Spectacles- What We Do Not Know

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Introduction
Spectacles is a common, cheap and easy method of prescribing corrective lenses in patients with refractive errors and presbyopia.

Working knowledge about spectacle lenses, frames and process of dispensing will help an ophthalmologist to give exact instructions to the optician. This will go a long way in ensuring patient satisfaction with glasses.

What is a Spectacle?
Spectacle is defined under British standard as an optical appliance comprising lenses and a frame with sides extending towards ears (Fig 1).

I. Spectacle Frames
A. Parts of a Spectacle frame
Each frame has two main parts - Front & Side.

- **Front** consist of rims, bridge, joints and lugs.
- **Rims**

May be complete or incomplete or full rim, rimless(3ps) and half rim(supra)
Lenses are supported by nylon or steel wires.

- **Bridge**
Is that part of front which forms the connection between two rims (Fig. 2). Bridges may be of three basic types
1. Regular:-it rest on the nose with full surface in contact.
2. Insets bridge/Keyhole:-Projects behind the frame plane so that area of contacts has behind the lenses plane.
3. Saddle Bridge:-Combination of regular and insets bridges. It mainly distributes the weight of spectacles on top as well as side of nose.
4. Modified saddle bridge
5. Adjustable nose pads:-Allow for good fit.

Different types of bridges

- **Lugs**: Projection on sides to which side pieces are attached.

- **Side Pieces / Temples** are the principal parts that fix spectacles to ear. They are made up of metals and plastic in combination.

B. SPECTACLE FRAME MATERIALS
An ideal spectacle material must be durable, adjustable, non allergic, non inflammable, non corrosive and preferably of low cost.

- Plastic frames
- Shell frames
- Nylon frames
- Metallic
- Combination

Fig. 1. Parts of a Spectacle

Regional Institute of Ophthalmology, Calicut
a) **Plastic Frames**: Thermoplastic material is used usually as these can be heated and cooled without losing their plasticity. Cellulose acetate, Cellulose nitrate, Cellulate propionate, Perspex (Synthetic acrylic resin-PMMA), Epoxy resins are examples.

b) **Shell frames**: Made from shell of Hawks bill turtle found in West Indies and Seychelles. They are durable, have attractive colours and mottling and are easy to maintain.

c) **Nylon**: were used in making spectacles for children where chances of breaking were high.

d) **Metallic frames**: These are stable, quite adjustable, non inflammable and non allergic (except nickel) and pleasing. They are inexpensive and can be mass produced. Variety of materials like stainless steel, nickel, silver (German Silver), anodized aluminum, gold, titanium and memory metal are used for making frames.

e) **Combination frames**

C. FRAME STYLES

Spectacle frames are available in different styles. They include Full Frame, Combination Frame, semi rimless and Rimless (Drill mount).

D. FRAME SELECTION

Correct fit and selection of frames is an essential part of accurate dispensing. Frames must be rigid, strong, and light and must be comfortable for the wearer.

**Points to be taken into account**: (Fig. 3)
- Temporal hairline margin distance
- IPD
- Shape of the face
- Physical features of face.
- Nose bridges and suitable side arms.
- FTB
- Pantoscopic tilt
- Fitting triangle

Computer software programs are available by which we can match the facial form with different type of spectacle styles and select the suitable frames.

**FTB**: Distance between back surfaces of the front to the ear. Too large FTB will cause the frame to sag.

**Pantoscopic Tilt**: Lower end of the frame is tilted backwards towards the face. In this way optical center of spectacle lenses coincides with the fixation axis. This is needed because, most of the time eyes are looking in downward direction. Pantoscopic tilt reduces chromatic aberration of a high power lens and has better cosmesis.

**Fitting triangle**: is an important criterion of good fit. Properly fit frames should touch the patient in only three places – bridge and the top of each ear. An imaginary line drawn from each point of contact with the wearer's face results in an triangular shaped form and this is called as “Fitting triangle” (Fig. 4).

II SPECTACLE LENSES

Spectacle lenses consist of a transparent material that has two polished opposing surfaces with ability to focus light rays in an expected manner. For proper understanding of the requisite features of lenses, one needs to be familiar with critical properties like...
refractive index, dispersion expressed by Abbe value and specific gravity.

**Refraction:** Bending of light when it passes from one medium to another.

**Power:** Power of an ophthalmic lens is determined by the difference between the front and back curve of the lenses expressed in dioptre.

**Refractive index:** is the ratio of velocity of light in vacuum to the velocity in a given medium at a given wavelength.

Increasing the refractive index reduces the edge thickness of minus lens and centre thickness of a plus lens. The volume of the material is reduced and also we get flatter surfaces.

**Specific gravity:** is the ratio of the weight of a substance to the weight of water with the same volume. A high index lens will be heavier due to high specific gravity.

