Femoral atherosclerosis in an older British population: prevalence and risk factors

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Abstract

Most estimates of the prevalence of peripheral atherosclerosis have been based on intermittent claudication or lower limb blood flow. The aim of this study was therefore to determine the prevalence of underlying femoral plaque, and to determine its association with other cardiovascular disease and risk factors. Presence of plaque was identified using ultrasound in a random sample of men (n = 417) and women (n = 367) aged 56–77 years. Coexistent cardiovascular disease, exercise and smoking were determined by questionnaire, blood pressure was recorded, and serum cholesterol and plasma fibrinogen were determined. Of the 784 subjects that were scanned, 502 (64%) demonstrated atherosclerotic plaque. Disease prevalence increased significantly with age (P < 0.0001), and was more common in men (67.1 vs. 59.4%, P < 0.05). Subjects with femoral plaque had a significantly greater odds of previous ischaemic heart disease (OR 2.2, 95% CI 1.3, 3.7) and angina (OR 1.7, 95% CI 1.03, 2.7), but not of stroke or leg pain on exercise. Current and ex-smoking, raised serum total cholesterol and plasma fibrinogen levels, but not blood pressure, were associated with an increased risk of femoral plaque, independent of age and sex. Frequent exercise and a high HDL cholesterol were significantly associated with lower risk. In conclusion, therefore, atherosclerotic disease of the femoral artery affects almost two-thirds of the population in late middle age. It is associated with an increased prevalence of ischaemic heart disease and angina, but whether detecting at risk individuals using ultrasound offers advantages over simpler and less expensive risk factor scoring requires evaluation in trials. © 2000 Elsevier Science Ireland Ltd. All rights reserved.

Keywords: Peripheral arterial disease; Risk factors; Cardiovascular disease; Epidemiology; Atherosclerotic plaque

1. Introduction

Lower limb arterial disease is an important cause of morbidity in the general population, particularly in elderly people [1]. It is associated with a significantly increased risk of death, primarily from coronary heart disease [2,3]. The most common symptom associated with lower limb disease is intermittent claudication, a characteristic pain in the muscles of the calf that appears on exercise and is relieved by rest. Population surveys suggest the prevalence of claudication increases with age, and affects ~ 4.5% of middle-aged men in the United Kingdom [1]. Risk factors for intermittent claudication are similar to those for coronary heart disease, including raised systolic blood pressure, elevated serum cholesterol and cigarette smoking [1,4]. Smoking, however, appears to be more important in the aetiology of lower limb disease than heart disease [5,6], although reasons for this are not clear.

More recent studies have attempted to determine the prevalence of asymptomatic peripheral arterial disease
using indirect tests of blood flow, such as the ankle brachial systolic pressure ratio (ABPI). Using this technique, ~ 15–20% of a middle-aged population have significant disease indicated by an ABPI ≤ 0.9 [7]. Patients with a reduced ABPI also have an increased risk of coronary events [8,9], but show a slightly weaker association with conventional risk factors than patients with intermittent claudication [7].

Modern ultrasound techniques now permit direct assessment of arterial thickening, enabling the prevalence of atherosclerotic plaque to be determined more accurately [10,11]. Studies of disease in the carotid artery suggest that plaque affects 25% [12] to 57% [13] of middle-aged men, but the prevalence of atherosclerotic plaque in the lower limb using this technique has not been reported. The aim of this study was to determine the prevalence of plaque in the common femoral artery using ultrasound, in a population sample drawn from the British Regional Heart Study, and to determine the association between plaque, cardiovascular disease and risk factors.

2. Methods

2.1. Study population

The study population was recruited from Dewsbury and Maidstone, two towns selected from the British Regional Heart Study (BRHS). The baseline response rates were 79% in Dewsbury and 72% in Maidstone. These towns had wide differences in the prevalence of coronary heart disease, high in Dewsbury and low in Maidstone [14], and were therefore selected for further investigation using ultrasound.

A total of 513 men and 545 women were invited by letter to attend a clinic for ultrasound examination. All male subjects were participants of the British Regional Heart Study, representing the survivors of 643 men recruited to the study in 1978–80, aged 40–59 years at enrolment [14]. A random sample of women of similar age to the men (56–77 years) was selected from the age-sex registers of the general practices in the original survey.

