Original Article

Study of problems associated with use of modulated power lenses (Varilux-2) by presbyopic aircrew during flying

Wg Cdr H. K. Nath, Wg Cdr GKG Prasad* VSM Gp Capt KS Soodan**

Institute of Aerospace Medicine, Vimanapura, Bangalore
**Air Force Central Medical Establishment, Subroto Park, New Delhi*
***Dy PMO HQ SWAC, Ratnada, Jodhpur*

Twenty aircrew of presbyopic age group who were already using corrective bifocal glasses were prescribed with modulated lenses fitted in tear-drop type of frame. The aircrew were required to comment on their inflight performance using modulated lenses. 85% aircrew reported marked degree of peripheral distortion with a very narrow field of central vision. 80% aircrew required significantly longer periods to focus on new objects after the gaze shift. The narrow central and vision distortion in the peripheral field vision also resulted in increased head movement which is not desired during flying from the point of view of disorientation. 80% aircrew felt multiple blur zones in the modulated glasses and considered these glasses incompatible with military flying.

A candidate for aircrew duties is not accepted if he is required to wear corrective glasses. Even retinoscopic myopes if they manifest before the completion of full flying training are taken off flying duties. But the problem is peculiar in trained aircrew who subsequently require near vision glasses for presbyopia. Different policies have been laid down at different times based on experience. Currently, aircrew are required to fly with an extra pair of glasses during flying. Presbyopia is a visual problem which is an inevitable physiological state occurring at an average age of 40 years and beyond and ceases after 65 years of age. In presbyopes, the near point recedes and at one stage, it becomes difficult for aircrew to read instruments on the panel and hand held reading materials. Most aircrew reach the peak of their flying career at the age of 30–35 years and remain in active flying till 40–42 years of age. Subsequently also, most of the aircrew may be employed on active flying duties in different assignments. Thus a large population of aircrew in IAF are required to fly with presbyopia.

In flying near vision is important during take off and landing during which monitoring of cockpit instruments is crucial. The aircrew have to be corrected for this presbyopia for their continuity in flying. Various types of glasses like bifocal, trifocal in different frames have been used to correct presbyopia in aircrew but these are not free from associated problems like narrowing of field of vision, ill fit, discomfort of wear for long hours of flying and effects of G forces. These associated problems are particularly peculiar to military flying where different combinations of mask and helmet are worn by the aircrew. An ideal solution of use of corrective glasses is yet to be reached and specified.

Vision through corrective glasses should be undistorted at various distances from the flight safety point of view. In addition, the corrective glasses should be comfortable during long hours of wear and free from other associated problems. In the conventional bi-focal glasses, there is some amount of distortions and blurring of vision during shift of vision from one segment to another due to abrupt change in the power of refraction.

The objective of this study is to see if the problem of distortion and blurring of vision can be overcome by using modulated lenses in lieu of conventional bifocal glasses. In a modulated corrective glass, there are no distinct visible zones but the glasses are progressively powered in each segment there by avoiding the shift of vision from one power to another differently powered segment. There glasses are a possible replacement for bifocal glasses during flying. The aim of this study was to find out the suitability of use of modulated power lenses by presbyopic aircrew of Indian Air Force.

Prescribing spectacles for aircrew

Vision is considered the best aid of aircrew inspite of technological advancements like infra red imaging system, head up displays and improved instrument lighting systems. Therefore, prescribing correct spectacles to aircrew is of critical importance. Prescribing corrective glasses for aircrew pose unique problems, more so in Presbyopic aircrew [1]. Following precautions should be observed while prescribing spectacles to a presbyopic aircrew:-

(a) The examination for and prescription of a corrective spectacle must be carriedout by an examiner who has knowledge of problems of vision in aviation.

(b) Lenses and frames should be compatible with aircrew task and aircrew equipment assemblies.

(c) The examinee should provide the examiner with the information of nature of task, measure of near vision working and field of vision so that appropriate single or multifocal lenses can be provided.

(d) The spectacle frame should be thin and light to reduce the restriction of field of vision. The spectacle side pieces should also be thin so as to avoid breaking of noise seal of head set and to avoid pain over the pinna in a tight fitting of the helmet. Ahluwalia *et al.* have recommended a tear drop metal frame for the aircrew [2].

(e) In order to reduce the incidents of ocular and facial injury due to bird strikes, the lens material should be of synthetic nature such as CR39 resin or Polycarbonate. Glass lenses should preferably be avoided.

(f) To cater for loss or breakage of spectacles, the aircrew must be advised to carry an extra pair of similar glasses, although, the loss of glasses while in use is very rare.

(g) Aircrew should adjust to the new glasses on ground before using them in flight. The various problems could be like, objects looking smaller or bigger, appear nearer or farther and visual distortions may be manifest for any period of time. This adjustment period may last from few days to few weeks to months in a few cases. The authors feels that even after adjustment, an aircrew should fly with a safety pilot for first few sorties so as to get adjusted to glasses in the flying environment. The aircrew may sometimes find some problems during landing and take off where vision plays a crucial role.

Material and Methods

20 presbyopic fighter pilots on active flying who were using presbyopic glasses participated as subjects in this study.

These subjects were called to the Institute of Aerospace Medicine (IAM) along with their personal sets of flying clothing.

Fitments at IAM: First a complete clinical eye examination was done including visual acuity. After distance correction, if any, the glasses for near vision were tested and power of glasses recorded.

