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Improving the description of the retinal vasculature and patient history taking for monitoring systemic hypertension

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Summary

Systemic hypertension is an important public health concern. If optometrists are to perform a more active role in the detection and monitoring of high blood pressure (BP), there is a need to improve the consistency of describing the retinal vasculature and to assess patient's ability to correctly report the diagnosis of hypertension, its control and medication. One hundred and one patients aged >40 years were dilated and had fundus photography performed. BP was measured and a self-reported history of general health and current medication was compared with the records of their general practitioner (GP). The status of the retinal vasculature was quantified using a numeric scale by five clinicians and this was compared to the same evaluation performed with the aid of a basic pictorial grading scale. Image analysis was used to objectively measure the artery-to-vein (A/V) ratio and arterial reflex. Arteriolar tortuosity and calibre changes were found to be the most sensitive retinal signs of high BP. Using the grading scale to describe the retinal vasculature significantly improved inter- and intra-observer repeatability. Almost half the patients examined were on medication for high BP or cardiovascular disease. Patients' ability to give their complete medical history was poor, as was their ability to recall what medication they had been prescribed. GPs indicated it was useful to receive details of their patient's BP when it was >140/90 mmHg. The use of improved description of the retinal vasculature and stronger links between optometrists and GPs may enhance future patient care.

Introduction

Despite improvements in awareness, treatment and control of high blood pressure (BP), cardiovascular disease and stroke continue to be the chief causes of death in developed countries (Marshall and Malinovsky, 1998). The retinal findings of cardiovascular disease include arteriolar nipping and focal narrowing, haemorrhages, lipid deposits, inner retinal ischaemia spots and microaneurysms. Their relevance to the detection and management of high BP have been discussed in detail in the accompanying review article (Hurcomb *et al*., 2001). Although retinopathy in the eye is a frequent complication as well as a good prognostic indicator of sustained hypertension (Wagener *et al*., 1947; Breshin *et al*., 1966; Walsh, 1982; Marshall and Malinovsky, 1998), BP measurement is a more specific and reliable (Schubert, 1998). There is a potential screening role, therefore, in optometrists measuring their patient's BP in addition to performing ophthalmoscopy (Terry, 1976; Klein *et al*., 1993).

There is still an important place for examination of the retinal vasculature as its appearance is a useful indicator of the general state of the body's vascular network via a non-invasive technique (ophthalmoscopy). Changes in the arterioles are thought to indicate the damage caused by acute or chronic elevated intra-arterial pressure and may

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be a clinical sign of greater value to the GP than hypertensive retinopathy per se, as the severity of hypertension can readily be assessed by BP measurement. The amount of sclerosis also serves as an excellent index of the duration of hypertension and hence prognosis (Scheie, 1953).

Grading scales for examining the retinal vasculature have been in use since the late 1930s and assist in predicting the prognosis for survival within groups (Walsh, 1982). The most commonly used grading scales and their limitations have been discussed in the accompanying paper (Hurcomb *et al*., 2001). It has been suggested that present classifications for hypertensive retinopathy are inadequate and result in the loss of clinical information (Svardsudd *et al*., 1978; Hayreh, 1989). A more detailed description of fundus features is more informative for assessing the current vascular status and for follow-up of any changes.

Many patients with high BP are asymptomatic, unaware of their condition and may not be attending their GP regularly. These people may attend an optometrist every 1 to 2 years and therefore optometrists can play an important public health role in screening for systemic hypertension (performing ocular fundus examination, measuring BP and emphasizing the importance of regular GP assessment and referring suspect patients to their GP for appropriate investigation and management).

It is essential that eye-care practitioners are aware of whether a patient has been diagnosed with systemic hypertension and of all the systemic medications they are taking. Systemic β-blockers, which are used to control hypertension, may interact with topical glaucoma medication, such as by increasing side effects or affecting intraocular pressure. In addition, the presence of significant cardiovascular disease may be a contraindication for non-selective β-blocker therapy (e.g. timolol). Systemic absorption of phenylephrine hydrochloride through conjunctival vessels or nasal and oral mucosa after topical instillation can cause a rapid rise in systemic BP (Garston, 1975). Unfortunately it has been suggested that patient reporting of hypertensive history is notoriously unreliable (Scheie, 1953).