2.2. Investigation

Each participant completed a standard questionnaire administered by a research nurse, including the WHO (Rose) angina questionnaire and selected questions from the WHO questionnaire on intermittent claudication [15]. These questions asked whether the subject experienced pain in the calf, either walking on the flat, uphill or hurrying, and whether the pain disappeared within 10 min of stopping. Subjects were also asked questions on smoking habits and social class, and to recall a doctor’s diagnosis of heart attack and stroke. Height and weight were measured, and systolic and diastolic blood pressures were recorded using a Dinamap 1846.

2.3. Ultrasound examinations

All examinations were performed using an Advanced Technology Laboratories HDI (high definition imaging) 3000 triplex system with a high resolution broadband width linear array transducer 7-4 MHz. Magnification and depth were preset, but could be adjusted depending upon patient anatomy and size. All measurements were made by two experienced vascular technologists, and images recorded on VHS video tape, optical disks and thermal paper for further analysis using previously described methods [10]. Each common femoral artery was examined in the longitudinal plane, over 3 cm, immediately proximal to the bifurcation, enabling the three layers of the posterior wall to be identified and assessed for the presence of atherosclerotic plaque. Plaque was identified by the appearance of localised wall thickening in excess of 1.2 mm and increased density involving all ultrasonic layers with or without haemodynamic disturbance on duplex ultrasound [16]. This technique has been shown to have low variability, with a between-observer coefficient of variation of 8.5% for assessment of the femoral bifurcation by four operators. The intraobserver variability, expressed as the mean absolute difference between measurements, is 0.0738 mm [17].

2.4. Biochemical analysis

A sample of non-fasting venous blood was taken for analysis of lipids and fibrinogen. Total cholesterol and high density lipoprotein (HDL) cholesterol were measured on frozen serum samples using an Hitachi 747 analyser (Roche Diagnostics) and standard reagents. Fibrinogen was estimated on frozen plasma samples, using the Clauss technique on a Coag-u-mate 2 analyser (Organon Technika, Cambridge, UK).

2.5. Analysis

Patients were classified as having femoral atherosclerosis if plaque was identified on one or both femoral arteries. Ischaemic heart disease (myocardial infarction and angina) and stroke were determined by a recall of a doctor’s diagnosis [18,19], and an additional diagnosis of angina was obtained from the WHO (Rose) questionnaire. Leg pain typical of intermittent claudication was recorded if the patient experienced pain which was relieved within 10 min, either walking uphill or on the flat. Occupation was coded in accordance with the Register General’s classification. Social class was

derived using the longest held occupation of each man or husband in the women. Where a woman was single, her own occupation was used.

Smoking status was classified into never, former and current smokers. In women, there was an additional group that was currently non-smokers (n = 46), but who could not be classified into never or ex-smokers due to inconsistent responses on the questionnaire, and were therefore excluded from analyses related to smoking. Physical activity was classified as none, occasional or frequent, as indicated by responses on the questionnaire.

Statistical analysis was performed using the SAS statistical package. Associations between femoral plaque, history of cardiovascular disease and risk factors were examined. Logistic regression was used to calculate age and sex adjusted odds ratios, and their confidence intervals, for each of the risk factor groups. In examining the relationship between femoral plaques and cardiovascular risk factors, odds ratios were further adjusted for the effects of smoking, social class, systolic and diastolic blood pressure, cholesterol, HDL cholesterol, fibrinogen and town of residence (Dewsbury or Maidstone). Continuous variables were grouped in tertiles or quintiles and analysed as categorical variables. A chi-squared test for linear trend was performed in analyses involving risk factors and the BRHS scores.

The relationship between femoral plaques and history of disease and risk factors was generally the same in both sexes, using sex interaction tests, and therefore data for men and women were combined in the analyses. The only significant sex interaction occurred for the relationship between leg pain and femoral plaques, and therefore these results are presented for men and women separately.

2.6. British Regional Heart Study and stroke scores

These scores were calculated from the risk factor data for men only, as they were developed based on male risk factor data. The BRHS score for risk of a major coronary heart disease event is based on: smoking years; systolic blood pressure; cholesterol; diagnoses of ischaemic heart disease and diabetes; angina on WHO (Rose) questionnaire; and parental death from heart trouble [20]:

\[
\text{BRHS score} = (5 \times \text{years smoking}) + (3 \times \text{SBP}) + (51 \times \text{cholesterol}) + 170 \text{ (if IHD)} + 100 \text{ (if angina)} + 50 \text{ (if parental history of heart disease)} + 95 \text{ (if diabetic)}
\]

The stroke score includes data on: systolic blood pressure; smoking; presence of cardiovascular disease; and age [21]:

\[
\text{Stroke score} = (9 \times \text{age}) + (2.85 \times \text{SBP}) + 70 \text{ (if angina)} + 90 \text{ (smokes 1–20 cigarettes)} + 130 \text{ (> 20 cigarettes per day)}
\]

3. Results

3.1. Response rates

Response rates were slightly higher for men than women: 481 men completed a questionnaire (93.8%) and 417 attended for an ultrasound examination (81.3%), compared with 441 women (80.9%) completing a questionnaire and 367 (67.3%) attending for ultrasound. There were no significant differences between the response rates in Dewsbury and Maidstone.

