

Study of ECG Changes in Apparently Healthy Adult Male Smokers

*Khan IS,¹ Rahman MA,² and Amin R³

This study was carried out to evaluate the changes in ECG in apparently healthy adult male smokers and non smokers to identify the possible high risk factor for cardiovascular diseases. This cross sectional study was carried out during the study period July 2006 to June 2007 in the department of Physiology of Dhaka Medical College. ECG was recorded in smokers and non smokers. Total 105 subjects age ranged from 20 to 50 years were selected, of whom 30 were non smokers (control) and 75 were smokers (experimental) who smoked for more than 5 years. Observations were made when the results were compared between smokers and non smokers. From the statistical analysis of the results obtained in the present study and their comparison with those of published reports, it may be concluded that, smoking causes no change in ECG wave forms except P-R interval.

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Key words: ECG, Smoker

Introduction

One billion people worldwide are still addicted to cigarettes. Every year, 3 million die from smoking related causes.¹ Cigarette smoking is a major risk factor for cardiovascular disease and epidemiological studies have established a gradient of risk; the highest for containing smokers, intermediate for reformed smokers and the lowest for non smokers.² Men under 65 years of age smoking 25 or more cigarettes a day had a relative risk of developing coronary heart disease of 2.6 times that of non smokers.^{3,4}

The effect of smoking on electrocardiographic (ECG) measurement has been examined⁵. Eight percent smoker showed changes of P-Pulmonale on their ECG. This might be due to development of corpulmonale subsequently

producing right atrial hypertrophy as a result of chronic smoking.⁶ P-R interval duration was shorter in current smoker than non smoker. Longitudinal results indicated that R, S and T wave amplitude decreased at greater rates in smokers than in nonsmokers. These finding suggest that changes in the electrocardiogram attributed to aging may be modified by smoking.⁵ It is also associated with prolonged QTc (correct QT interval) in healthy smokers.⁷

Cigarette smoking is a common problem in Bangladesh and also a major public health problem associated with morbidity and mortality. The prevalence of cigarette smoking has peaked among the adult. Given the importance of adverse effect of smoking, the present study has been undertaken to see ECG changes in healthy adult male smokers.

1. *Dr. Indira Sufia Khan, Assistant Professor of Physiology, Medical College for Women, Uttara, Dhaka, email: seruj6203@yahoo.com
2. Dr Md Abedur Rahman, Lecturer of Physiology, Dinajpur Medical College, Dinajpur, Bangladesh.
3. Professor Dr. Ruhul Amin, Professor of Physiology, Sylhet MAG Osmani Medical College, Sylhet, Bangladesh.

*For correspondence

Methods

This cross sectional study has been undertaken to evaluate the changes of ECG in apparently healthy adult smokers and non smokers during the study period July 2006 to June 2007 in the department of Physiology of Dhaka Medical College. For that purpose ECG was recorded in smokers and non smokers. Total 105 subjects age ranged from 20~50 years were selected, of whom 30 were non smokers (control) and 75 were smokers (experimental) who smoked for more than 5 years.

The subjects were grouped as follows:

Group A (control): consisted of 30 apparently healthy adult non smokers.

Group B (Experimental): consisted of 75 apparently healthy adult smokers.

The experimental group was again sub divided into following groups:

Group B1: Consisted of 25 smokers consuming 1-9 cigarettes/day for more than 5 years.

Group B2: Consisted of 25 smokers consuming 10-19 cigarettes/day for more than 5 years.

Group B3: Consisted of 25 smokers consuming > 20 cigarettes/day for more than 5 years.

All these subjects were from the different socio-economic classes and apparently healthy. Height, weight and resting blood pressure were measured. Smoking history of smokers was recorded. ECG was recorded after a light breakfast without any caffeinated beverages, non-exercising state and abstains from smoking two hours prior to the test.

The study was conducted on an outpatient basis according to the principles of the Declaration of Helsinki and was approved by the medical ethics review board of the Dhaka medical College. Informed consent was obtained from all volunteers after oral and written information had been given.

Analysis of data was done with the help of computer by SPSS program version of 12.0 Software facilities.

Results

Observation on Subjects Profile

Mean (\pm SD) age of smokers and non smoker were 30.8 ± 6.9 years and $31.3 (\pm 5.0)$ years. Mean (\pm SD) BMI of smoker and non smoker was $21.8 (3.8) \text{ kg/m}^2$, $22.0 (3.4) \text{ kg/m}^2$ respectively. Table I shows mean of age and BMI in different group of subject.

Table I: Mean of Age and BMI in different groups of subjects

Groups	Age (Years)	BMI(kg/m^2)
	Mean \pm SD	Mean \pm SD
A (N=30)	31.3 ± 5.0	22.0 ± 3.4
B (N=75)	30.8 ± 6.9	21.8 ± 3.2
B1 (N=25)	29.4 ± 7.1	21.5 ± 2.9
B2 (N=25)	30.1 ± 7.4	21.3 ± 3.4
B3 (N=25)	33.0 ± 5.7	22.7 ± 3.1

P wave (mm)

Table II and III show association of presence of P-pulmonale in group A (control) and group B (study). In control group, 1 subject had P pulmonale out of 30. In study group 8 subjects had P pulmonale out of 75. The association was not statistically significant ($p > 0.05$). The association was not statistically significant between group A ($p > 0.03$) and B₁, B₂ ($p = 1.34$), and B₃ ($p = 0.3$) respectively. In B₁ vs B₂, value of presence of P pulmonale

was not significant ($p > 0.05$) which was not statistically significant. In B_1 vs B_3 , value of presence of P pulmonale was not statistically significant ($p > 1.00$). In B_2 vs B_3 , value of presence of P pulmonale was not statistically significant ($p > 0.66$).