In the population of Beaver Dam, there was a 90% agreement between in person and telephone reporting of eye disease, but the presence of disease was greatly underestimated (Linton *et al*., 1991). Even a patient's ability to accurately record BP in a log book has been found to be poor (Mengden *et al*., 1998). If optometrists are to take a more active role in minimising morbidity and mortality due to systemic hypertension, it is important to have the support of the patient's GP and to ascertain appropriate referral criteria. Wasloski (1999) stated few doctors would object to optometrists measuring BP in the USA, but this is yet untested in countries such as the UK and Australia where BP measurement is not commonly a part of every day optometric practice.

The aims of the study were to devise and test a basic clinical descriptive grading system for retinal vasculature and to investigate its relationship with respect to BP measures. The potential of image analysis to measure objectively certain features of the retinal vasculature was also investigated. Patient ability to report correctly the diagnosis of systemic hypertension, its control and medication was compared to the information supplied by their GP. Referral criteria for optometrists measuring BPs were also examined.

Methods

Subjects were recruited from patients attending the Melbourne Optometry Clinic of the Victorian College of Optometry for routine optometry care. The Melbourne Optometry Clinic is a publicly funded clinic providing reduced cost eye-care for people who are disadvantaged and with limited means. The study was approved by the Human Ethics Committee of the Institution. Those who had been dilated (using Tropicamide Hydrochloride 0.5%, one drop in each eye) as part of their routine eye-care were invited to take part in the study after completion of their eye examination. They were given an information sheet on the procedures to be undertaken and, if willing to take part, signed a consent form. They also completed a release form allowing information of their results to be sent to their GP and for the practitioner to return information about their general health. The researcher and the patient's optometrist were separate individuals. The 101 subjects who took part in the study ranged in age from 43 to 84-years-old (median 67-years-old). Forty-seven percent of the participants were male and 53% female.

Subjective gradings

Fundus colour 45° photographs of both eyes, centred on the optic nerve head, were taken through dilated pupils using a Nikon NF-505 fundus camera attached to a Kodak DCS professional 420c digital camera. In five subjects the photographs were of poor quality due to cataracts and were not used for the subjective gradings. The five clinicians described independently the vascular features observed in the remaining photographs in one session. Ten photographs appeared twice to examine intra-observer repeatability. The clinicians were masked from each other's descriptions and the patient's age, gender and BP readings. The retinal vascular tree is essentially arteriolar, rather than arterial, as it has lost its elastic lamina and the muscular coat is not continuous by the first or second bifurcation (Scheie, 1953). Therefore, the following characteristics of the retinal vasculature were graded within one and three disc diameters of the optic nerve head:

1. artery-to-vein (A/V) ratio (as a percentage);
2. tortuosity (graded between 1 and 5 in half steps);
3. arterial reflex (as a percentage);

