INTRODUCTION

Arterial hypertension (HTN) is a common condition in clinical practice and an important risk factor for the development of metabolic syndrome and cardiovascular disease (CVD) and therefore, is a leading cause of mortality and morbidity. Since HTN is often diagnosed late in its course, it increases the risk of other damaging conditions like heart failure and kidney damage. Even before the existence of the concept of metabolic syndrome, a significant association between elevated blood pressure (BP) and cardiovascular outcomes had been demonstrated. HTN was defined as an elevated BP of above 160/90 mmHg until the year 1997. A revision in the definition of HTN was introduced after several randomized trials documented that there was an increased risk of CVD by 20–30% for an increase of 5 mmHg of systolic or diastolic BP. The Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure (JNC VI) recommended a cut-off point of 140/90 mmHg and 130/85 mmHg for general population and diabetic patients, respectively in 1997. In 2003, a value of 130/80 mmHg for diabetic patients was recommended by JNC VII. In parallel, a new classification of 120/80 mmHg was proposed by the European Society of Hypertension and Cardiology (ESH/ESC). This organization also proposed that a single cut-off value for diagnosing HTN is unrealistic and the threshold for treatment initiation should be determined on the basis of other associated risk factors, risk for organ damage in future, and so on. The table 1 provides the ESH guidelines which are difficult to follow in current clinical practice. Antihypertensive treatment in high-normal BP was only recommended for patients at high risk i.e., those with diabetes and/or metabolic syndrome.

RISK FACTORS

Metabolic syndrome is defined as the clustering of risk factors like increased fasting glucose, hypertriglyceridemia, elevated BP, abdominal obesity, and low high density lipoprotein
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TABLE 1: Blood pressure criteria by the European Society of Hypertension and Cardiology

<table>
<thead>
<tr>
<th>Range</th>
<th>Systolic (mmHg)</th>
<th>Diastolic (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal</td>
<td>&lt;120</td>
<td>&lt;80</td>
</tr>
<tr>
<td>Normal</td>
<td>120–129</td>
<td>80–84</td>
</tr>
<tr>
<td>High-normal</td>
<td>130–139</td>
<td>85–89</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage I</td>
<td>140–159</td>
<td>90–99</td>
</tr>
<tr>
<td>Stage II</td>
<td>160–179</td>
<td>100–109</td>
</tr>
<tr>
<td>Stage III</td>
<td>≥180</td>
<td>≥110</td>
</tr>
<tr>
<td>Isolated systolic</td>
<td>≥140</td>
<td>&lt;90</td>
</tr>
</tbody>
</table>

(HDL)-cholesterol. For a detailed reading on the various criteria, controversies, and utilities of metabolic syndrome, readers are requested to refer to our recent chapter on metabolic syndrome. The inclusion of HTN as a metabolic syndrome component has facilitated a deeper insight into the condition, thereby facilitating early diagnosis and treatment. HTN has been known to affect about 85% of patients with metabolic syndrome. On the other hand, metabolic syndrome patients have a two-fold increased risk of new HTN and five-fold greater risk of diabetes. In the Pressioni A-teriose Monitorate E Loro Associazioni study, it was observed that elevated BP was the most common component of metabolic syndrome and was observed in 95.4% of the cases. The study also showed that metabolic syndrome increases CVD risk and long-term risk of death. This contribution of metabolic syndrome to CVD and mortality was closely related to BP abnormalities and hyperglycemia. Further, in a 20-year follow-up study showing the predictive value of metabolic syndrome on chronic heart failure, diastolic dysfunction emerged as the major contributor. A Chinese study also documented that increased BP was the only metabolic syndrome component that conferred substantial CVD risk even in the absence of other conditions. Hence, elevated BP has a considerable influence on the clinical course and prognosis of metabolic syndrome and diabetes patients.

Insulin resistance and abdominal obesity have been recognized as the major risk factors in the pathogenesis of metabolic syndrome and these factors also contribute to elevated BP. Elevated BP, in turn, induces vascular damage in renal, cardiac, and brain tissues. Insulin resistance and hyperinsulinemia also cause BP elevation by activating the sympathetic nervous system and the renin-angiotensin-aldosterone system (RAAS) and this increases the angiotensin II levels. This leads to increased retention of sodium and volume expansion, renal and endothelial dysfunction. Hyperinsulinemia also stimulates the mitogen-activated protein kinase pathway that exacerbates inflammation, vascular and cardiac damage. RAAS activation in the visceral adipose tissue has a dominant systemic effect compared to subcutaneous adipose tissue. Angiotensin II also inhibits the vasodilatory effects of insulin by acting via angiotensin receptors. It also decreases glucose uptake into the skeletal muscles by blocking the insulin signaling pathway via production of free radicals.
INDIAN SCENARIO

Deepa et al. have shown that with increasing levels of insulin resistance, the prevalence of HTN increased. HTN was associated with insulin resistance even after adjusting for several confounders like age, smoking habit, and alcohol consumption. A study from south India has estimated the prevalence of metabolic syndrome to be 25.8% by the International Diabetes Federation (IDF) criteria, 23.2% by the World Health Organization criteria, and 18.3% by the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria. The risk factors constituting metabolic syndrome, particularly elevated BP are highly prevalent in Asian Indians. It has been shown that the prevalence of abdominal obesity is 31.4%; HTN 55.4%; low HDL 65.5%, and raised fasting glucose 26.7%. An association of metabolic syndrome with obesity and insulin resistance, diet, inflammation has also been reported in the Asian Indian population. Mohan et al. have shown that the prevalence of HTN in an urban south Indian population was 20%. Isolated systolic HTN, defined as systolic BP more than or equal to 140 mmHg and diastolic BP less than 90 mmHg was present in 6.6% while isolated diastolic HTN (diastolic BP ≥90 mmHg and systolic BP <140 mmHg) was present in 4.2% of the population. Among the elderly population, 25.2% had isolated systolic HTN. There are very few studies on the prevalence of HTN in the eastern Indian population. A high prevalence of 61% has been reported in a study from Assam. Representative studies for the whole of Indian population on the prevalence of HTN are lacking. However, a recent comprehensive systematic review on HTN has shown that the overall prevalence of HTN in India was 29.8% after the regional population sizes were weighted. The study also showed that the pooled rural and urban prevalence for north, south, west, and east India were 14.5, 21.1, 18.1, and 31.7%, respectively. However, there are only a few studies that looked at the prevalence of metabolic syndrome among hypertensive patients. A recent study from north India has reported that the prevalence of metabolic syndrome in hypertensive patients was 68.6% (modified NCEP-ATP III) and 63.6% (IDF criteria).

