



COMPARATIVE EVALUATION OF BODY MASS INDEX AND WAIST-HIP RATIO AS RISK FACTOR PARAMETERS IN CORONARY ARTERY DISEASE PATIENTS AND NORMAL INDIVIDUALS

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Abstract: One hundred diagnosed patients of coronary artery disease including those of angina pectoris, unstable angina and acute MI were examined anthropometrically. Patients with known risk factor like smoking, hypertension and diabetes mellitus were excluded from this study. BMI and waist hip ratio were calculated along with the variables of age sex, and socio-economic status. This was compared with those of one hundred healthy individual this study involved age groups of 40yrs and above. The study and controlled group were analyzed statistically. Waist- hip ratio in the study group was higher (91/100) and comparatively lower (59/100) in the control group. Thus central obesity is significantly associated with coronary artery disease and it can be taken as a better index as compared to body mass index as a risk factor parameter for coronary artery disease. It was also observed the affected age for coronary artery disease was from 50 years to 70 years and predominantly male from middle income group from urban area. Waist-hip ratio is the better indicator for the coronary artery disease than body mass index

Key Words: Body Mass Index, Waist-Hip Ratio, Central Obesity, Coronary Artery Disease

INTRODUCTION

Prevalence of cardiovascular disease is on rise in both developed and developing countries. Conventional risk factors for coronary disease include smoking, Diabetes mellitus, hypertension, obesity and dyslipidaemia.¹ Association between the anthropometrics measurements- body mass index (BMI), waist-hip ratio (WHR) and waist-thigh ratio are positively related with cardiovascular risk factors. National Health and Nutrition examination study suggested that men who were overweight, determined by relative weight for height had greater risk factor for acquiring cardiovascular diseases than normal weight men.² In Frahmingham study, the relationship between MRW (metropolitan relative weight) and coronary artery disease was stronger in males than in females.³

Results from previous longitudinal studies suggested that only a sub sample of obese subject's carries the cardiovascular risk of excess body fatness because it was shown that the regional distribution of the body fat display is significantly and independent association with the ischemic heart disease. In fact, obese individual with the peripheral accumulation of the body fat display no increase in the risk of cardiovascular disease, whereas subjects with an excessive deposition of fat in the abdominal region display a clear increase in the incidence of CAD. This fact of body fat distribution was consistently reported in both sexes and is independent from the fact of obesity itself.⁴

Body mass index is the best studied predictor of risk of complications related to obesity. As a limitation, some people within normal BMI range may have excessive central fat accumulation and elevated metabolic risks and there are evidences which link central (visceral or intra-abdominal) obesity more strongly than peripheral fat distribution with the subsequent development of cardiovascular disease.⁵ As central fat distribution is considered more atherogenic than peripheral obesity, much attention has been focused on methods that can evaluate central obesity.^{5,6}

Some studies, have found that measures of abdominal obesity, principally, waist circumference (WC) and waist-to-hip ratio (WHR) are more closely related to Coronary vascular disease morbidity and mortality than is BMI.^{7,8}

Currently it has been found to be of value in identifying people with abnormal distribution of body fat and it is now believed that excessive body fat around abdomen in contrast to that around hip could be clinical as well as epidemiological marker in predisposing towards coronary artery disease.^{9,10} A waist hip ratio of more than 0.88 in males and more the 0.85 in females should be considered as central obesity in Indians because prevalence of these factors and coronary artery disease beyond these limits is higher.^{10,11}

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The main objectives of the study is to

1. To study the body mass index of patients of coronary artery disease as risk factor.
2. To study the waist hip ratio of patients of coronary artery disease as risk factor.
3. To compare body mass index and waist- hip ratio as risk factor parameter in coronary artery disease patients and normal individuals

MATERIAL AND METHOD

This study was conducted on the patients who attended medical outpatient department of Rajindra Hospital, attached to Government Medical College, Patiala, Punjab.

One hundred diagnosed patients of coronary artery disease including those of angina pectoris, unstable angina and acute myocardial infarction were examined anthropometrically. Patients with known risk factors like smoking, hypertension and diabetes mellitus were excluded from this study. Body mass index and waist hip ratio of these patients were calculated along with the variables of age, sex, socioeconomic status, and area background. This was compared with those of one hundred healthy individuals. This study involved age group of 40yrs and above

A detailed history was taken to ascertain the presence of coronary artery disease in all cases. Family history and history to rule out smoking, hypertension and diabetes mellitus was also asked.