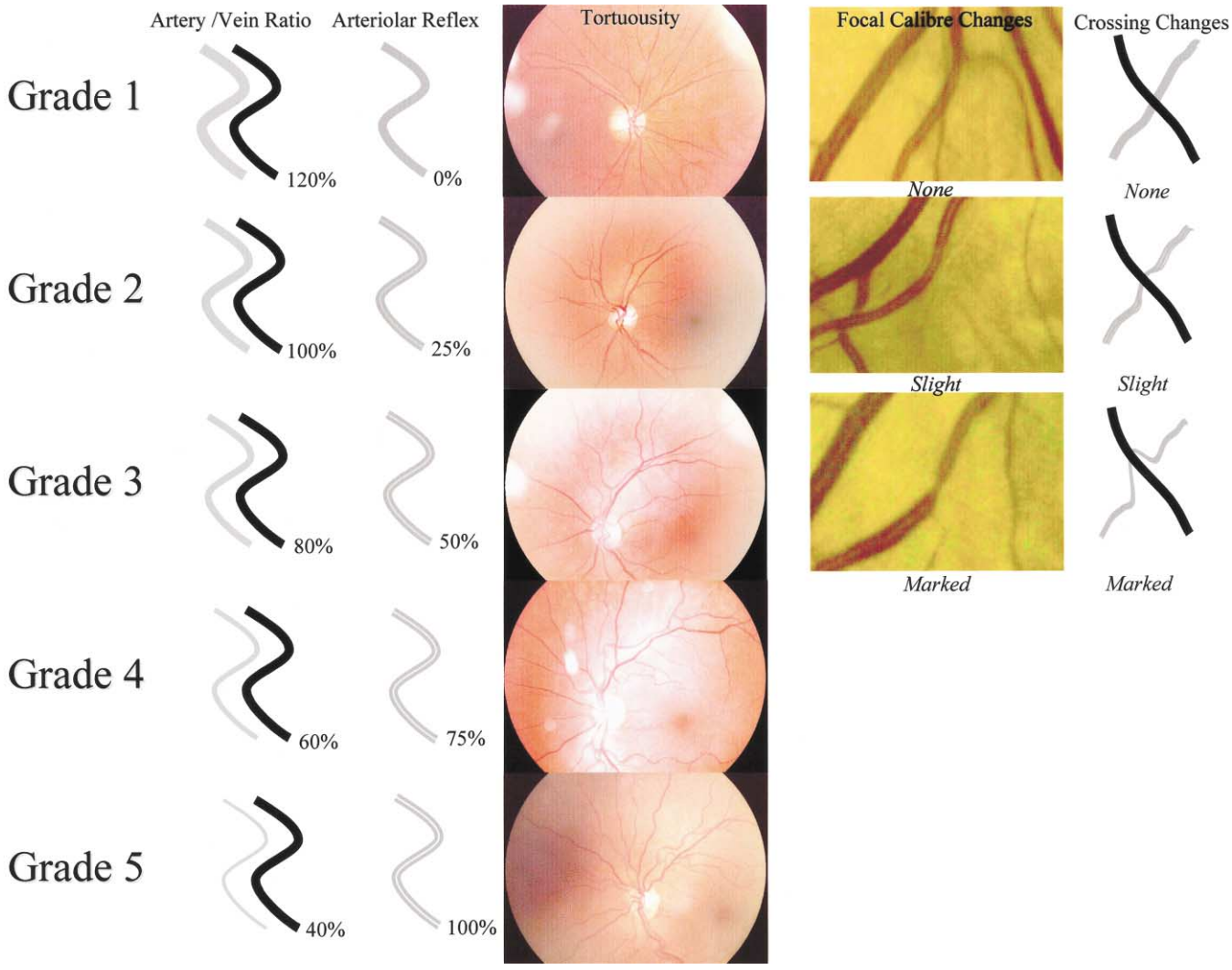

Figure 1. Pictorial grading scale.

4. arterial crossing changes, a decrease in the diameter of the venule on both sides of the arteriole crossing it (graded as none, subtle or gross);
5. arterial focal calibre changes (graded as none, subtle or gross).

Other retinopathy signs noted such as haemorrhages, microaneurysms, inner retinal ishaemia spots, lipid deposits, venous beading, new vessels on the disc and elsewhere were also recorded. When there was a discrepancy in the presence and severity of a lesion between the two eyes of a participant or in different areas of the same eye, the grade assigned for the participant was that of the more severely involved eye or region. The photographs were randomly re-ordered and the grading repeated 2 days later using a standardised basic pictorial grading scale, devised by reviewing the range of clinically observed vascular features in general optometric practice (*Figure 1*).

BP Measurement

BP was measured using an Omron T3 automatic BP monitor, which has been shown to be accurate and reliable compared to conventional mercury sphygmomanometry (Anwar *et al.*, 1998). Using an automatic measure allowed for inter-clinician differences to be eliminated. The recommendations of the Joint National Committee on prevention, detection, evaluation and treatment of high BP were followed (JNC; Marshall and Malinovsky, 1998). BP was measured after participants had been comfortably seated for at least 5 min (Yu *et al.*, 1998). Subjects were seated in a chair, with their backs supported, their left arms bared and supported at heart level. The cuff was fitted 1/2″ above the patient's elbow

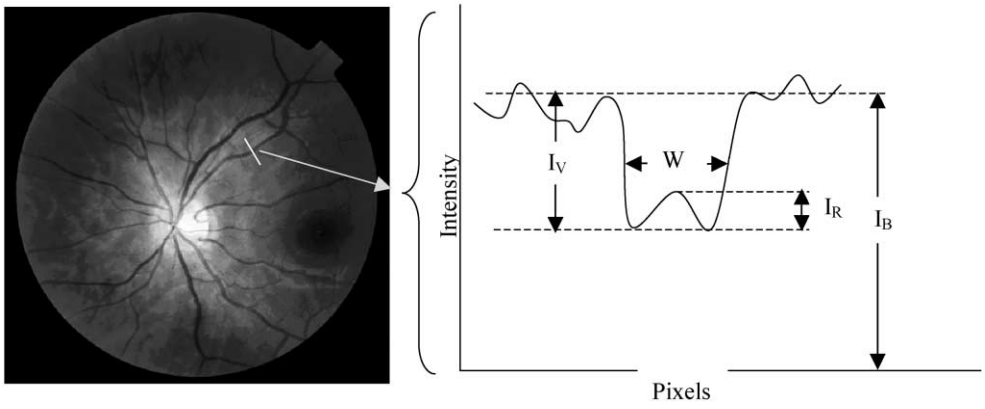

Figure 2. Image analysis measurement technique for the arterial reflex and A/V ratio at one and a half disc diameters above and below the optic nerve head. The intensity of the background retina (I_B) was averaged on either side of the blood vessel. The intensity difference between the background retina and the blood column is denoted as I_V. The width of the retinal vessel (W_V) was measured at half the intensity of I_V. The arterial reflex relative to the background intensity was calculated from the maximum intensity difference between the centre and edge of the blood column (I_R) and was expressed as a percentage. The A/V ratio was calculated by dividing the width of the artery by the width of the vein.