3.2. Prevalence of femoral plaque and coexistent cardiovascular disease

Of the 784 subjects who were scanned, 502 (64.0%) had evidence of atherosclerotic plaque in one of their femoral arteries (Table 1). In Dewsbury, 68.9% (95% CI 64.2, 73.6) of the population had femoral plaque on ultrasound, compared with 59.9% (95% CI 54.1, 63.6) of the population in Maidstone. On adjusting for age and sex, there were statistically significant odds of not having disease for those living in Maidstone compared with Dewsbury (OR 0.58, 95% CI 0.43, 0.79, \( P < 0.01 \)). The prevalence of ischaemic heart disease was also higher in Dewsbury (16%, 95% CI 12.2, 19.7) compared with Maidstone (10.7%, 95% CI 7.7, 13.6).

There was a significant increase in the prevalence of femoral plaque with age (\( P < 0.0001 \)), and there was significantly more disease in men than women: 67.1% of men had plaque compared with 59.4% of women (\( P < 0.05 \)). This trend of increasing disease with age occurred in both men and women, \( P < 0.05 \) (Fig. 1), but was particularly marked in women.

<table>
<thead>
<tr>
<th>Age</th>
<th>Total number</th>
<th>Plaque (%)</th>
<th>95% Confidence intervals (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;60</td>
<td>146</td>
<td>51</td>
<td>43–59</td>
</tr>
<tr>
<td>60–64</td>
<td>217</td>
<td>55</td>
<td>48–62</td>
</tr>
<tr>
<td>65–69</td>
<td>192</td>
<td>70</td>
<td>64–77</td>
</tr>
<tr>
<td>70+</td>
<td>229</td>
<td>74</td>
<td>68–80</td>
</tr>
<tr>
<td>Total</td>
<td>784</td>
<td>64</td>
<td>61–67</td>
</tr>
</tbody>
</table>

* \( P < 0.0001 \) test for trend.
Prevalence of symptomatic and asymptomatic femoral plaque by age. Femoral atherosclerosis detected on ultrasound scanning in 417 men (M) and 367 women (F) in Dewsbury and Maidstone, and leg pain recorded on questionnaire.

Prevalence of concomitant cardiovascular disease was greater in those with femoral plaque than those without (Table 2). This difference was particularly marked for previous ischaemic heart disease (present in 16.6% of those with plaque compared with only 7.1% of those without; age-sex adjusted odds ratio 2.2 (95% CI 1.3, 3.7)) and questionnaire angina (15.4% compared with 9.6%; age-sex adjusted odds ratio 1.7 (95% CI 1.03, 2.7)). The prevalence of stroke was only slightly higher in those with plaque, but the plaque group contained significantly more subjects taking anti-hypertensive therapy (37.9% compared with 22.4%; age-sex adjusted odds ratio 2.0 (95% CI 1.4, 2.9)). The only significant interaction between men and women occurred in the prevalence of leg pain. Men with plaque had significantly increased odds of leg pain (OR 2.9, 95% CI 1.3, 6.3) whereas women did not. This difference is reflected in Fig. 1, which also clearly illustrates that asymptomatic plaque is much more prevalent in the population than leg pain.

There was a statistically significant linear trend between increasing BRHS scores and increasing prevalence of plaque (P < 0.01, Table 3). In contrast, the equivalent trend in the stroke score was much less marked.

### 3.3. Association between plaque and cardiovascular risk factors

There were no statistically significant interactions between men and women for any of the risk factors. Current and ex-smokers demonstrated more plaque than never smokers (Table 4), and there were a significantly increased odds of plaque in both ex- and current smokers, even after adjusting for age, sex and other risk factors.

