Work and Ischemic Heart Disease

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Abstract: Recent studies provide convincing evidence that work-related stress contributes significantly to the pathogenesis and onset of ischemic heart disease. Work-related stress is one of the most widely studied chronic life stresses related to ischemic heart disease. Many factors in the work environment have been studied in relation to the development of ischemic heart disease. One model proposed based on studies of tension at work is the “job strain” model, defined by Karasek as jobs with high demand but low decision latitude. Hyperresponsivity of the sympathetic nervous system is manifested by an exaggerated heart rate and blood pressure responses to work-related stress. Like other psychosocial factors, chronic work-related stress appears to have direct pathophysiological effects, including stimulation of the hemodynamic system and neurohumoral arousal. However, the data have indicated the existence of individual differences in responsivity of the sympathetic nervous system. Acute stress triggers myocardial ischemia, promotes arrhythmogenesis, and stimulates platelet function, and in the presence of underlying atherosclerosis, it causes coronary vasoconstriction. Because multiple coronary risk factors, including previously established factors such as hypertension, hypercholesterolemia, and smoking, as well as work-related stress, contribute to the development of ischemic heart disease, worker-specific targeted interventions are necessary.

Key words: Work-related stress; Ischemic heart disease; Sympathetic nervous system; Psychosocial factors; Coronary risk factors

Introduction

Ischemic heart disease pursues a course that starts with diffuse intimal thickening of the coronary arteries in adolescence, with symptoms developing in the final stage, coronary arteriosclerosis, which progresses through complex interactions between cells over a long period. In addition to genetic constitution, lifestyle and environmental factors affect its onset.
and progression. Clinical factors related to the onset and progression of coronary artery disease have been elucidated based on epidemiological studies, including the Framingham Study, and they are referred to by the general term “coronary risk factors”.

Subsequent studies have shown that stress is also a coronary risk factor. Models that consider worker stress based on three types of stressors: 1) workplace stressors, 2) non-workplace stressors, and 3) personal factors, and the opposite, relaxing factors that relieve stress, have been proposed to evaluate worker stress (Fig. 1). In some cases of ischemic heart disease some of these factors, such as amount of work and nature of the work, are thought to play a major role in the onset of the disease as stressors in the workplace. The social medicine term “Karoshi (death from overwork)” has come into widespread use and has attracted the attention of the public. In other cases of ischemic heart disease, in particular, an acute onset occurs in an asymptomatic worker and pursues a course leading to sudden death, giving the family the impression of a disease of the acute onset type. Thus, ischemic heart disease possesses aspects that make it easy to view as a disease associated with industrial accidents.

In this paper I will outline the associations between stress according to type and aspects of work and ischemic heart disease in workers by dividing it into 1) relatively long-term effects and 2) stressors immediately before the onset that act as a trigger.
known that diffuse intimal thickening is observed in the coronary arteries in childhood and adolescence, and the thickening is said to be the basis for the development of coronary disease in later years. The lipid-rich plaques of atherosclerotic lesions cause ruptures and fissures, and vessel-obstructing thrombi form and are thought to cause the onset of acute myocardial infarction and sudden cardiac death.

Onset of Ischemic Heart Disease

1. Definition of ischemic heart disease
In ischemic heart disease the oxygen supply becomes insufficient to meet the demands of the myocardium because of lesions in the coronary arteries, and as a result the myocardium becomes hypoxic (ischemic), and myocardial function is impaired. The term “coronary artery disease” is used when there are lesions in the coronary arteries, but symptoms due to myocardial ischemia or demonstration of myocardial ischemia are not always necessary to make the diagnosis. “Ischemic heart disease” is a diagnostic category based on functional abnormalities that develop as a result of myocardial ischemia, and “coronary artery disease” is a diagnostic term that depends on whether morphological abnormalities are present in the coronary arteries.

2. Progression of atherosclerosis and the onset of ischemic heart disease
“Arteriosclerosis” is a general pathological term used to describe pathological sclerosis and thickening of arterial walls. Based on their pathological characteristics, coronary arteriosclerosis, some cerebral infarctions, and occlusive arteriosclerosis of peripheral arteries are classified under arteriosclerosis.

According to pathology studies, it is now known that diffuse intimal thickening is observed in the coronary arteries in childhood and adolescence, and the thickening is said to be the basis for the development of coronary disease in later years. The lipid-rich plaques of atherosclerotic lesions cause ruptures and fissures, and vessel-obstructing thrombi form and are thought to cause the onset of acute myocardial infarction and sudden cardiac death.