Hypertension and Metabolic Syndrome in Indian Children

It is also recognized now that HTN has its origin early in childhood. The increase in the prevalence of obesity in children could be one of the reasons for the development of HTN in children. Hypertensive children are also at increased risk of diabetes and dyslipidemia. In a sample of 2,067 children in the age group of 15–16 years from south India, the prevalence of HTN was 2.4 and 2.1% in female and male children, respectively. The proportion of hypertensives was found to be highest in the age groups of 14–16 years. In a study done in north India, the prevalence of HTN was 5.9% and prehypertension was 12.3% in children. However, in adolescents, a study reported a prevalence of 21.5% and increased body mass index and decreased physical activity was found to confer three times increased risk of developing HTN. In another study done in Orissa on a sample of 5,155 students, 3.7% had sustained HTN and about the same proportion of students were obese. Also, a significant association was reported between HTN and obesity.
Prehypertension in India

A new category called ‘prehypertension’ was introduced by JNC VII on the basis of many studies and meta-analyses. Subjects with a systolic BP of 120–139 mmHg and/or diastolic BP level of 80–89 mmHg are considered prehypertensive. Even in young and healthy subjects, prehypertension was found to be common and associated with metabolic syndrome and cardiovascular risk factors. In a sample of over 6,000 subjects derived from 11 Indian cities, it was found that the prevalence of prehypertension was 40.2% and 30.1% in males and females, respectively. Ray et al. have assessed the prevalence of prehypertension in young military adults and found that about 80% were prehypertensive. Despite undertaking moderate-to-heavy exercise, the prevalence was high and associated with overweight, dyslipidemia, and higher intake of salt and saturated fat. Further, psychosocial factors like job stress might also have contributed to such high prevalence of prehypertension. In another study done in north India, the prevalence of prehypertension was found to be 32.3% and was highest in the age group of 30–39 years. If prehypertension is diagnosed, lifestyle modifications are advocated as long as the BP remains in the prehypertension range and target organs are unaffected.

Awareness, Treatment, and Control of Hypertension in India

In an urban south Indian population, it has been demonstrated that of the total hypertensive subjects, only 37.3% were known hypertensives and among the known hypertensives, only 50% were on antihypertensive therapy. Of these subjects on therapy, only 40% had their BP under control. This shows the validity of the rule of halves in this population and also reflects the inadequacy of awareness, control, and treatment measures. In another study involving 4,193 subjects, metabolic syndrome was prevalent in 40% of the sample. However, only 10% were aware that they were hypertensive and an even lesser proportion of 8% were on treatment. Also the level of awareness is lower in rural compared to urban areas and this could be explained by the socioeconomic differences, quality of the available healthcare in the regions, and the risk factors. Also, the literacy rates are lower in the rural parts and these regions experience wide disparity in health care access compared to urban regions. An increased prevalence of HTN among lower education group has also been observed.

MANAGEMENT OF HYPERTENSION

After risk stratification, treatment for HTN is initiated and lifestyle modification followed by drug therapy is advocated to hypertensive patients. As there is a significant decrease in BP after weight reduction in obese and overweight subjects, strategies to reduce weight is advised. Physical exercise for about 30 minutes has also been shown to reduce BP and CVD morbidity. Also, behavioral changes like quitting of smoking and alcohol moderation is also advocated. If lifestyle modification fails to achieve the targeted level of BP, antihypertensives are prescribed. Angiotensin receptor blockers, diuretics, β-blockers, angiotensin-converting enzyme inhibitors, α-blockers, calcium channel blockers, and some centrally acting drugs are the different classes of antihypertensive drugs used in the treatment of HTN. Combination therapy
is also used for improving compliance. Imidazoline class of drugs inhibit the sympathetic nervous system outflow from the brain and thereby, counteract sympathetic nervous system activation commonly seen in hypertensive patients with metabolic syndrome. This also exerts beneficial effects on insulin sensitivity.

**CONCLUSION**

In summary, HTN is not just elevated BP levels, but also a substantial contributor to metabolic syndrome and CVD. Hence, a multi-targeted approach for the treatment of elevated BP should be applied with a proper assessment of CVD risk. Future research should also focus on increasing our understanding of the mechanisms leading to HTN. Further, an evidence-based strategy for the treatment of the disease should be derived by critically analyzing the results of antihypertensive trials. More importantly, rigorous strategies to combat obesity and overweight in children and adolescents should be developed. The goal of dietary restriction should not only be weight reduction, but also improve quality of life. The involvement of the adolescent or child to establish healthy habits is very important. There is also a debate on the best form of physical activity for children and adolescents and this should involve an integrated effort from families, multidisciplinary teams, and the patients to reach the targeted weight loss and, therefore, prevent prehypertension and HTN.

**SUGGESTED READINGS**


SECTION 7: Comorbidities of Hypertension