#### Table 2

Prevalence of cardiovascular disease

<table>
<thead>
<tr>
<th>Prevalence of cardiovascular disease</th>
<th>No plaque (n = 282), % (95% CI)</th>
<th>Plaque present (n = 502), % (95% CI)</th>
<th>Adjusted odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ischaemic heart disease&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.1 (4.1, 10.1)</td>
<td>16.6 (13.3, 19.9)</td>
<td>2.2 (1.3, 3.7)</td>
</tr>
<tr>
<td>Angina&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.6 (6.1, 13.1)</td>
<td>15.4 (12.1, 18.7)</td>
<td>1.7 (1.03, 2.7)</td>
</tr>
<tr>
<td>Stroke&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.6 (1.4, 5.8)</td>
<td>5.3 (3.3, 7.3)</td>
<td>1.1 (0.4, 1.9)</td>
</tr>
<tr>
<td>Anti-hypertensive treatment</td>
<td>22.4 (17.5, 27.2)</td>
<td>37.9 (33.6, 42.1)</td>
<td>2.0 (1.4, 2.9)</td>
</tr>
<tr>
<td><strong>Leg pain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men only</td>
<td>6.4 (2.1, 10.7)</td>
<td>17.2 (12.6, 21.8)</td>
<td>2.9 (1.3, 6.3)</td>
</tr>
<tr>
<td>Women only</td>
<td>6.7 (2.5, 10.9)</td>
<td>5.6 (2.4, 8.8)</td>
<td>0.7 (0.3, 1.7)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Prevalence and odds ratios for cardiovascular disease (adjusted for age and sex) in subjects with and without femoral plaque.

<sup>b</sup> Based on recall of a doctor’s diagnosis.

<sup>c</sup> Based on the WHO (Rose) questionnaire.
factors. Increasing levels of exercise were associated with less plaque, and those taking frequent exercise had a significantly decreased odds of plaque, even when other risk factors were taken into account.

Increasing systolic blood pressure was associated with a greater prevalence of femoral plaque, but adjustment for age, sex and other risk factors resulted in an insignificant odds ratio. The trend in relation to diastolic blood pressure was less marked, and only those in the middle tertile had a significantly increased odds of disease.

Higher levels of total cholesterol were also associated with significantly more plaque, and those in the middle and upper tertiles had significantly increased odds of disease compared with those in the lowest tertile. This pattern was reversed for HDL cholesterol, where increasing levels were associated with less disease, and significantly reduced odds ratios. The protective effect of HDL cholesterol was not statistically significant after adjusting for other risk factors, however, whereas the increased risk associated with total cholesterol was independent of other factors.

Subjects in the highest tertile for fibrinogen had more plaque than those in the lower tertiles and a significantly increased odds of disease compared with the lowest tertile. The association with fibrinogen was lost, however, when the analysis was adjusted for other risk factors.