The clinical examination was done to include general physical examination along with the local examination for cardiovascular system, chest and per abdomen examination to rule out any abnormal finding. Electrocardiography was done for diagnosis of coronary artery disease cases and healthy individuals. Diabetes mellitus was ruled out by blood sugar level.

Anthropometrical examination for height, weight, waist circumference was done for both coronary artery disease cases and healthy individuals. Weight was taken without shoes, it was in kilograms. Height was measured in standing position without shoes. Waist was measured at narrowest point between lower rib and iliac crest. It was measured in centimeters. Hip circumference was taken in centimeters as circumference of hip at maximum point for buttocks.

Body mass index was calculated as body weight in kg divided by squares of height in meters (kg/m^2). Body mass index range criteria was followed as upto less than $25 \text{ kg}/\text{m}^2$ as normal, $25\text{-}30 \text{ kg}/\text{m}^2$ as overweight and more than $30 \text{ kg}/\text{m}^2$ as obese.

B.M.I= weight in kilograms /Square of height in meters

Waist hip ratio calculated by dividing waist circumference in centimeters by hip circumference in centimeters.

Waist hip ratio= waist circumference in centimeters / hip circumference in centimeters

In our study, we had followed the criteria of Waist hip ratio more than 0.88 for centrally obese men and more than 0.85 for centrally obese women. It has been mentioned in our study as group II Waist hip ratio of less than and equal to 0.88 for men and 0.85 for women was taken as centrally non obese.

In statistically analysis, standard methods were used to calculate mean values and standard deviation. Statistically analysis, standard methods were used by using student 't' test, Chi square test. Inter group difference were compared using t-test. All p-value are two tailed and significant when less than 0.05.

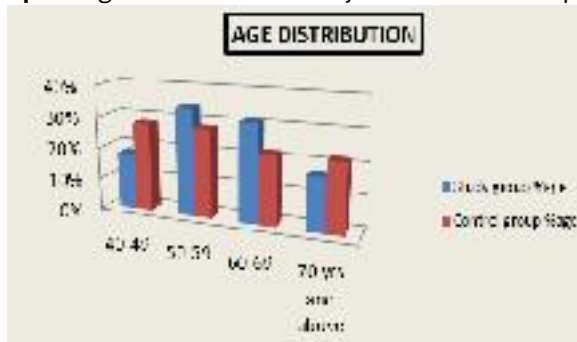
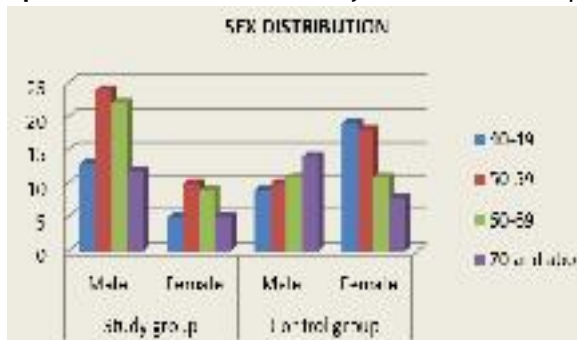
RESULTS

In the present study, randomly two hundred persons were chosen for the study, who attended the medicine department of Rajindra hospital attached to government medical college, Patiala, during the study period. One hundred cases were of coronary artery disease diagnosed clinically and by ECG and this was considered as study group. Controlled group included 100 individuals who were free from coronary artery disease and any other major ailment with age from 40 years and above.

In this study, stress was given on body mass index level and waist hip ratio of all the subjects with general clinical history and electrocardiography done to know the condition of their hearts and finally compared the two parameters to ascertain that whether any of these was significant to predict the disease alone, for all ages or better predictor among them for the disease.

Age Distribution and Sex Distribution

Age was taken 40years and above. Patients were divided into 4 groups i.e. 40-49, 50-59, 60-69, and 70yrs and above, least number of cases reported above 80yrs of age. 71% of CAD patients were male and 29% were female and maximum lie in the age group of 50-59yrs of age group (males-33.80 and females-17.24%) with male predominance as shown in graph I & II.

