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The Prevalence of Aphakia in the Civil Airman Population

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16. Abstract <p>The Federal Aviation Administration allows civilian airmen with aphakia to fly with waived certificates. This study analyzes the distribution of aphakia in the civil airman population by type (unilateral, bilateral), class of airman medical certificate, and gender for a 4-year period (1982-85). Medical records were evaluated for all certified airmen during the study period who were carrying pathology codes for aphakia and artificial lens implant. The percentage increase in the prevalence of aphakia was higher for bilateral, second-class certificate holders, and male aphakics. The incidence of total and unilateral aphakia declined during the last 2 years of the study period. Aphakia has become increasingly prevalent in the civil airman population. The increased application and modification of surgical procedures for cataract extraction, coupled with possible visual complications from these procedures in flight operations, strongly suggests continued specialized aeromedical certification and clinical research review.</p>			
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THE PREVALENCE OF APHAKIA IN THE CIVIL AIRMAN POPULATION

INTRODUCTION

An association of age-related visual conditions with aircraft accidents has been identified in prior studies. Harper (1), in a study of 3,182 pilots in general aviation accidents during 1963, found that visual defects were 2.1 times more frequent in a sample population of airmen involved in accidents than in the total pilot population, and that older pilots comprised a significant proportion in the accident related sample. Dougherty & Harper (2) reported that the average pilot medically certified in 1963 with eye pathology had a relative accident risk 1.78 times greater than that of pilots with no defects. Dille & Booze (3), in the 1979 study of accidents involving airmen with vision pathologies, found that aphakia and artificial lens implant populations had significantly higher accident rates when compared to the total airman population. In a follow-up study of 1980-81 airman accidents, Dille and Booze (4) found that pilots with aphakia and artificial lens implant, when compared to the total airman population, had higher rates in two categories of exposure: accident rates per 1,000 airmen per year and accident rates per 100,000 hours of recent flight time.

Elderly pilots are becoming a larger percentage of the total civil airman population. In 1966, pilots over 50 years of age made up only 9.5% of the total civil airman population. Twenty years later, that age group increased to almost 22% of the total population (5). As the frequency of elderly pilots increases, the prevalence of visual impairment also increases. Eye pathology, the most prevalent medical condition among active airmen (48.9/1,000 population) as of January 1, 1980 (6), increased in prevalence rate to 63.8/1,000 population by 1986-87 (7).

Cataract, a condition in which a loss of transparency of the crystalline lens or its capsule has occurred, is the third leading cause of blindness in the United States (8) and is normally associated with the aged. Aphakia, a condition in which the crystalline lens of the eye has been extracted, is usually a result of a cataract. In 1980, approximately 396,000 cataract procedures were performed in the United States (9); while in 1988, nearly one million cataract operations were performed (8). Cataract surgery accounts for about 40% of all eye operations in the United States (10) and currently results in a success rate of better than 98% (11). There are three ophthalmic devices normally employed to correct aphakia: spectacles, contact lenses, and artificial or intraocular lens (IOL) implants.

Aphakic spectacles have many disadvantages, including: reduced peripheral field of vision; enlarged visual image (30% magnification); aniseikonia in monocular aphakia; and *prismatic and aberrational effects that require head rather than eye movements* (12). Flying when wearing one or more "cataract" spectacle lenses is generally considered unacceptable because of the extreme degree of anisometropia present and the seriously affected field of vision (13). Although superior to spectacles, contact lenses to correct for aphakia have their own deficiencies. Compliance is poor, especially with rigid lenses (14); they are more difficult to locate when misplaced and are poorly handled by older aphakics; and their wearers are more prone to infections and more often develop sensitivities to contact lens solutions.

The first modern-day artificial lens implant was performed by Dr. Harold Ridley in 1949. However, during the next 10-20 years, because of problems in surgical procedures, lens designs, and sterilization techniques, the use of implanted lenses was performed by a handful of ophthalmic surgeons primarily in foreign countries. Only in the last decade has artificial lens implantation become the primary therapeutic modality for correcting aphakia. In the United States, the percentage of cataract surgeries that include intraocular lens implantations has risen from 30% in 1980 (9), to 90% in 1988 (8). Advantages of intraocular lenses include: freedom from patient handling, normal peripheral vision, minimal aniseikonia, and rapid return of binocular vision (10).