Table 4
Risk factors and odds ratios for presence of femoral plaque

<table>
<thead>
<tr>
<th>Smoking</th>
<th>No</th>
<th>Plaque present (%)</th>
<th>OR (95% CI), adjusted for age and sex</th>
<th>OR (95% CI), adjusted for age, sex and other risk factors*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>277</td>
<td>48.7</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Ex</td>
<td>303</td>
<td>67.7</td>
<td>2.0 (1.4, 2.8)**</td>
<td>1.9 (1.3, 2.9)**</td>
</tr>
<tr>
<td>Current</td>
<td>145</td>
<td>82.8</td>
<td>5.2 (3.2, 8.7)**</td>
<td>4.3 (2.5, 7.5)**†</td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>487</td>
<td>67.6</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Occasional</td>
<td>63</td>
<td>61.9</td>
<td>0.9 (0.5, 1.5)</td>
<td>0.95 (0.5, 1.8)</td>
</tr>
<tr>
<td>Frequent</td>
<td>178</td>
<td>51.1</td>
<td>0.5 (0.4, 0.7)**</td>
<td>0.5 (0.4, 0.8)**†</td>
</tr>
<tr>
<td>Social class</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-manual</td>
<td>327</td>
<td>58.7</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Manual</td>
<td>402</td>
<td>66.9</td>
<td>0.3 (0.96, 1.8)</td>
<td>0.9 (0.6, 1.3)</td>
</tr>
<tr>
<td>Systolic BP,</td>
<td></td>
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<tr>
<td>textiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>262</td>
<td>58.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>261</td>
<td>60.2</td>
<td>1.0 (0.7, 1.4)</td>
<td>0.7 (0.5, 1.2)</td>
</tr>
<tr>
<td>3</td>
<td>260</td>
<td>71.5</td>
<td>1.4 (0.96, 2.1)</td>
<td>1.2 (0.7, 2.1)</td>
</tr>
<tr>
<td>Diastolic BP,</td>
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<td></td>
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<tr>
<td>tertiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>258</td>
<td>58.1</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>265</td>
<td>68.3</td>
<td>1.5 (1.03, 2.2)*</td>
<td>1.7 (1.1, 2.8)*</td>
</tr>
<tr>
<td>3</td>
<td>260</td>
<td>63.9</td>
<td>1.2 (0.8, 1.7)</td>
<td>0.9 (0.5, 1.6)</td>
</tr>
<tr>
<td>Cholesterol,</td>
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<tr>
<td>tertiles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>257</td>
<td>56.8</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>260</td>
<td>65.4</td>
<td>1.6 (1.1, 2.3)*</td>
<td>1.8 (1.2, 2.8)**</td>
</tr>
<tr>
<td>3</td>
<td>251</td>
<td>68.5</td>
<td>2.0 (1.4, 3.0)**</td>
<td>2.2 (1.4, 3.6)**†</td>
</tr>
<tr>
<td>HDL cholesterol,</td>
<td></td>
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<tr>
<td>tertiles</td>
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<tr>
<td>1</td>
<td>224</td>
<td>72.3</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>299</td>
<td>62.2</td>
<td>0.7 (0.4, 0.96)*</td>
<td>0.8 (0.5, 1.3)</td>
</tr>
<tr>
<td>3</td>
<td>230</td>
<td>57.0</td>
<td>0.6 (0.4, 0.8)**†</td>
<td>0.6 (0.4, 1.1)</td>
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<tr>
<td>Fibrinogen,</td>
<td></td>
<td></td>
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<tr>
<td>tertiles</td>
<td></td>
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<tr>
<td>1</td>
<td>250</td>
<td>60.4</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
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</tr>
<tr>
<td>3</td>
<td>253</td>
<td>71.2</td>
<td>1.5 (1.1, 2.3)**†</td>
<td>1.2 (0.7, 1.9)</td>
</tr>
</tbody>
</table>

* Smoking, exercise, systolic and diastolic blood pressure, total and HDL cholesterol, fibrinogen and social class.
* P<0.05, ** P<0.01, compared with base group.
† P<0.05, † P<0.01, test for linear trend.
4. Discussion

4.1. Prevalence of femoral plaque and coexistent cardiovascular disease

This paper is the first report of the prevalence of femoral plaque identified by ultrasound in the general population. Almost two-thirds of the subjects who were scanned showed evidence of femoral plaque. This is almost three times higher than the proportion expected to show evidence of disease on testing with the ankle-brachial pressure index [7], and therefore suggests that ultrasound is able to detect much less severe disease. Most epidemiological studies of intermittent claudication demonstrate higher prevalences of disease in men than women, and increasing prevalence with age [1], a pattern reflected in this study.

There are no other reports of the prevalence of femoral plaque in the general population, but ultrasound studies in carotid arteries indicate plaque occurs in 16% [12] to 45% [13] of middle-aged to elderly women and 25% [12] to 57% of men [13]. Reasons for these lower estimates may reflect differences due to anatomical site, true differences in population prevalence, or variation in measurement technique. Using ultrasound measurement, the prevalence of carotid plaque in this BRHS population was also found to be very common, affecting 57% of men and 58% of women [22]. This suggests that there is less difference between the prevalence of disease in the lower limb and the carotid arteries than might be predicted from other studies. Previous estimates of the population prevalence of lower limb atherosclerosis have relied on autopsy studies, which demonstrated similar high levels of disease. A study of 293 unselected adult autopsy cases carried out in Oxford found 15% of men and 5% of women had more than 50% stenosis of at least one artery [23], and none of the men and only one of the women was completely free of atherosclerotic plaques in their common iliac arteries. Similar results have also been found in autopsy studies in Pittsburgh, USA [24], and Malmö, Sweden [25].

Subjects with peripheral arterial disease defined by intermittent claudication or a low ABPI have a greater risk of death from other cardiovascular diseases, particularly coronary heart disease [1,9]. Studies of patients presenting with intermittent claudication indicate that almost 50% have evidence of coronary artery disease on clinical history or electrocardiogram [26], and 90% have evidence of disease on angiogram [27]. The subjects in this study with less severe disease might therefore be expected to have a lower risk of cardiovascular disease, and indeed only 16.6% of those with plaque had a history of ischaemic heart disease. The odds of having previous ischaemic heart disease in this group was significantly greater than in those without plaque.