Graph I: Age Distribution in Study and Control Group**Graph II: Sex Distribution in Study and Control Group****Weight and Height Measurement**

Weight of the study and control groups of 50-59 years of age was found to be statistically significant. Height measurement in the age group of 40-49 years and 50-59 years was found to be highly significant as shown in the table I.

Table I: Comparison of Weight and Height

Age group	Groups	No.	Mean \pm SD Weight	Mean \pm SD Height
40-49	Study	18	65.25 \pm 13.87	1.64 \pm 0.08
	Control	28	65.03 \pm 8.61	1.56 \pm 0.06
t=0.06, >0.05 NS t=3.62, p<0.001 HS				
50-59	Study	34	68.25 \pm 12.53	1.63 \pm 0.08
	Control	28	62.21 \pm 10.64	1.57 \pm 0.08
t=2.01, p<0.05 S t=3.09, p<0.001 HS				
60-69	Study	31	64.41 \pm 11.85	1.61 \pm 0.09
	Control	22	61.74 \pm 14.08	1.60 \pm 0.07
t=0.75, p>0.05 NS t=0.51, p>0.05 NS				
70 and above	Study	17	64.64 \pm 15.38	1.64 \pm 0.11
	Control	22	61.02 \pm 8.05	1.61 \pm 0.08
t=0.95, p>0.05 NS t=0.83, p>0.05 NS				

In the comparison of waist and hip circumference in both groups, waist circumference in the age group 50-59 years was found to be statistically significant as shown in table II.

Table II: Comparison of Waist and Hip Circumference According To Age

Age group	Groups	No.	Mean \pm SD Waist circumference	Mean \pm SD Hip circumference
40-49	Study	18	90.83 \pm 11.72	96.55 \pm 9.23
	Control	28	90.58 \pm 09.72	99.42 \pm 8.25
t=0.07, p>0.05 NS t=1.33, p>0.05 NS				
50-59	Study	34	94.88 \pm 12.44	98.39 \pm 8.25
	Control	28	87.12 \pm 11.30	96.80 \pm 8.36
t=2.54, p<0.05 S t=0.75, p>0.05 NS				
60-69	Study	31	91.81 \pm 12.25	95.22 \pm 9.42
	Control	22	85.59 \pm 13.26	95.31 \pm 8.36
t=1.76, p>0.05 NS t=0.03, p>0.05 NS				
70 and above	Study	17	90.14 \pm 13.20	93.23 \pm 10.11
	Control	22	83.09 \pm 10.51	94.27 \pm 7.97
t=1.85, p>0.05 NS t=0.35, p>0.05 NS				

A level of waist circumference was high in study group than control group. Waist circumference of 100cm or above was noted among 29 males and 10 females in study group with male predominance as shown in table III.

Table III: Comparison of Waist and Hip Circumference According To Sex

Sex	Group	NO	Mean \pm SD Waist circumference	Mean \pm SD Hip circumference
Male	Study	71	92.83 \pm 12.62	96.08 \pm 9.38
	Control	44	86.64 \pm 11.15	94.04 \pm 6.72
t=2.65, p<0.001 HS t=1.25, p>0.05 NS				
Female	Study	29	91.32 \pm 11.77	96.50 \pm 8.81
	Control	56	87.02 \pm 11.60	98.07 \pm 8.03
t=1.61, p>0.05 NS t=1.16, p>0.05 NS				

BMI and WHR According To Age

BMI of study and control groups of all age groups were found to be statistically not significant except in the age group of 40-49 years, where it was significant as shown in table IV.

Table IV: Comparison of Body Mass Index according To age

Age Group	Groups	No.	Range	Mean \pm SD	t-value	p-value	Significance
40-49	Study	18	18.35-30.06	24.80 \pm 3.68	2.65	<0.05	S
	Control	28	22.13-35.49	26.73 \pm 3.21			
50-59	Study	34	17.39-33.33	25.72 \pm 4.26	0.44	<0.05	NS
	Control	28	17.48-33.78	25.24 \pm 4.24			
60-69	Study	31	17.94-30.78	24.38 \pm 3.40	0.59	<0.05	NS
	Control	22	18.51-33.86	23.75 \pm 4.37			
70 and above	Study	17	17.08-30.98	23.72 \pm 3.70	0.13	<0.01	NS
	Control	22	15.95-29.77	23.56 \pm 3.86			

WHR in the study and control group of age groups 50-59 years, 60-69 years and 70 years and above were found to be statistically highly significant as shown in table V.