and two readings separated by at least 2 min were averaged as suggested in the manufacturers instructions.

Objective image analysis

Image analysis was performed using a purpose written program, in a similar manner to that described by Brinchmann-Hansen and colleagues (1990). A typical profile across a retinal vessel is illustrated in *Figure 2*. The intensity of the background retina (I_B) was averaged on either side of the blood vessel. The intensity difference between the background retina and the blood column is denoted as I_V. The width of the retinal vessel (W_V) was measured at half the intensity of I_V. The percentage intensity of the reflex was calculated from the maximum intensity difference between the centre and edge of the blood column (I_R) and was expressed as a ratio by dividing by I_V and multiplying by 100. The profile perpendicularly across the central retinal artery and vein were measured one and a half disc diameters above and below the optic nerve head. The A/V ratio was calculated by dividing the width of the artery by the width of the vein. As the characteristics measured are expressed as ratios, they are unaffected by magnification effects caused by differences in ametropia or luminance effects caused by optical media differences between subjects.

Information provided by patients

A standardised questionnaire was administered by the researcher with the following questions asked in a set order:

1. Do you have any problems with your general health?
2. Do you or have you had diabetes, a heart attack, a stroke, heart disease, angina, high or low BP?
   2.1. If so when or for how long?
   2.2. What medication are you prescribed for it?
3. When did you last have your BP checked?
   3.1. Do you know what your BP was on that occasion?
   3.2. When is the next scheduled review of your BP?

The name and address of the patient's GP were also recorded. If the address given could not be confirmed by reference to the local business directory, the patient was telephoned to confirm the details initially given.

Information provided by GPs

A letter was written to the patient's GP with the BP reading measured during the study and accompanied by the patient's fundus photographs. A stamped addressed envelope was enclosed for the GP to return a questionnaire asking about the patient's history of hypertension and cardiovascular disease and ascertaining at what level (taken from the JNC VI hypertension classification; Marshall and Malinovsky, 1998) they would find it beneficial to receive information from optometrists about their patients BP. Space was given for GPs to provide additional comments.

Results

Subjective grading

The use of the pictorial grading scale to assist in the description of the retinal vasculature enabled greater agreement between observers (consistency of gradings between the five clinicians, taken as the SD of the difference of each observer from the mean: A/V ratio 14.8–11.3%; arterial reflex 15.0–9.7%; tortuosity 0.48–0.48; focal narrowing

Table 1. Clinician grading of retinal features (±SD) in those taking blood pressure medication, with high pulse or blood pressure and the range of results from objective grading. Group (a) normal BP; (b) non-treated high BP; (c) treated high BP. Superscript lower-case letters indicate significant differences between groups <0.05. Index of detectability of those not taking medication who had high blood pressure $d' = ((\text{average group a}) - (\text{average group b}))/\text{SD}$ (Green and Swet, 1966)

	Taking BP medication	Blood pressure (mmHg)	Number of subjects	A/V ratio (%)	Clinician grading: Arteriolar calibre (1–3)	Arteriolar crossings (1–3)	Arteriolar reflex (%)	Arteriolar tortuosity (1–5)
Group (a)	No	Sys <160 Dias <95	34	64.4 ± 10.5	$1.4^{b,c}$ ± 0.6	1.5 ± 0.6	38.2^{c} ± 18.7	$1.4^{b,c}$ ± 0.5
Group (b)	No	Sys ≥160 Dias ≥95	21	67.4 ± 16.6	1.8^{a} ± 0.7	1.9 ± 0.6	46.4 ± 24.1	2.1^{a} ± 0.9
Group (c)	Yes		46	67.1 ± 13.5	1.8^{a} ± 0.7	1.8 ± 0.6	50.0^{a} ± 21.1	1.8^{a} ± 0.7
Index of detectability				0.30	0.62	0.67	0.38	1.00
Pulse pressure		Difference <70	62	65.4 ± 12.2	1.5 ± 0.6	1.6 ± 0.6	44.0 ± 19.0	1.6 ± 0.7
		Difference ≥70	39	67.6 ± 14.8	1.9 ± 0.7	1.8 ± 0.6	47.4 ± 24.9	1.9 ± 0.7
All subjects								
Mean				66.3	1.7	1.7	45.3	1.8
SD				13.2	0.7	0.6	21.4	0.7
Range				40–100	1.0–3.0	1.0–3.0	0–100	1.0–5.0