There was no significant difference in the prevalence of stroke in those with and without femoral plaque, probably reflecting the weaker association between lower limb atherosclerosis and cerebrovascular disease [1]. There were, however, more people on anti-hypertensive therapy in the group with plaque.

The stronger association between femoral plaque and heart disease than stroke is reflected in the stronger association between plaque and the British Regional Heart Study score than the stroke score. Those in the top quintiles of both scores have a greatly increased risk of heart disease or a stroke in the next 5 years [20,21], and therefore the associations between plaque and these scores suggest that plaque identified by ultrasound may have clinical significance.

Intermittent claudication is the main symptom of peripheral arterial disease, and therefore subjects with femoral plaque might be expected to experience more leg pain than those without. Indeed in men there was a significantly higher prevalence of leg pain in those with plaque, but not in women. This sex difference may have arisen because the men had more severe disease, or because the women had a higher prevalence of other causes of leg pain such as arthritis or varicose veins. The questionnaire in this study did not include all the questions from the WHO claudication questionnaire, but it did contain the question concerning the presence on calf pain relieved at rest, which is particularly specific in diagnosing pain of claudication [28]. It is therefore more likely that the men had more severe disease than the women.

4.2. Association between plaque and cardiovascular risk factors

Cigarette smoking is known to be the strongest risk factor for intermittent claudication [5], and these results confirm that smoking is also the most powerful risk factor for femoral atherosclerosis. Interestingly, current smokers in this study had a higher odds ratio for femoral plaque than other studies have reported for intermittent claudication [29,30] or a low ABPI [31,32]. This probably reflects the greater accuracy of ultrasound compared with other techniques for defining peripheral arterial disease, thus enabling all those with significant disease to be identified.

Infrequent exercise is also an important risk factor for peripheral arterial disease, and several epidemiological studies demonstrate that claudication is more likely to occur in those with sedentary habits [33,34]. This study confirmed that undertaking frequent exercise was associated with a significantly lower risk of femoral plaque, but it is difficult to estimate the true effect of exercise in a cross-sectional study, as debilitating disease may restrict the amount of physical activity that can be performed. To demonstrate the true effect of
exercise on disease, a prospective period of observation on these subjects is required.

Blood pressure generally shows only a small or weak association with intermittent claudication [1], so the lack of a statistically significant association between femoral plaque and either systolic or diastolic blood pressure was not surprising. This lack of association may also have been produced by the high prevalence of treated hypertensives in the group with plaque.

Most, but not all, studies [30,35] demonstrate that raised total cholesterol is a significant risk factor for intermittent claudication, but the risk is much lower than that associated with smoking [1]. There was a clear association between raised cholesterol and femoral plaque in this study, however again possibly because of the greater accuracy of ultrasound in detecting disease. Higher levels of HDL cholesterol were also associated with a reduced risk of femoral plaque, but not following adjustment for other risk factors. This was a surprising finding, as previous studies have suggested that HDL cholesterol has a protective effect in relation to intermittent claudication [1].

This study also demonstrated a significant association between raised fibrinogen levels and femoral plaque, confirming other studies which have shown elevated fibrinogen concentrations in those with intermittent claudication [36]. Fibrinogen levels are known to be influenced by other risk factors including age, obesity, social class, cholesterol, diabetes and smoking [1], and in this study the risk of femoral plaque associated with fibrinogen was lost on adjusting for smoking, exercise, blood pressure and cholesterol.

In this study, the subject’s home town might also be considered as a risk factor. The prevalence of femoral plaque was significantly greater in those living in Dewsbury compared with Maidstone, even after adjusting for age and sex. The prevalence of ischaemic heart disease was similarly higher in Dewsbury, but it is difficult to determine whether town had more effect on the development of heart disease than lower limb disease. This is partly because of the different prevalence of disease, and because of the different sensitivity and specificities of the tests used to define disease. Further adjustment of the risk factors given in Table 4 for town had no effect on the significance levels.

5. Conclusions

Atherosclerosis of the femoral artery is very common in the general population, affecting almost two-thirds of men and women in late middle age. The proportion of people with femoral plaques who might also be recognised by their associated symptoms is relatively small. As ultrasound detected femoral plaques are associated with risk factors, prevalent disease and predictive risk scores, it is likely that those people with femoral plaques will have a high risk of clinical cardiovascular events. It is feasible to carry out ultrasound examinations in primary care settings as shown in this study, but whether this mode of screening offers advantages over simpler and less expensive risk factor scoring requires evaluation.

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