Risk Factors for Arteriosclerosis

1. Outline of coronary risk factors
The chief uncorrectable risk factors are age, gender, and family history. The correctable risk factors include hyperlipidemia, hypertension, smoking, diabetes, and obesity, with three of them, hyperlipidemia, hypertension, and smoking, constituting the greatest risk factors. The impact of the risk factors varies with the pathological type of arteriosclerosis. Hypertension is the greatest risk factor for arteriosclerosis, whereas hyperlipidemia contributes more to arteriosclerosis. Recent studies have shown that high serum Lp (a) values, elevated homocysteine values, and high CRP values are also risk factors.

2. Impact of arteriosclerosis risk factors and their evaluation
The impact of arteriosclerosis risk factors in
each individual varies with the strength of the effect of each factor, its duration, timing of its effect, sensitivity and reactivity of the individual, etc. Arteriosclerosis develops when a coronary risk factor acts in addition to a genetic constitution, and when more than one risk factor is present, the risk of developing arteriosclerosis has been found to increase in an additive manner (Table 1).\(^2\)

**Occupational Factors**

1. **Work time**

   Based on previous studies, correlations have been reported between long work hours and the prevalence rate of blood pressure elevation and heart disease. The following are suspected of being reasons why long work hours have an impact on cerebrovascular and cardiovascular disease: 1) sleep time is insufficient, and fatigue builds up, 2) decreased breaks and rests during off-work hours and decreased time for leisure activities, 3) the stress imposed by having to marshal mental and physiological functions decreased by fatigue and maintain the constant level demanded by the job when hours are long, and 4) increased time in contact with work-related stressors.

   One of these factors, lack of sleep, is thought to increase the responsiveness of the sympathetic nervous system and the prevalence rate of heart disease.\(^3\) In a study on the acute effects of short sleep time, significant increases in blood pressure and heart rate were observed at sleep times of 3–4 hours a day. There is also a report claiming a 2.08 times higher mortality rate from ischemic heart disease at sleep times under 4 hours a day than when sleep lasted 7–7.9 hours. In addition, morbidity and mortality from stroke and heart disease have been shown to rise in sleep-deficient states with sleep times under 4–6 hours a day for long periods.\(^3\)

2. **Irregular work hours**

   Irregular work hours interfere with the sleep-wakefulness rhythm and cause deterioration of the rhythm of daily living. Moreover, irregular shift-work hours entail the possibility of never being able to take a complete rest. Persons with occupations associated with irregular work hours include transportation workers, such as taxi and truck drivers, guards, and medical personnel on call.

   The results of research on shift work and the development of heart disease suggests that the relative risk is 1.2–1.5 times greater, and shift-work hours, frequency, night-work time frame, work intervals, etc., are thought to affect the aggravation by shift work.

   However, when shift work is performed according to schedule as routine work or when routine work is in a night-work time frame, the stress experienced can also be considered to fall within the range of the stress in ordinary life. Long work hours and work that involves a great deal of travel may also have an impact on the cardiovascular system.\(^3\)

3. **Work environment**

   Hot environments are thought to subject the circulatory system to considerable stress, but there have been no data showing a direct association with increased mortality from heart disease, and dehydration may be a factor that triggers its onset. Elevation of blood pressure have been observed during exposure to noise, and there has even been a report describing an association between the onset of ischemic heart disease and noise, but no conclusion has been drawn that it is a risk factor.\(^3\)

4. **Work associated with mental stress**

   (1) **Effect of mental strain on the circulatory system**

   Changes in the circulatory system due to stress develop as a result of activation of the amygdalo-sympathetic-adrenomedullary system. Its response has been found to consist of blood pressure elevation, increased heart rate, increase in free fatty acids due to an increase in noradrenaline in the blood, and blood glucose elevation. Chronic persistence of this response
is thought to have an effect on the progression of coronary arteriosclerosis mediated by risk factors. In earlier research blood pressure elevations while at work were reported to be mild. Moreover, while many cohort studies examining work-related stress and the incidence of ischemic heart disease have reported an increased relative risk, other research data have shown no difference, and no consensus has been reached.

Several stress models have been proposed as methods of evaluating the mental stress of work. The job strain model proposed by Karasek and colleagues features a high level of mental strain, low job decision latitude, and little support in society or at work, and a tendency for high levels of stress to develop and an increased relative risk of onset of ischemic heart disease have been shown in so-called “high-demand, low-freedom, low-support” work.