Airmen must meet specific Federal Aviation Administration (FAA) medical standards to obtain a particular class of medical certificate. There are three classes of airman medical certificates: first-class (airline transport pilot), second-class (commercial pilot), and third-class (private pilot) (15). The designated Aviation Medical Examiner may issue a medical certificate to an aphakic applicant for a third-class medical certificate, if the applicant meets certain medical standards. Applicants for first- and second-class airman medical certificates who have had cataract surgery are deferred issuance of a certificate and their applications are submitted to the FAA Aeromedical Certification Division for further consideration. A waiver can be granted for such applicants (15), after review of a completed ophthalmological evaluation.

Prompted by the substantial frequency of visual defects and the associated corrective procedures and devices used in the airman population, the Federal Air Surgeon requested a continuing research effort on vision disorders as they affect airman performance. The Vision Research Section, Civil Aeromedical Institute, in collaboration with the Aeromedical Certification Division, performed an epidemiologic study on two certifiable eye pathologies (aphakia and artificial lens implant) and their association to aviation accident risk in civilian airmen during the study period (1982-85). Due to the size of the database, the report on airmen with artificial lens implants and the association of aphakia to aviation accident risk will be presented in separate publications. The objective of this paper is to present the results of a descriptive analysis of aphakia in the civil airman population during the study period.

METHODS

The study protocol included:

1. A listing was generated identifying in FAA computer files all civil airmen who were issued airman medical certificates between January 1, 1980, and December 31, 1985, who carried one or both of the FAA-specific pathology codes 134 (aphakia) and 160 (artificial lens implant).
2. The medical records of these airmen were reviewed and selected information extracted from each record and recorded on individual data cards.
3. A Vision Defect Database was constructed from the medical examination records and FAA computer files; it contained demographic (name, date of birth, sex, restrictions, etc.) and medical (date and type of cataract extraction, date and type of artificial lens implanted, type of corrective modality, etc.) data on these aphakic airmen, if known.
4. The frequency of active airmen (those holding a current medical certificate) with aphakia was determined as of December 31 of each year of the study period (Note: Aeromedical certification guidelines consider an airman to be active for a period of 24 months after the month in which the certificate is issued.).
5. The aphakic airmen were stratified by type (unilateral, bilateral) of aphakia, effective class of medical certificate held, gender, and age.
6. Point prevalence and incidence were calculated using the total active airman populations from the Aeromedical Certification Statistical Handbook (16).

RESULTS

Among the airmen who were issued airman medical certificates between January 1, 1980, and December 31, 1985, 3,499 airmen were identified with pathology codes 134 and/or 160. Upon review of the medical records, it was discovered that 156 airmen were inappropriately coded and 10 medical records were unsalvageable, resulting in a total aphakic airman population of 3,333.

The trend in the total active civil airman population during the study period by year is presented in Figure 1. The total airman population has declined over the years, decreasing by 4.43% since 1982.