0.57–0.39; crossing changes 0.60–0.35). Analysis of variance between the five clinicians also showed this to be the case (ratio of variance '*F*' values: A/V ratio 25.4–13.8; arterial reflex 3.9–3.6; tortuosity 15.3–6.3; focal narrowing 22.8–4.2; crossing changes 26.5–4.9). The use of the scale to assist in the description of the retinal vasculature also improved the repeatability of grading within each individual observer (A/V ratio 14.9–12.6%; arterial reflex 18.0–9.0%; tortuosity 0.41–0.38; focal narrowing 0.60–0.43; crossing changes 0.76–0.45). The average improvement in the agreement between observers grading the retinal vasculature achieved by using the pictorial grading scale was 28%.

Approximately half the patients examined (55%) were not on any medication for high BP or cardiovascular disease (*Table 1*). Of these patients, those who were measured as having a systolic BP >160 mmHg or a diastolic BP >95 mmHg had been graded with the pictorial grading scale as having a statistically significant greater degree of arteriolar tortuosity ($P < 0.01$) and calibre changes ($P < 0.05$) than those with BP below this level. There was no significant difference in the degree of arteriolar crossings changes ($P = 0.11$), the brightness of the arteriolar reflex ($P = 0.13$) or the A/V ratio ($P = 0.34$) with BP in those not taking BP medication.

Those on medication for systemic BP had a statistically significant greater degree of arteriolar tortuosity ($P < 0.01$), calibre changes ($P < 0.05$) and a brighter arteriolar reflex ($P < 0.05$) than those with normal BP who were not taking any BP medication, but there was no difference in the degree of arteriolar crossings changes ($P = 0.19$) or the A/V ratio ($P = 0.30$). The index of detectability was calculated and recorded in *Table 1* to give an indication of the sensitivity of the retinal feature gradings in detecting those with high BP (Green and Swets, 1966).

Best regression modelling was used to assess all the retinal features. The best model accounted for 14.4% of the variance in systolic BP and 7.4% of the variance in diastolic BP ($P < 0.001$). The modelling involved the features tortuosity (T), focal arterial constriction (F) and arterial crossing changes (C) expressed in the equations:

$$\text{Systolic BP} = 6.8T + 4.5F + 8.6C + 120.0$$

$$\text{Diastolic BP} = 3.4T + 3.9C + 76.5$$

An elevated pulse pressure (the difference between systolic and diastolic BP) indicates reduced vascular compliance in the large arteries and may be a better predictor of cardiovascular disease than either systolic or diastolic BP (Marshall and Malinovsky, 1998). The pulse pressure ranged from 19 to 117 mmHg, therefore the clinical vasculature gradings of those with a pulse pressure of 70 mmHg or above ($n = 39$ with a pulse pressure in the upper half of the population range) were compared with those who had a pulse pressure below this level (*Table 1*). The pulse pressure was primarily due to an elevated systolic BP (175.8 ± 18.0

vs 144.5 ± 18.1 mmHg, $P < 0.001$) with little difference in diastolic BP between the two groups (88.0 ± 14.1 vs 91.0 ± 12.3 mmHg; $P = 0.83$). Those with a higher pulse pressure had a significantly greater degree of tortuosity ($P < 0.05$), focal calibre changes ($P < 0.01$) and arteriolar crossing changes ($P < 0.05$) than those with a lower pulse pressure, but there was no difference in the arteriolar reflex ($P = 0.89$) or the A/V ratio ($P = 0.14$).