Generally speaking, there are often large individual differences in response to stress, with the degrees and patterns of response to external factors differing, and medical evaluation of whether acute stage reactions are associated with a significant increase in rate of occurrence of chronic disease, etc., is often difficult.

(2) Occupation/job classification and ischemic heart disease

In a study examining the relationship between the onset of stroke and heart diseases and occupation/job classification, associations were reported to have been found with bus and taxi drivers and other motor vehicle drivers, administrative workers, physicians, guards, etc. There are also reports that indicate an association between work-related stress and blood pressure elevation and reports that do not. Some studies have shown that systolic blood pressure elevations of 4–12 mmHg and diastolic blood pressure elevations of 2.8–4.3 mmHg while working. However, many of the studies that examined the association between work-related stress and the occurrence of cardiovascular disease over a long period have found low relative risk levels of 1–2.

5. Personality traits and ischemic heart disease

Associations between personality traits and ischemic heart disease have been investigated by focusing on factors in individuals exposed to stress rather than on the stress itself. Freidman and colleagues called the behavior pattern that is susceptible to ischemic heart disease “Type A”. Type A behavior is characterized by being short-tempered, aggressive, and emotionally labile, whereas type B is described as not paying much attention to the environment, proceeding at one’s own pace, and being easygoing. In an 8-year follow-up survey the incidence rate of ischemic heart disease in the subjects with a type A behavior pattern was reported to be double the rate in the subjects with a type B behavior pattern.

Based on a subsequent study in the United States and Japan an association between “anger” and the onset of ischemic heart disease was reported among subjects with a type A behavior pattern. Thus, how personality is associated with work-related factors, whether it is an independent factor, and even its chronic effects are unknown. Furthermore, determining whether the onset of ischemic heart disease can be prevented by controlling these factors is a challenge in the future.

6. Short-term overwork as a factor promoting the onset of manifestations of ischemic heart disease

Mental and physical overloading due to encountering unforeseeable circumstances and, in particular, short-term excessive overloading, cause abrupt blood pressure fluctuations, vasoconstriction, etc., with stroke and heart disease sometimes developing, and significant increases in sudden death and acute myocardial infarction as a result of acute stress due to unusual events, earthquakes, etc., have been reported in such cases. There is a great deal of research evidence indicating that it is reasonable to consider the effect of unusual events that occur between immediately before the onset and one
day before the onset or within one week before the onset. This concept has been incorporated into the approved criteria for death from overwork for some time.

Prevention of Ischemic Heart Disease in Workers

1. Evaluation of work-related factors

Accumulation of fatigue as a result of working for a long period has been demonstrated to affect the cardiovascular system medically as well. However, it is necessary to comprehensively evaluate work-related factors that cause stress based on work hours, irregularity of work hours, fixed work hours, shift work, work environment, and mental strain factors originating from the work. There is also a need for employers and employees to cooperate in efforts to improve working conditions, such as shortening work time, restricting work time outside hours, etc.3)

2. Early detection of risk factors for arteriosclerosis by regular health checkups and correcting them

Several risk factors for arteriosclerosis are capable of being corrected by improving one’s lifestyle or by treatment. Workers can quit smoking, engage in moderate exercise, consume alcoholic beverages in moderation, and avoid overeating. Cessation of smoking has been shown to reduce the risk of onset of ischemic heart disease to the same level as that of non-smokers beginning immediately after quitting. Continuing to smoke, on the other hand, raises the relative risk to 1.4.

Receiving regular health checkups makes it possible to know whether risk factors are present, e.g., obesity, high blood pressure, hyperlipidemia (hypercholesterolemia, hypo-HDL-cholesterolemia), abnormal glucose tolerance, and the severity of underlying heart disease. If risk factors are detected early, in the mildly abnormal stage, they can be sufficiently corrected by improving one’s lifestyle, and it has even been demonstrated that a preventive effect can be obtained by correcting them. These factors generally contribute much more to the onset of ischemic heart disease than work-related factors.

Conclusion

It is impossible to lead a healthy happy life while working without making efforts at self-help. Non-pharmaceutical therapy, such as improvement of lifestyle, improvement of diet, etc., takes priority as a means of preventing ischemic heart disease. The addition of drug therapy must also be considered in patients belonging to high-risk groups.

REFERENCES