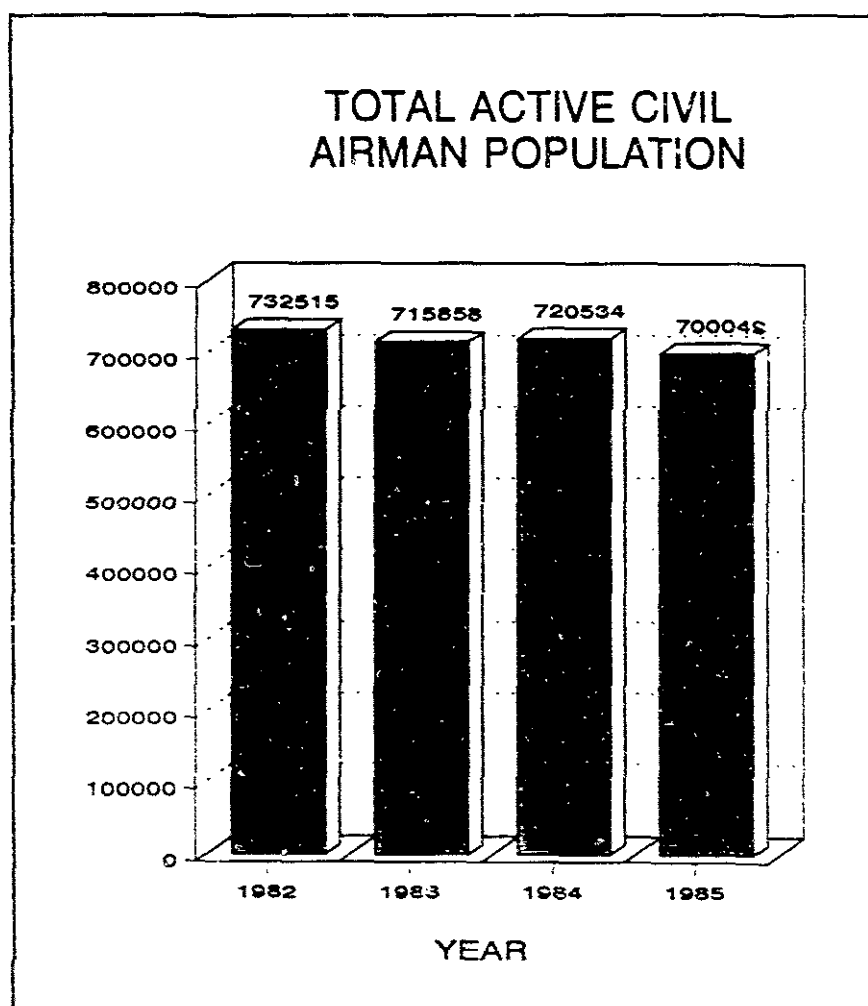


Figure 1

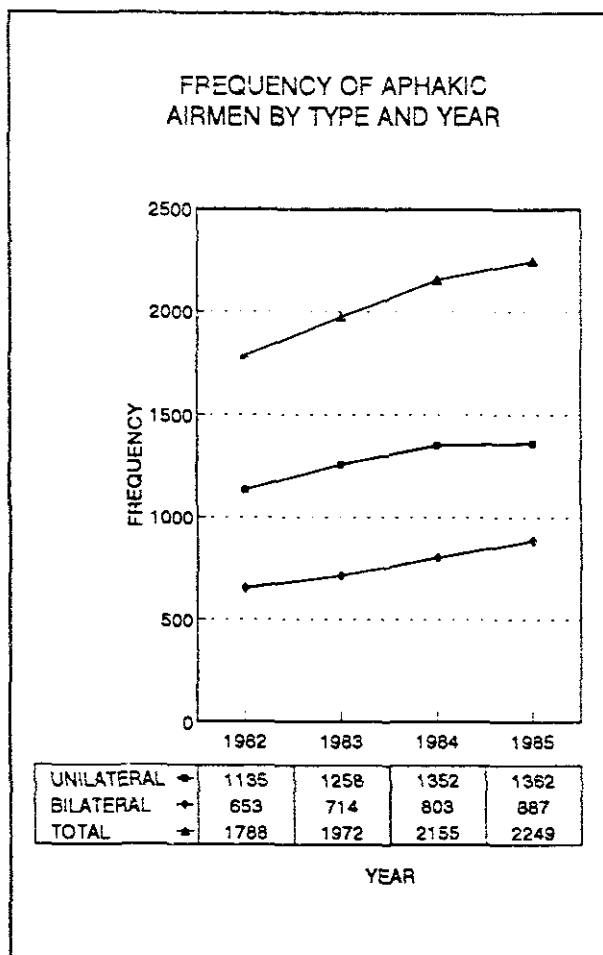


Figure 2

The frequency of aphakic airmen by type (unilateral, bilateral) and by year during the study period is presented in Figure 2. Total active aphakic airmen increased by 25.78%, unilateral aphakics by 20.00%, and bilateral aphakics by 35.83% between 1982 and 1985.