Objective image analysis

Subjective rating of the fundus vasculature using the pictorial grading scale had a relatively poor relationship with objective rating of fundus photographs for the A/V ratio (Pearson's correlation $r = 0.26$, $P = 0.07$; average ± SD difference = −14.2 ± 11.6%) and arteriolar reflex ($r = 0.10$, $P = 0.49$; difference = 23.7 ± 23.9%). There was no significant difference between the right and left eyes in their A/V ratio (85.7 ± 16.5% vs 83.3 ± 14.5%, $P = 0.60$; difference = −0.1 ± 0.2%) and their arteriolar reflex (34.0 ± 29.1% vs 39.4 ± 30.4%, $P = 0.64$; difference = −5.7 ± 0.2%). There was also no significant difference between the superior and inferior retina in their A/V ratio (84.6 ± 16.1% vs 83.3 ± 14.9%, $P = 0.14$; difference = 2.5 ± 0.1%) and their arteriolar reflex (34.0 ± 29.2% vs 37.1 ± 30.4%, $P = 0.51$; difference = −3.7 ± 0.3%). The arteriolar reflex was significantly brighter than the reflex from the retinal veins (35.8 ± 29.8% vs 17.3 ± 16.3%, $P < 0.001$), as previously stated by Scheie (1953), and ranged from 0 to 100% (median 34.0%). The A/V ratio ranged from 45 to 130% (median 83.3%). The range of values found cover those pictorially represented by the grading scale. Ten subjects' fundus photographs were reanalysed by image analysis in a masked manner to determine repeatability of this analysis method. The differences in A/V ratio and reflex percentage were found to be 6.3 ± 10.5% and −5.3 ± 12.3% respectively.

Information provided by patients

When 101 patients were asked a non-specific question regarding their general health, the prevalence of reporting significant systemic diseases was far lower than when asked specifically whether they had been diagnosed with systemic hypertension (16 compared to 40 subjects), diabetes mellitus (10 compared to 18 subjects) or cardiovascular disease (14 compared to 38 subjects). Of the 18 patients who had a history of type II diabetes mellitus, four had retinopathy. Of the remaining patients, only three had retinopathy (all in the form of blot haemorrhages). Of the 101 patients, only 20 were able to give full contact details on their GP, with 70 not being able to give the street number, 22 the street name and 17 the suburb the practice was located in. Women were slightly more accurate at reporting their GP's details than men. Less than 5% of patients had their GPs business card.

Information provided by GPs

Of the patients examined, 98 currently had a GP. Sixty-eight GPs responded to the questionnaire regarding their patient's general health. Of the 68 patients they represented, 39 (57%) were on hypertensive or cardiovascular medication. Only 14 (21%) correctly reported to all, 18 (26%) correctly stated some and five (7%) failed to correctly report any of the medication they had been prescribed. Two patients wrongly stated they had been prescribed no BP medication. All those who were not taking hypertensive or cardiovascular medication correctly stated this to be the case. Thirty-nine different medications had been prescribed to patients with systemic hypertension and cardiovascular disease and the main drugs are given in *Table 2*.

Compared to their GPs' responses, 17 out of 23 (74%) of those with cardiovascular disease and 24 out of 35 (69%) of those with systemic hypertension correctly stated this to be the case when asked specifically about whether they had been diagnosed with the condition. The duration of the disease was in agreement between the patient and their GP (±5 years) in 16 out of 23 (70%) of those with cardiovascular disease, but in only 14 out of 35 (40%) of patients with hypertension. Twenty-nine out of 68 (43%) of patients correctly stated their last BP check with their GP (±1 week) and 15 (22%) were in agreement with their GP about their next BP review (±1 week). One-third had no scheduled review made by their GP. When asked about their last BP reading, 24 of the 101 patients were able to report a systolic value (one-third of whom were ±5 mmHg of that given by their GP) and 20 were able to report a diastolic value (approximately three-fifths of whom were ±5 mmHg of that given by their GP). A further 19 patients reported their BP was 'normal' when last measured and 13 stated they had no idea what their BP level was last time it was measured.

The average BP measured during the study (in those patients whose GP responded) was 156 ± 23 mmHg systolic and 90 ± 11 mmHg diastolic, which was significantly higher ($P < 0.001$) than that reported by the patient's GP (141 ± 15 mmHg systolic and 81 ± 9 mmHg diastolic BP). Diastolic BP lower than 75 mmHg constitutes a low BP, which can also have serious deleterious cardiac effects (Hayreh, 1996). This was the case in 12 subjects. Virtually all the GPs who responded to the study (67 out of 68) considered it useful to receive details of their patient's BP when it was measured to be above 160/100 mmHg, two-thirds when the BP was above 140/90 mmHg, but only six GPs (9%) when the BP was under this level. Sixty-two GPs (91%) also appreciated receiving photographs of their patient's ocular fundi.