Table V: Comparison of Waist-Hip Ratio According To Age

Age Group	Groups	Range	Mean± SD	t	p	S
40-49	Study(18)	0.83-1.03	0.934±0.058	1.57	<0.05	NS
	Control(28)	0.80-1.05	0.903±0.069			
50-59	Study(34)	0.78-1.14	0.957±0.068	3.73	<0.001	HS
	Control(28)	0.78-1.01	0.895±0.061			
60-69	Study(31)	0.84-1.11	0.960±0.065	2.85	<0.001	HS
	Control(22)	0.73-1.10	0.895±0.100			
70 and above	Study(17)	0.86-1.12	0.959±0.074	3.42	<0.001	HS
	Control(22)	0.75-1.12	0.874±0.080			

WHR was highly significant in case of males of study and control group as shown in table VI.

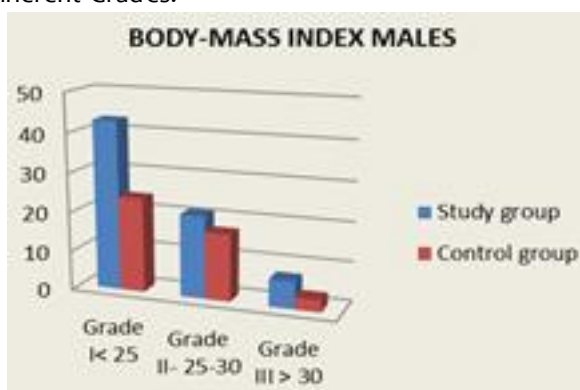
Table VI: Comparison of Body Mass Index and Waist-Hip Ratio According To Sex

Sex	Group	NO	Mean± SD	Mean± SD
			Body Mass Index	Waist-Hip Ratio
Male	Study	71	24.39 ±3.86	0.960 ± 0.062
	Control	44	24.96± 4.07	0.892 ± 0.77
			t-0.38, p>0.05 NS	t-3.88, p<0.001 HS
Female	Study	29	25.32 ±3.78	0.940± 0.07
	Control	56	24.10 ±3.78	0.912 ± 0.069
			t-1.33, p>0.05 NS	t-1.68, p>0.05 NS

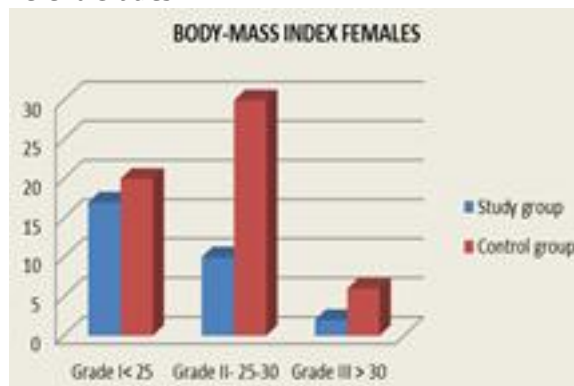
BMI and WHR According To Sex

Graph IV and V: show comparison of BMI in both sexes according to different grades. Grade I- < 25, Grade II- 25-30, Grade- III- > 30

Graph IV: Comparison of BMI in Males According To Different Grades.

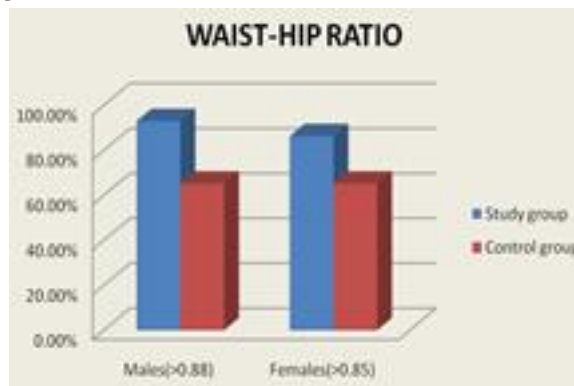


Graph V: Comparison of BMI in Females According To Different Grades.