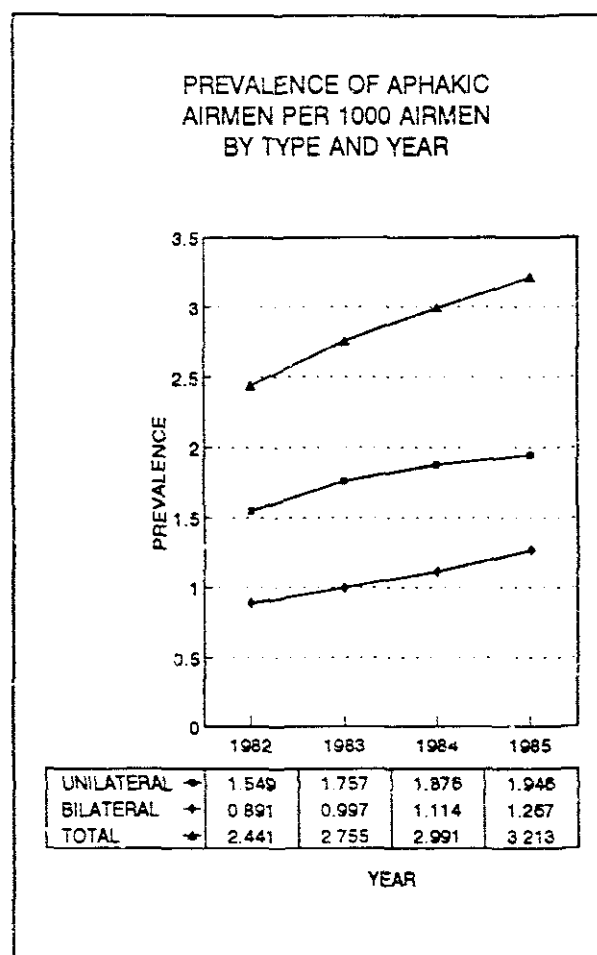


Figure 3

The prevalence of aphakic airmen by type and by year during the study period is presented in Figure 3. The prevalence of total aphakic airmen increased by 31.62%, while the percentage increase in the prevalence of unilateral (25.57%) aphakic airmen is lower than that of bilateral (42.13%) aphakic airmen between 1982 and 1985.

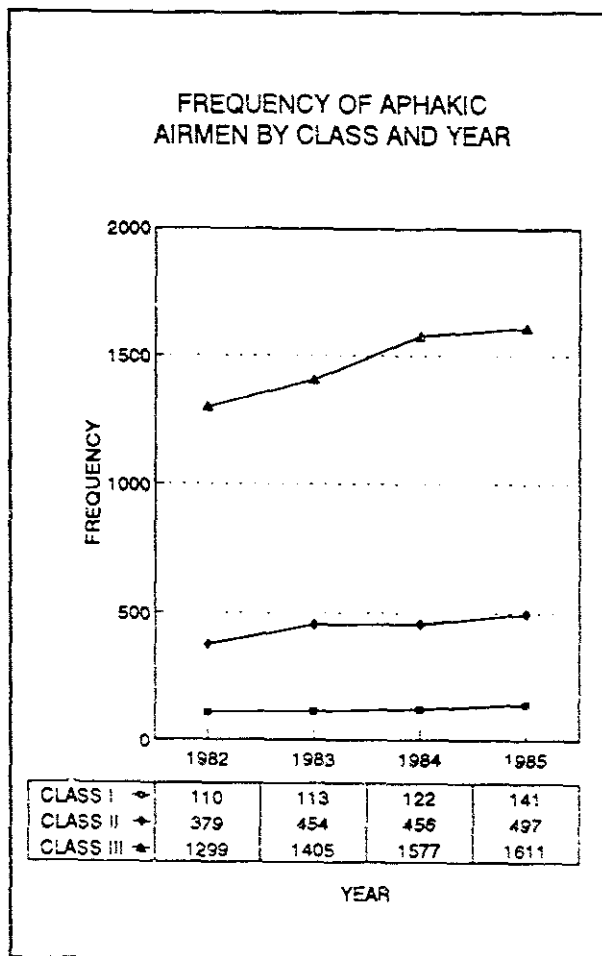


Figure 4

The frequency of aphakic airmen by class of medical certificate (first, second and third-class) and by year during the study period is presented in Figure 4. First-class increased by 28.18%, second-class by 31.13%, and third-class by 24.02% between 1982 and 1985.