Table 2. Main anti-hypertensive and cardiovascular medications patients had been prescribed

Drug mode of action	Drug active ingredient	Drug brand/ proprietary name	Number of subjects
Acetylcholine inhibition	Quinapril hydrochloride	Accupril	2
	Captopril	Capoten	2
	Perindopril erbumine	Coversyl	2
	Ramipril	Tritace	2
Angiotensin II inhibition	Irbesartan	Avapro	5
	Irbesartan	Karvea	1
Antiarrhythmic agents	Amiodarone hydrochloride	Cordarone	1
β Adrenergic antagonism	Metoprolol tartrate	Betaloc	1
	Atenolol	Noten	5
	Atenolol	Tenormin	4
Calcium inhibition	Nifedipine	Adalat	3
	Diltiazem hydrochloride	Cardizem	6
	Verapamil hydrochloride	Isoptin	3
	Amlodipine besylate	Norvasc	4
	Felodipine	Plendil ER	3
Diuretic	Chlorothiazide	Chlotride	3
	Frusemide	Lasix	4
	Amiloride hydrochloride & hydrochlorothiazide	Moduretic	2
Hypolipidaemic agent	Gemfibrozil	Jezil	1
	Simvastatin	Lipex	1
	Atrovastatin calcium	Lipitor	3
	Simvastatin	Zocor	4
Muscle relaxant	Quinine bisulfate	Quinate	2
Prostaglandin synthesis inhibition	Aspirin	Aspirin	9
Vasodilation	Glyceryl trinitrate	Anginine	1
	Isosorbide mononitrate	Imdur Durules	1
	Minoxidil	Loniten	1

Discussion

In this elderly population sample, approximately 40% of the patients had been diagnosed with systemic hypertension. This is slightly higher than has been found in the general population (Klein, 1992), but the population in this study were older (median 67 years) and receiving state benefit due to age or ill-health. Systemic hypertension is a major health concern, especially as the general population ages and in the presence of high stress lifestyles and unhealthy diets. Despite continued improvements in drug treatments, lifestyle counselling and BP monitoring devices, the methods for assessing retinal vasculature changes due to systemic hypertension have progressed little over the past few decades. However, the retinal vasculature is easily visualized and may provide a useful image of vascular compromise. Although hypertensive retinopathy has been reduced by improvements in the control of systemic hypertension, the ability to examine an end arteriolar vascular system non-invasively is still of great importance and the retina is a prime site for detecting more subtle changes from chronic disease.

The retinal features most sensitive to high BP in the population studied were an increased arteriolar tortuosity and the degree of focal calibre changes. Arteriolar focal calibre changes have previously been found to be a sensitive measure of systemic hypertension and an important prognostic indicator for mortality (Svardsudd *et al*., 1978). However, little detailed study has been made of arteriolar tortuosity and few studies have examined GP records alongside one-off BP measurements. Further research involving a large, non-self selected population would be needed to confirm these findings. Surprisingly, arteriolar crossing changes and the A/V ratio were found to be poor indicators of high BP in this study. These vascular changes are thought to be a sign of prolonged elevation of BP and, therefore, may develop at a later age in the population (Scheie, 1953).

Detailed examination of the retinal vasculature could allow for better monitoring of the effect of hypertensive drug therapies and to examine whether any reverse in the damage caused to the vascular system by high BP can be achieved. In this study, those patients on medication for systemic hypertension were graded as having a vascular profile in between those who were not diagnosed with systemic hypertension with normal BP and those in the same group who had a systolic BP >160 mmHg or a diastolic BP >95 mmHg but were untreated. This may suggest that reducing BP with systemic medication allows for

vascular integrity to be improved, although the sample size was small. Nevertheless, previous studies have shown that in people using antihypertensive medications, retinopathy prevalence was higher in cases of uncontrolled BP compared with controlled BP (Klein, 1992; Yu *et al*., 1998).

In an attempt to improve the description of retinal vascular features, both for repeated measurements by the same observer and between observers, a basic (pilot) pictorial grading scale was devised (*Figure 1*). As hypertensive retinopathy (such as haemorrhages) is relatively rare in clinical practice, such signs should be described by their location and appearance or a retinal photograph should be taken. The grading scale allowed the retinal vasculature in the form of arteriolar focal calibre changes, tortuosity and reflex along with the A/V ratio and crossing changes to be described quickly and in a standardised form. Since only three patients had retinopathy and no subject had an A/V ratio of less than 40%, the Keith, Wagener and Barker grading scale would have classified over 95% of the patients as grade I or normal (Keith *et al*., 1939). The use of the scale achieved an average improvement agreement between observers of 28%, so that each vasculature feature description was precise to approximately half a grading increment. The disagreement level in this study, using the photographic grading scale, for the artery-to-vein ratio gradings was half that found by Kagan and colleagues (1966), despite their attempts to describe the characteristics of each grading level. Therefore the new grading scale will allow more precise information to be retained on mild cases so detailed follow-up can be achieved.