Statistically analysis showed that comparison was significant in females in both groups. In the study group 92.96% males were above the 0.88 waist hip ratio level and 86.21% of females were above the level of 0.85 which was statistically highly significant (p< 0.001) as shown in graph VI.

Graph VI: Comparison of Waist-Hip Ratio According To Sex



It was observed that when compared with variables of weight and BMI it was highly significant (p<0.02). In males whereas compared with variables age and height were not statistically significant as shown in table VII.

Table VII: Anthropometric and Clinical Variables in Two Groups of Males Patients

Variables	Group I	Group II	t-Value	p-Value	S
	WHR ≤ 0.88 N=25	WHR > 0.88 N=66			
AGE	58.60±10.96	58.68 ± 0.43	0.01	>0.05	NS
Ht (In M)	1.63 ± 0.036	1.67± 0.076	1.25	>0.05	NS
Wt (In kg)	54.10 ± 5.22	69.23 ± 13.26	2.52	<0.001	HS
BMI Wt/Ht²	20.39 ± 1.19	24.69 ± 3.82	2.49	<0.001	HS

It was observed that different variables (age, weight, height, BMI) in comparison two different groups of

waist- hip ratio were statistically not significant ($p > 0.05$) as shown in table VIII.

Table VIII: Anthropometric and Clinical Variables in Two Groups in Females Patients

Variables	Group I	Group II	t-Value	p-Value	S
	WHR \leq 0.85 N=24	WHR $>$ 0.85 N=25			
AGE	50.75 \pm 9.34	60.76 \pm 11.76	1.63	>0.05	NS
Wt (In kg)	55.0 \pm 5.77	61.24 \pm 10.53	1.14	>0.05	NS
Ht (In M)	1.55 \pm 0.04	1.536 \pm 0.051	0.08	>0.05	NS
BMI (Wt/ Ht ²)	23.28 \pm 2.76	25.64 \pm 3.86	1.16	>0.05	NS

DISCUSSION

Obesity has been associated with coronary artery disease (CAD) since long. General obesity has been studied as risk factor by workers. It was further impressed to be regional adiposity more than the general obesity. This study has been conducted to find out BMI and WHR as risk factors parameters for CAD in longitudinal study of population and to compare the BMI and WHR of CAD cases with healthy individuals to find out which parameter is more dependent, taking into account their age and sex.

Body Mass Index (BMI)

It is indicator of general obesity. More the BMI, more is the general obesity. In our study, in study group of 100 cases, according to age and sex, BMI was calculated and mean was 24.62 with S.D. \pm 4.09 in males and females together whereas in males it was 24.22 \pm 3.88 and in females 25.03 \pm 4.30. Among the 24 males, from the age group of 50-59, highest of BMI were 25.31 \pm 4.13 and 10 females of age group, highest BMI was 26.71 \pm 4.62. ($p > 0.05$) which was statistically not significant. Lowest BMI 23.93 \pm 4.01 and 23.20 \pm 3.18 were in age group of 70 years and above from 12 males and 5 females respectively ($p > 0.05$). BMI in all other age groups, acc to sex was statistically not significant.

In control group of 100 cases, mean BMI was 24.33 \pm 3.60 with highest mean of 26.61 \pm 3.19 in the age group 40-49 years and lowest 22.43 \pm 3.05 in the age group 70 years and above. These findings were consistent with other studies.^{12,13, 14} In present study it had been observed that BMI was low in the age group 40-49 years, increased to highest in the age group of 50-59 years and declined thereafter in both the sexes.

Waist-Hip Ratio (WHR)

It is an indicator of central obesity. More the WHR, more is person centrally obese. In our study, the study group of 100 cases, consists of 71 males and 29 females, females whose WHR was 0.958 \pm 0.60 and

0.937 \pm 0.77 respectively. WHR was recorded higher in age group 60-69 years in males (0.968 \pm 0.065) at age group of 50-59 years in females (0.951 \pm 0.07) and lower in age group of 40-49 yrs in males and in females (0.943 \pm 0.045 males and 0.912 \pm 0.085 females). WHR when compared in all age group in both the sexes was found to be not significant.