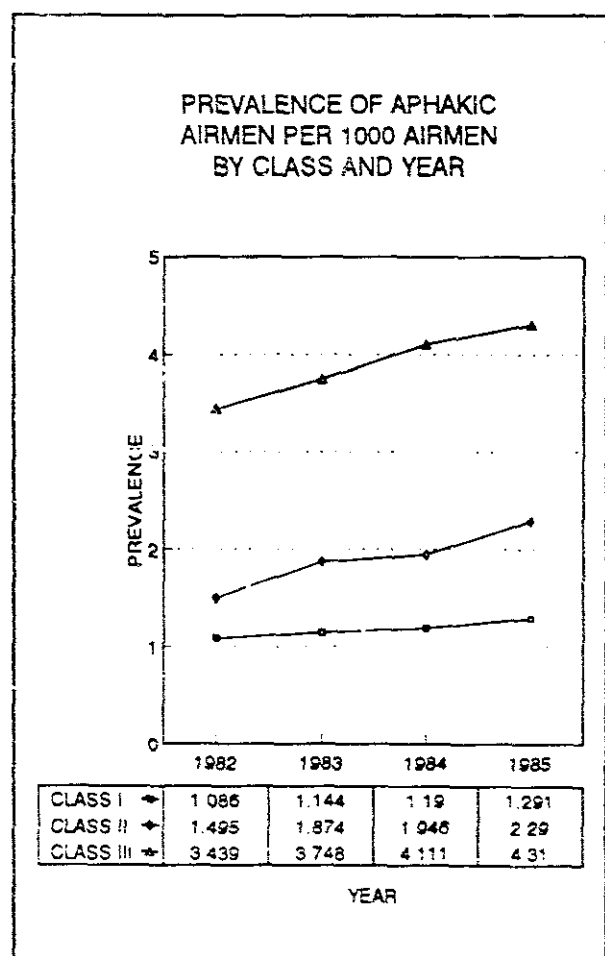
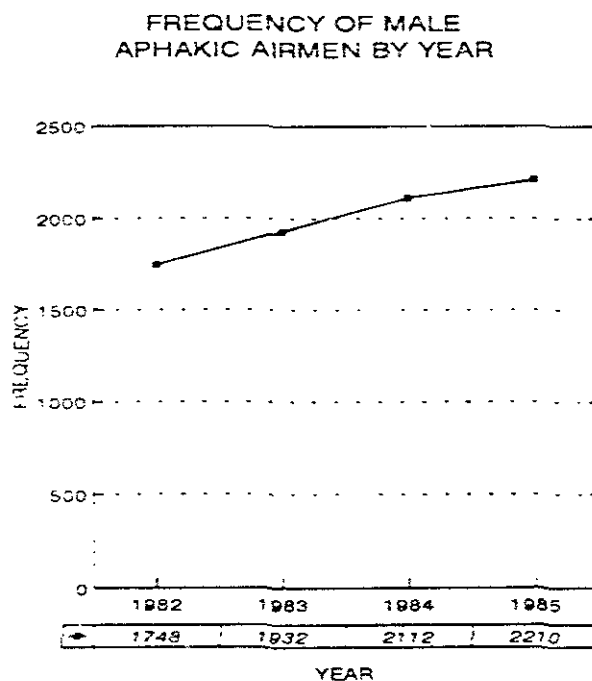
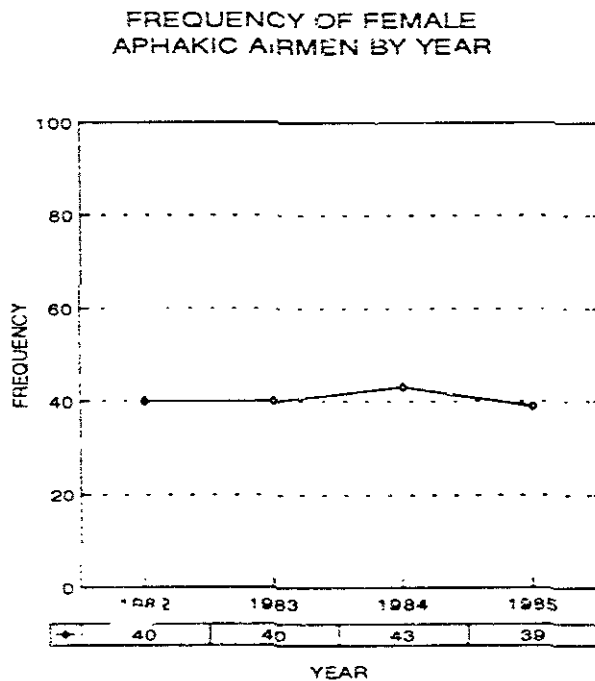


