بجفاف العين بعد جراحة إستحلاب العدسة.

المرضى وطرق البحث: كانت هذه دراسة إستطلاعية أجريت على ٦٠ عيناً بدون علامات أو أعراض جفاف العين، الذين خضعوا للإستحلاب القرنية الواضح لإعتام عدسة العين، والذي تم إجراؤه فى أقسام طب وجراحة العيون بمستشفى رمد قلاوون ومستشفيات جامعة الأزهر (مستشفى الحسين ومستشفى السيد جلال) فى الفترة ما بين يناير ٢٠٢٠ حتى يناير ٢٠٢١.

نتائج البحث: أشارت النتائج التى توصلنا إليها إلى أن قيم اختبار شيرمر واختبار وقت تكسير الدموع تغيرت بعد العملية. تغير تقيمة وقت تكسير الفيلم المسيل للدموع بعد الجراحة فى اليوم الأول واليوم السابع بشكل ملحوظ. لوحظ فرق ذو دلالة إحصائية بين قيم وقت تكسير الفيلم المسيل للدموع فى اليوم الأول (٦.٠٨ ± ١.١٩) واليوم السابع (٧.٠٦ ± ١.٠٢) عند مقارنتها مع القيمة قبل العملية (١١.١ ± ١). تغير تقيمة اختبار شيرمر بعد الجراحة فى اليوم الأول واليوم السابع بشكل ملحوظ. لوحظ فرق ذو دلالة إحصائية بين قيمة اختبار شيرمر فى اليوم الأول (٩.٨ ± ١.٤) واليوم السابع (١٢.٠٨ ± ١.٣) بالمقارنة مع القيمة قبل العملية (١٤.١ ± ٢.٢).

الاستنتاج: أظهرت النتائج التى توصلنا إليها تحسناً تدريجياً فى وقت تفكك الفيلم المسيل للدموع ونتائج اختبار شيرمر عندما تمت مراجعة المرضى فى شهر واحد.