After testing the power of glasses, suitable size of frame was selected (Rayban Type Pear shaped frames ranging from No 4–7). The selected frame was tried with the flying clothing

Table 1. A comparison of problems reported by the subjects using conventional bifocal glasses and modulated power lenses. (n = 20)

Parameters		*Bifocal/ Lookover*	*Modulated Power lens (Varilux Glass)*	*P Value*
I. On Ground				
1 Ground Activity	Comfort	20	11	<0.05
	Discomfort	0	9	
2 Restricted Field Vision	Yes	0	17	<0.05
	No	20	3	
3 Judging of distances	Yes	20	4	<0.05
	No	0	16	
4 Ghost Images	Yes	0	3	NS
	No	20	17	
II While Flying				
1 Flying Activity	Comfort	20	3	<0.05
	Discomfort	0	17	
2 Reading of Overhead Panel	Yes	20	4	<0.05
	No	0	16	
3 Fogging of Glasses	Yes	10	3	<0.05
	No	10	17	
4 Displacement				
(a) With Flying clothing	Yes	20	14	<0.05
	No	0	6	
(b) Spectacles During +Gz	Yes	20	4	<0.05
	No	0	16	
III Remarks for Acceptance of Glass	Suitable	16	4	<0.05
	Not Suitable	4	16	

assembly to ensure compatibility and proper fitment.

After the above trial, optometric measurement was taken and Varilux glasses prescribed.

Varilux or Modulated Power Lenses. In these lenses, the whole lens surface has been optimised so as to obtain the best overall comfort. The manufacturers claim that there is no loss of extra foveal and kinetic vision with modulated power lenses. The present study has been undertaken due to advantageous claims of varilux lenses over Single-Vision and Multi-Vision.

Fitment trials with Varilux glasses were repeated again with the individual flying clothing of the subject to ensure compatibility. Vision test was done at varying heights and distances to simulate head down and head level instrument panels. He was also tested in cockpit of locally available aircraft as far as possible or under simulated conditions of aviation environment at IAM.

All subjects were given detailed instructions for use of glasses during the initial adjustment period and later during flying. Their observations were recorded on a specially designed proforma.

Results

The proformae completed by all subjects were analysed and the findings are presented in Table 1 as compared with conventional bifocal glasses.

Discussion

A study of compatibility of modulated power lenses wear by presbyopic aircrew was necessi-

tated to find an alternative to bifocal spectacles. In the present study the subjects were using these varilux glasses during different flight profiles and on ground.

On the ground the aircrew felt difficulty in focusing different distances with modulated power lenses. To over come this the pilots had to move their head up and down. This involved longer time to get adjusted with modulated glasses as compared to old bifocal glasses. The percentage reporting on this aspect was 100% comfortable with bifocal and 55% in case of modulated lens. This difference observed in the percentages of these two lenses is statistically significant.

The percentage of comfort while flying with modulated power lens is decreased to 15% as compared to bifocal which provides 100% comfort to pilots. This is attributed to the inherent quality of modulated lens in which the clear vision is limited to the central area of the lens resulting in frequent head movements. The lateral movements of the eye without head movement resulted in blurring effect due to the peripheral disturbances of the lens. These disturbances are due to the nonspherical curvatures of the modulated (Varilux) lens and moderate degree of astigmatism with oblique axis [3].

Restricted field of vision is another factor in Varilux lenses which has been noted during flying as well as on the ground by aircrew in the study. 85% of aircrew had noticed the effect of restricted field which is statistically significant ($P < 0.05$) in comparison with bifocal glasses where it was nil as shown in the table. Restricted field of vision is also due to gradual increase of power from upper end of the lenses to lower periphery where maximum power is reached. This effect was further noticed while looking over instrument panel. The aircrew also noticed a change in shape of the sidewards instrument panel. To overcome this effect he has to turn his head laterally. 20% aircrew reported this effect compared to bifocal/lookover glasses, where none reported this effect, thus showing a significant difference.

Fogging effect of glasses was less in modulated power lens as compared with bifocal, 15% and 50% respectively. It may be due to proper size and shape of the frame used in prescribing modulated lenses.

Ghost images were less with bifocal/lookover glasses (0%) as compared to modulated power glasses (15%). This was not statistically significant.

With regard to the frame used there was no displacement of frame noted with tear drop shaped spectacles, during + Gz as also reported by Ahluwalia *et al.* [2]. Displacement was 20% in comparison with bifocal/lookover glasses when other type of frame was used.

Thus the acceptance of bifocal lens is 100% as compared to 20% of modulated lenses which is significantly lower.

Modulated varilux lens have multiple segments with increasing power towards lower side. While taxiing and take off the pilot gets a feeling of high power due to segmental in-crease in power. It is less in bifocal as there are only two segments. Therefore, he has to adjust to this effect by his head movements which are much more in varilux as compared to bifocal glasses.

The blur zone along with embedded transient power of these segments may also be responsible for distortion effects to adjust to the datum lines (visual axis). To overcome this effect the pilot has to change his head and eye position.

The distortion and waviness in peripheral vision appear to be due to the varilux surface in which the central area of lens is mainly used in focal vision. This effect also decreases with head/eye movements.

The above complaints increase during night flying. It is because of diminution of illumination intensity resulting in paramacular and peripheral retinal stimulation which becomes more active after dark adaptation.

Conclusion

Most of the aircrew were not comfortable in flying with varilux glasses. Therefore, these glasses are not suitable for use in aviation as there is an increase in head movements due to peripheral distortions and restricted field vision to view distant and near objects. Bifocal glasses are found to be relatively more suitable as compared to modulated (Varilux) lenses.

References

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