Figure 5

The prevalence of aphakic airmen by class of medical certificate and by year during the study period is presented in Figure 5. The percentage increase in the prevalence of active second-class aphakic airmen (53.16%) is higher than either first-class (18.85%) or third-class (25.33%) between 1982 and 1985.



The frequency of aphakic airmen by gender (female, male) and by year during the study period is presented in Figure 6. Female aphakics decreased by 2.50%, while male aphakics increased by 26.43% between 1982 and 1985.

Figure 6

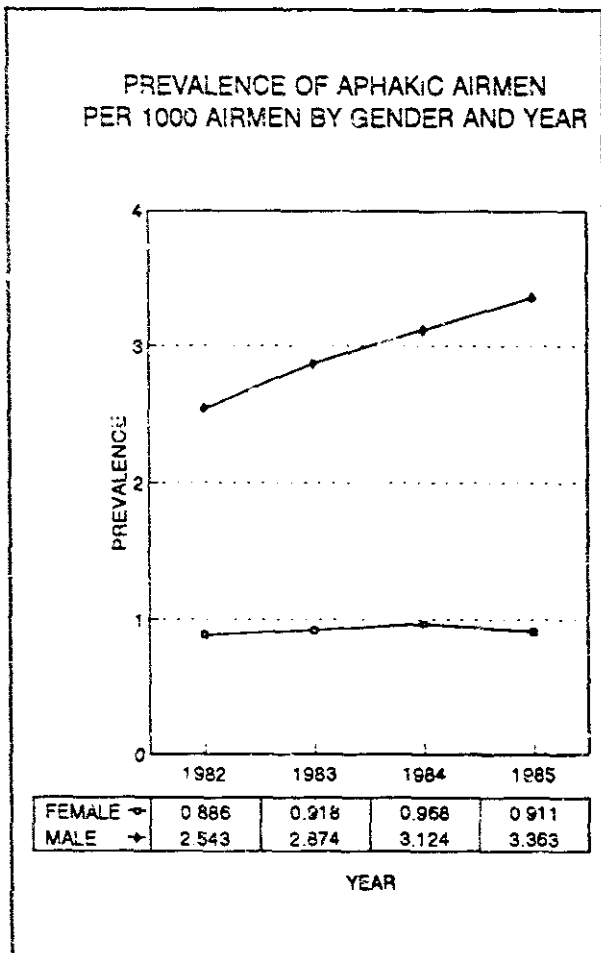


Figure 7

The prevalence of total aphakic airmen by gender and by year is presented in Figure 7. The percentage increase in the prevalence of active female aphakics (2.78%) is lower than for their male (32.23%) counterparts between 1982 and 1985.