While we compare the study group with control group of 100 cases each, it was noted that the comparison between study group and control group was highly significant in age group of 50-59 years, 60-69 years and 70 years and above, the mean values being 0.957 \pm 0.068, 0.985 \pm 0.061, 0.960 \pm 0.065, 0.895 \pm 0.050 and 0.959 \pm 0.07, 0.874 \pm 0.08 respectively ($p < 0.001$).

When we compare these figures sex-wise it was found that in males these were highly significant at age group of 70 years and above. ($p < 0.001$) and in males and females in the age group of 50-59 years were significant ($p < 0.05$). In rest of group the comparison was not significant.

WHR level equal and less than 0.08 for males and 0.85 for females when compared in both the study and control group and compared sex-wise in both the sexes it was highly significant ($p < 0.001$).

The present study WHR for males 0.958 \pm 0.060 and females 0.937 \pm 0.077 is very near to the study of Hodgson et al., (1994) for males 0.96 \pm 0.045 and for females 0.92 \pm 0.09.^{12,13,14}

Waist Circumference

Waist circumference has a significant role in the calculation of WHR as for the prediction of coronary artery disease (CAD); it is the measure to know about lipolytic active fat in the body and indicator of central obesity.

In the present study while comparing study groups with control group according to age groups, it was found statistically age group of 50-59 yrs was significant ($p < 0.01$), but not significant in other age groups. Where as in comparison of waist circumference in study and control group, according to sex, it was highly significant (mean value 92.83 \pm 12.62, 86.67 \pm 11.15) $p < 0.02$ and in females, this comparison was not significant (mean value 91.32 \pm 11.77, 87.02 \pm 11.60) $p > 0.05$.

The present study in males 92.83 \pm 12.62 is comparable with Seidell et al., 2001, 93.4 \pm 16.3 while in case of females 91.32 \pm 11.77 was very near to Seidell et al., 83.1 \pm 17.9.¹⁴ the findings of other workers had reported low values for males.^{15,16}

Hip Circumference

Hip circumference is an important component of WHR parameters showing the condition of body peripheral muscles. In the present study, the variables of WHR hip measurement is one of the important variables but when it was compared according to age and sex between the study group and the control group, statistically these were not significant. Hip circumference was highest 98.39+8.25 in the age group of 50-59yrs of study group where it shows decline with the advancing age. Figure in age group of 40-49 years was bit higher 96.55 than in age group of 60-69 years 95.22. The maximum hip measurement was in age group of 70 years and above 93.234. whereas in control group, hip circumference was maximum 99.42 in the age group of 40-49 years and thereafter it declined steadily in rest of age group, minimum in the age group of 70 years and above, 94.27.

Present study of hip circumference for male 96.08 + 9.38 and female 96.50 + 8.81 is comparable with Seidell et al., 2001, 100.5+11.2 for males and 104.2+15.9 for females^{14,17}.

SUMMARY

All the individuals in this study were 40 years and above. In the study, it was observed that most commonly affected age for CAD was from 50 to 70 years and predominantly males. Weight ranged from 39-95 kg (mean wt 65.87) and height 1.45 m to 1.9 m (mean ht 1.63m), whereas in control group ranged from 34-106kg and ht from 1.37-1.77m with mean weight 62.63 and mean height 1.59 m respectively. Although the mean weight of study group was higher but due to height, BMI was low in comparison to control group.

In study group mean WHR in males was 0.96 and in females mean WHR was 0.94. In the control group mean WHR in control group was 0.892 in males and 0.912 in females. So waist circumference was more as compared in hip circumference in CAD cases. More the waist circumference more is the WHR and greater chances of CAD.

WHR in the study group was higher (91 patients out of 100 patients). In the control group WHR was higher (59 subjects out of 100 subjects). Thus it clearly indicates that central obesity is significantly associated with CAD and it can be taken as better index as compared to BMI as a risk factor parameter for CAD

CONCLUSION

BMI is the most commonly used indicator of obesity in population studies, although it is not a perfect one. It does not take into account waist size

and WHR. Increased central or visceral fat independent of relative body weight is associated with a variety of metabolic disorders and increased cardiovascular mortality.

Measures of abdominal obesity principally, waist circumference (WC), waist-to-hip ratio (WHR), is more closely related to CVD morbidity and mortality than is BMI. Among men in the normal and overweight BMI categories, WHR and waist circumference are positively associated with coronary artery disease.

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