**Abbe value:** indicates the ability of a lens material to refract white light without chromatic aberration. Abbe value runs between 1 and 100. Higher the Abbe value the better but only upto a point. Abbe value of the human eye is 45, hence it becomes difficult to perceive above this value. Optimum Abbe value is necessary for optical efficiency of a lens.

**Optical center:** of a lens is the position along the optic axis where no prismatic effect is found.

**Visual axis:** is an imaginary line from an object of fixation in the field to the fovea. The best and least distorted image is obtained when optic centre matches the visual axis.

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**A. Types of Spectacle Lenses**

a. Can be classified as spheres, cylinders, and prisms.

b. Can be grouped based on choices of lenses.
   1. Single Vision
   2. Bifocals
   3. Lenticular
   4. Aspheric
   5. Multifocals/Progressives

c. Can be grouped based on the purpose for which they are given
   1. Optical Purposes
   2. Sunglasses
   3. Vocational Spectacles
      - Half eye reading
      - Safety spectacles
      - Swimming goggles
      - Spots glasses
      - Driving mask
      - Computer glasses
      - Welding goggles
      - Lorgnette, quizzers
      (held before eyes by a handle)

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**B. Lens Materials**

Lenses like frames are made up of a variety of materials.

**Common materials:**
- Glass, plastics.

**Special Materials:**
- Poly carbonate
- Hi-index lenses
- Trivex

An ideal ophthalmic lens material should satisfy several parameters and requirements.

**Visual requirement:** Abbe value and other visually related concerns are to be considered.

**Cosmetic:** should be cosmetically acceptable to the wearer - “People should see the wearer’s eye than the glasses”.

**Safety:** particularly for children, individuals involved in sports, special jobs and monocular individuals.

**Health:** In terms of UV and other occupational hazards.
1. Glass
Crown glass :- with RI of 1.5223 is used mostly
Abbe value 58.5. They are highly transparent, scratch resistant and low cost but they are thick, heavy and can break easily
Flint glass:–has high RI of 1.62. Due to high specific gravity and low abbe value, flint glass has the disadvantage of being heavier and has high chromatic aberration.

2. CR 39 (Columbia resin)
Chemically it is allyl digtycol carbonate and was created by chemists at Columbia Southern Corporation in 1942. 39 indicates that the 39th test resin produced by the company was successful
RI 1.498, 1.58, 1.6, 1.74. As it is a thermosetting material it can be ground and polished after manufacturing without risk of deformity.

Advantages:-
a. Good optics and chemical resistance.
b. Comfortable due to light weight.
c. Safer than glass lenses.
d. Unlimited designs, coating and tinting.
e. Photo chromatic options available.

Disadvantages:-
a. Poor structural integrity
b. Unstable at high temperature
c. Scratches more easily
d. More expensive
e. Not suitable for rimless frame as they can wreck.
f. Difficult to drill without cracking

3. Polycarbonate Lenses
RI 1.586 is an amorphous material and is the lens of choice when safety is an issue.

Advantages:-
a. Thinner as they have high refractive Index. Centre thickness can be ground to 1.2 mm.
b. Lighter (26% Lighter than CR 39) due to low density.
c. They can bend easily without getting deformed therefore they have got high impact resistance.
d. Has built in UV protection.
e. Bullet proof.

Disadvantages:-
a. Soft so very low scratch resistance.
b. Tinting not possible.
c. Cause peripheral chromatic aberration in high minus power.
d. Low abbe value and needs ARC.
It is the lens of choice in children, athletes and people working in industry.

4. Hi-index Lenses
Are made of denser materials than conventional materials. They are available in plastic resin (Mitsui Resin-MR-8, MR-10, MR-11) and glass. They can be made thinner hence useful in high powers. RI - 1.6, 1.7, 1.8, 1.9. They can be anti reflection coated.

Disadvantages:
a) Not necessarily lighter even though thinner.
b) Costly.
c) Low Abbe value.
d) ARC is a must.

5. Photochromatic Lenses
Has the property to change the colour when the sunlight or UV light strike the lens surfaces. They are also called variable tint/Day and Night /Transition lenses.
The darkening process takes as little as 45 seconds but the reverse lightening process takes up to 20 mts. For this reason it is not advisable to prescribe them as a routine.

Photo grey (PG) photo brown (PB), Photopink (PP) are the available colours. They are available in glass and plastic. They provide UV protection and some relief from glare.

6. Trivex (Trilogy) – (Essilor)
This is an alternative to polycarbonate lenses. TRIVEX material has good optics and inherent UV protection.
Antireflective coating and Scratch resistance coating can be done. Tinting is possible. It has less chromatic aberration compared to polycarbonate lenses. They are the lightest lens available, are unbreakable and resistant to chemicals. Easy drilling and mounting is possible hence it is the ideal material for rimless spectacles. Abbe value of human eyes and Trilogy is 45 which is the reason for its excellent clarity.