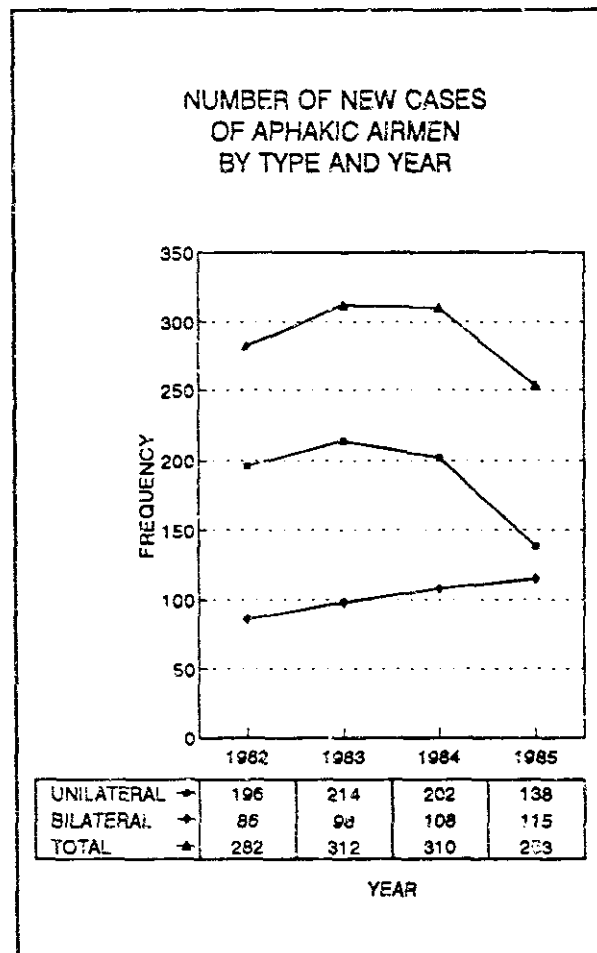


Figure 8

The number of new cases of aphakic airmen by type and by year during the study period is presented in Figure 8. Compared to its peak value in 1983, there is a decline in new cases of both the unilateral (-35.51%) and the total (-18.91%) aphakic populations in the last 2 years of the study, while new cases of bilateral aphakia have increased by 33.72% between 1982 and 1985.

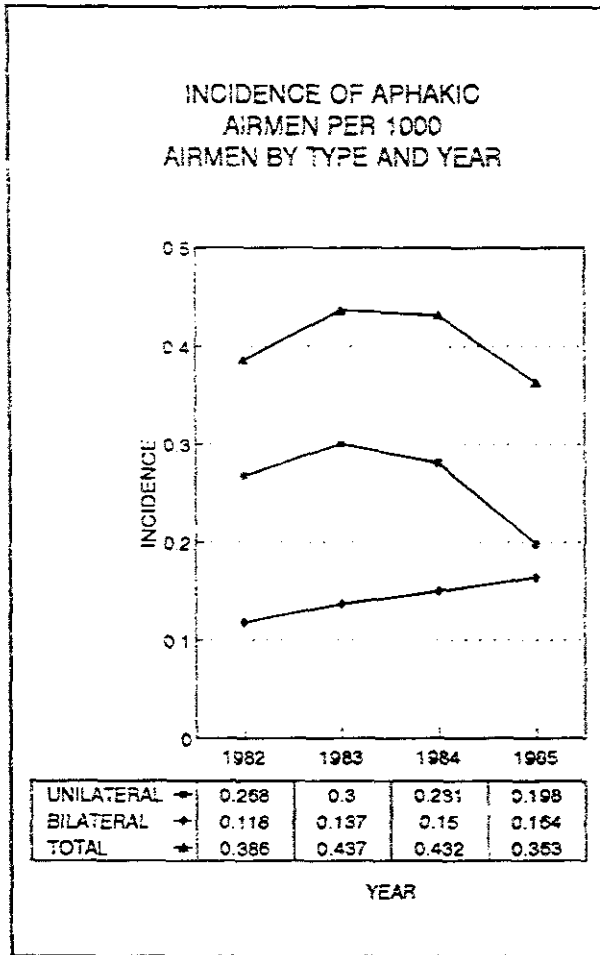


Figure 9

The incidence of aphakic airmen per 1,000 airmen by type and by year during the study period is presented in Figure 9. As in the number of new cases of aphakic airmen, since 1983 there is a decline in incidence of both the unilateral (-34.00%) and the total (-16.93%) aphakic populations in the last 2 years of the study, while the incidence of bilateral aphakia has increased by 38.97% between 1982 and 1985.