Objective measures of the A/V ratio and arteriolar reflex using digital image analysis did not correlate well with clinical gradings of these vasculature features. The objective measures were only taken at two locations, one and a half disc diameters above and below the optic disc on the central retinal artery and vein. However, the clinician made their subjective measure judgement by examining all the blood vessels within one and three disc diameters from the optic disc, which may account for the absence of a strong correlation. The objective measures demonstrated that the retinal vasculature is similar between the two eyes and between superior and inferior locations in the same eye. Therefore, a global grading of retinal vascular features can be given and a note made of any substantial differences between the eyes.

A non-specific question regarding a patient's general health failed to identify almost half of the patients with a condition in which eye-care is important. This supports Scheie's (1953) clinical impression that the reporting of high BP by patients was notoriously poor. Patients are often not aware of the diseases that can have an affect on the eyes and relate their general health to present symptoms, rather than the diagnosis and treatment of a medical condition. Therefore, within the history taking as part of an optometric examination, specific questions should be asked regarding diabetes mellitus, systemic hypertension and cardiovascular disease as well as conditions that are specific to the eyes, such as glaucoma. Even then, only about two-thirds of patients report all the conditions diagnosed by their GP. The patients' understanding of how long they have had high BP and what pressure the last measure had shown, was particularly poor. Few patients knew when they should next have their BP checked and one-third of this elderly population had no scheduled review made by the GP. Only one-fifth of subjects were able to give full contact details of their GP, so an increased use of business or appointment cards may be beneficial. There appears to be a need to educate the general public and particularly the elderly regarding the dangers of high BP and the need for regular monitoring. The optometrist is in an ideal position to contribute to screening for hypertension as some patients may be attending regularly for eye care due to vision difficulties while only consulting their GP when they feel unwell. Optometrists are easily accessible, community based eye care practitioners and are well distributed in both urban and regional areas. Optometrists have a large patient base and on average examine over 2000 different patients each year, with most patients having a routine eye examination every 1–2 years. Therefore optometrists are well placed to play a key public health screening role for assisting in the detection of hypertension and referring at risk patients to their GP.

The GPs who responded to the survey regarding their patients indicated that optometrists should inform them about any patients who were found to have a BP of greater than 140 mmHg systolic or 90 mmHg diastolic. The BP measured by the automatic monitor used in this study was on average 10 mmHg higher than that recorded by the patients GP. It was not the purpose of this study to evaluate the observer–device disagreement of the Omron BP monitor which has already been established as 0.76 ± 6.55 mmHg for systolic and 1.0 ± 5.5 mmHg for diastolic BP (Anwar *et al*., 1998). The difference may be accounted for by a combination of the daily variation in BP and the time elapsed since the last BP check by the patient's GP, but the accuracy of such automatic monitors must be validated and appropriate referral criteria established between individual optometrists and GPs. At least one patient was prescribed anti-hypertensive medication by their GP as a result of the BP findings of this study.

From the findings of this study, it is recommended that patients should be asked to fill in a short form, regarding the medication they are taking and their GP's contact details, prior to their eye-examination. The patient is then able to check the information, such as from medicine containers and doctor prescription forms, so the eye-care practitioner has a more complete and accurate record. However, the inaccuracy in reporting of prescribed medication in this study was of concern and better links between the eye-care practitioner and the patient's GP need to be encouraged to promote the exchange of important information regarding

the patient's health, in addition to having accurate and complete information regarding systemic medications being taken by patients. It is important for the eye-care practitioner to understand the mechanism by which cardiovascular medications act to avoid drug interactions and to monitor patient symptoms, particularly if they prescribe topical therapeutic drugs such as β-blockers or non-steriod anti-inflammatory drugs (NSAIDs).

In conclusion, systemic hypertension is a common condition affecting an elderly population with serious consequences to health. Systemic hypertension is a major risk factor for cardiovascular disease and the leading cause of death in developed countries. Use of a basic (pilot) pictorial grading scale of the retinal vasculature can be more informative than previously used scales and achieved a high degree of repeatability. Tortuosity and focal narrowing of the arterioles appear to be sensitive indicators of vascular damage caused by high BP, although BP should still be measured. The ability of patients to report their medical history and the medication they are taking is poor. More education needs to be given to the general public, especially the elderly, regarding the consequences of high BP and the need for regular BP checks. In addition, BP screening by optometrists and appropriate referral to a patient's GP may achieve significant improvements in patient care.

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