III) LENS ENHANCEMENTS

- UV protection
- Scratch resistance coating (SRC)
- Anti reflection coating (ARC)
- Tinting
- Hydrophobic coating

UV Protection:

In the electromagnetic spectrum we are capable of seeing wavelengths between 400nm-760nm (VIBGYOR). Rays above 700 and below 400nm are harmful to the eyes.

UVC (250-286), are filtered by Ozone layer of earth
UVB (286-320nm) are primarily absorbed by cornea and can lead to snow blindness, photokeratitis etc,
UVA (320-40nm) are absorbed by crystalline lens and cause cataract.

Plastic lenses are treated chemically for obtaining UV protection.

Scratch Resistance Coating (SRC)

Done to prevent easy scratching of plastics. This clear coating hardens to provide a durable, tougher lens. Scratch resistant does not mean scratch proof.

Anti Reflection Coating (ARC)

This reduces reflection from the surface of lens and increase transmission of light. Maximum transmission gives maximum clarity. This helps to eliminate “shop window” effect and road blindness (temporary blindness caused by high beam head lights of oncoming vehicles). It also reduces eye fatigue in artificially lit environment. Available in yellow, green and blue colour.

Hydrophobic Coating:

Is a water resistant coating which prevents staining and smudging on the lens surface making it easy to clean.

Essilor Crizal Alize and TMC Satin (Titanium Multi Coating with Satin) are examples of superior ARC with hydrophobic properties.

Fig. 5. Demonstrates the beneficial effect of anti refractive coating

Tinting:

Can cut the amount of light that reaches your eyes and provide relief. Lenses can be tinted in a solid pattern, meaning entire lens is tinted the same colour or they can be tinted in a gradient pattern. Several tints like pink, brown, grey, green, blue etc are available.

Drive Wear Technology: combines ARC, UV protection and tinting effectively. In addition to glare and excessive light protection, drive wear enhances red and green traffic signal recognition. It blocks 100 % UV light also. They are available as prescriptions for plano, single vision and as progressives.

IV) Lenses For Correction of Presbyopia

Single vision lenses: Corrects for one focal length. ie., for distance or near only.

Bifocal lenses – correct vision at two distances ie Distance and near

Can be kryptok bifocals, or as Univis / D bifocals

Disadvantages : No clear vision for intermediate distance, has a disturbing dividing line and has “image jump”.

Progressive Lenses: These are aspheric lenses in which power gradually changes from distance
correction at the top through intermediate powers to the near prescription at the bottom of the lens.

**Progressive design**

**Advantages:**

a) No lines in the way of vision  
b) Convenience of having a single pair  
c) Available in a variety of materials

![Fig. 6. Progressive lens](image)

**Customized designs** have no preconceived design. They utilize each patient's unique head and eye movements which are measured using a device called “Vision Print System” for optimal visual performance. e.g.: varilux ipseo, rodenstock pure life, solax etc

**Occupational Progressives:** are multifocal aspheric progressives, designed for both near and intermediate vision. The lower half is for NV correction and upper half for mid range vision up to 2.5 metres.

They are an ideal solution for CVS as computer users benefit from a natural head and neck position, and form a wide intermediate area for computer use.

Eg: AO compact, Zeiss RD, Panorama Mini, Essilor Ellipse, Kodak Precise

**Spectacles for Kids:**

- Choose colourful/trendy/sturdy frames  
- Not unisex, separate for boys / girls  
- Give special attention to frame material, nose bridge, nose pads, hinges etc. High quality spring temples, silicone nose pads, elastic straps etc are good options  
- Lens material can be CR39 or Polycarbonate  
- Use aspheric design  
- Provide SRC, ARC and avoid tinting  
- The lens should cover the eyes

**Points to be considered in lens fitting:**

1. **Vertex Distance** - Should be specified for higher prescription.

   Pupillary alignment: Pupils should be close to the optic centre of each lens to take full advantage of refractive correction given.

2. **IPD:** Interpupillary distance should be measured both for distance and near.

3. **Fitting plane of lenses** – lenses should be in a plane perpendicular to the visual axis, ideally fitted 15.7mm in front of cornea which corresponds to...
anterior principal focus, but practically fitted as close to the eye as possible.

4. Optical centres: Marking is very important for proper fitting as it should coincide with visual axis. Hold the lens against a cross line chart horizontally or vertically and move until one gets an unbroken cross.

**Conclusions**

Spectacles still form a major share in optical correction of refractive errors and presbyopia. Wider choices are available in frames and lenses. Selection depends on taste and budget of the patient, occupational condition and requirement – Finally the **wearer should see well and look good.**

**Fig. 7. Measurement of Interpupillary distance**

**Fig. 8. Marking of optical centre of the lens**

**References**

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