Using the Chi-Square test (X^2c), the number of older aphakics (age category ≥ 50 years of age) was found to be significantly greater ($p < .001$) when compared to the number of younger aphakics (< 50 years of age) in the airman population for each year of the study. The average ratio of frequency for the study period of unilateral aphakia was $9.20 \pm .202$, and that of bilateral aphakia was 26.69 ± 1.57 in airmen ≥ 50 years of age relative to airmen < 50 years of age.

DISCUSSION

Aphakia has become increasingly prevalent in the civil airman population. While the total civil airman population decreased by approximately 4.43% from 1982 to 1985, the frequency and prevalence of aphakic airmen increased substantially during the same period. The percentage increase in the prevalence of aphakia by type, class of medical certificate, and gender was higher for bilateral, second-class certificate holders, and males, respectively. The ratio of frequency of aphakia in the older airman population (≥ 50 years of age) was on an average 9 times higher for unilateral and 26 times higher for bilateral conditions than in the younger airman population (< 50 years of age). Although a higher ratio of frequency of aphakia in older airmen was anticipated (since cataract is often an age associated vision condition and a lens extraction procedure would be necessary in order to pass the medical certification vision standards), a ratio of this magnitude was greater than we have observed in our clinical experiences.

The decline in both the number of new cases of aphakia and the incidence per 1,000 airmen, which appears to be contrary to the increasing trend in cataract surgery in the United States during the study period, may suggest important implications to flight safety and to the airman medical certification process. Factors that could contribute to these unexpected findings include:

- 1) Self-selection (voluntary removal) from flight status by airmen with cataract and aphakia due to perceived or real visual impairment while in the cockpit;
- 2) Reluctance of airmen with cataract to have their pathology corrected with surgery;
- 3) Incompatibility of modes of correction (intraocular lens implant, contact lenses) or complications of surgical procedures for aphakia to certain flight operations or environments;
- 4) Vision disability (e.g., glare, reduced accommodation, field of vision) as a result of aphakia during routine aviation procedures being considered hazardous; and
- 5) More stringent FAA disqualification criteria being initiated during the study period.

Improvements in the surgical procedures, instrumentation, and aphakic therapeutic modalities have aided airmen with cataracts to correct their condition and improve their vision to meet current FAA medical standards. Although in recent years these improvements have reduced the incidence of complications from cataract surgery with intraocular lens implantation (8), there are concerns expressed by some medical experts related to these procedures which may directly affect the aviator. These concerns include: greater glare

sensitivity (17), incidence of other pathologies (retinal detachment, cystoid macular edema, glaucoma) (18), and injury to intraocular structures (19). Although not reported in this manuscript due to the variable information in the airman medical records, all major cataract etiologies (age-related, congenital, traumatic, etc.) and types of cataract extraction procedures (intracapsular, extracapsular and Kelman phacoemulsification) were present in the aphakic airman population. Surprisingly, it was not unusual to find an airman with different types of extraction procedures between two eyes. These various surgical procedures are being considered in future research protocols for further evaluation as to their impact on vision performance in flight simulations.

CONCLUSIONS

This study shows an increased prevalence of cataract extraction surgery in the airman population. The continued modification of these procedures, coupled with possible visual complications in flight operational settings, strongly suggest that continued aeromedical attention is needed to assess the current acceptability of aphakia and corrective devices for aphakia in the airman population. To aid in future FAA epidemiologic studies, the Aviation Medical Examiner should assure that complete information on each aphakic airman is properly documented on their medical records (FAA 8500-8 - Application for Airman Medical Certificate or Airman Medical and Student Pilot Certificate; FAA 8500-7 - Report of Eye Evaluation (15)), including: date of surgery, type of correction, complications, etc. Additionally, a study of aphakic airmen who have discontinued flying to determine the effect of aphakia on their decision would be valuable in evaluating individual cases for waivers.

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