Table II: Association of presence of P pulmonale in different groups of subjects

Group	N	P pulmonale (LII)		P	Remark
		Present	Absent		
A	30	1	29	0.41	Not significant
B	75	8	67		
A	30	1	29	0.87	Not significant
B_1	25	2	23		
A	30	1	29	0.25	Not significant
B_2	25	4	21		
A	30	1	29	0.87	Not significant
B_3	25	2	23		

Table III: Statistical analysis of p wave (mm) among different groups

Group	p value	Remark
B_1 vs B_2	0.66	Not significant
B_1 vs B_3	1.00	Not significant
B_2 vs B_3	0.66	Not significant

QRS complex (sec):

The results are obtained by unpaired Student's "t" test are shown in Table IV, V and Fig 1, 2. The mean (\pm SD) duration of QRS complex was 0.07 (\pm 0.01) and 0.07 (\pm 0.01) sec in study group (smokers) and control group (non smokers) respectively. The means (\pm SD) duration of QRS complex were 0.07 (\pm 0.01), 0.07 (\pm 0.01), 0.08 (\pm 0.01) sec in B_1 , B_2 and B_3 groups respectively. The mean QRS complex was not significantly different ($p > 0.05$) in study group compared to that of control group. The results were also not significantly different between group A and smoker's group B_1 ($p > 0.05$), B_2 ($p > 0.05$), but significantly different between A and B_3 ($p < 0.05$). Again the differences of mean QRS complex among the smoker's groups B_1 vs.

B_2 ($p > 0.05$), B_2 vs. B_3 ($p > 0.05$) and B_1 vs B_3 ($p > 0.05$) were not statistically significant.

Table IV: Distribution of QRS complex in different groups of subject

Group	N	Minimum	Maximum	Mean	Std. Deviation
A	30	0.04	0.12	0.07	0.01
B	75	0.06	0.12	0.07	0.01
B_1	25	0.06	0.12	0.07	0.01
B_2	25	0.06	0.12	0.07	0.01
B_3	25	0.06	0.12	0.08	0.01

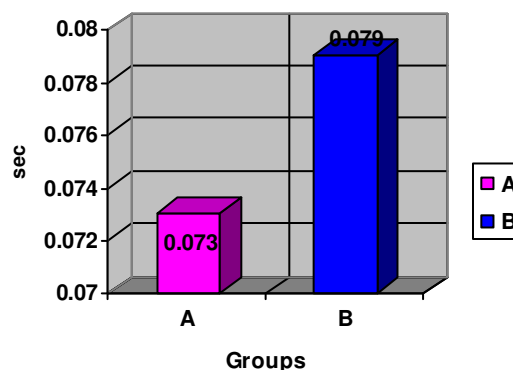


Figure 1. Bar diagram illustrates mean QRS complex distribution in non smokers and smokers

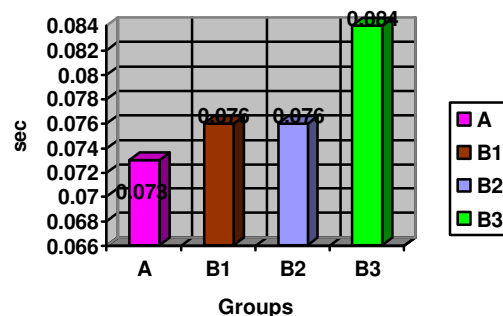


Figure 2. Bar diagram illustrates mean QRS complex distribution in non smokers and different categories of smokers

Table V: Statistical analysis of QRS complex (LII) among different groups

Groups	p value	Remark
A vs B	0.135	Not Significant
A vs B1	0.533	Not Significant
A vs B2	0.520	Not Significant
A vs B3	0.029	Significant
B2 vs B3	0.099	Not Significant
B1 vs B3	0.109	Not Significant
B1 vs B2	1.000	Not Significant

R wave (mm) (V5)

The results are obtained by unpaired Student's "t" test are shown in Table VI, VI and Fig 3, 4. The mean (\pm SD) amplitude of R wave (mm) was 17.1 (\pm 5.4) and 18.1 (\pm 5.8) mm in study group (smokers) and control group (non smokers) respectively. Again the mean (\pm SD) amplitude of R wave (mm) were 19.1 (\pm 5.7), 17.1 (\pm 4.4), 14.8 (\pm 5.5) in B₁, B₂ and B₃ groups respectively. The mean R wave (mm) was not significantly different ($P > 0.05$) in study group compared to that of control group. But the results was significantly different between group A and smoker's group B₃ ($p < 0.05$). Again the differences of mean R wave (mm) among the smoker's groups B₁ vs. B₂ ($P > 0.05$) were not significant, and B₂ vs. B₃ ($P > 0.05$) were not statistically significant. But B₁ vs B₃ ($p < 0.01$) were statistically very significant.

Table VI: Distribution of R wave (mm) in different groups of subject

Group	N	Minimum	Maximum	Mean	Std. Deviation
A	30	9.00	31.0	18.1	5.8
B	75	4	36.0	17.0	5.4
B1	25	11.00	36.0	19.1	5.7
B2	25	9.00	25.0	17.1	4.4
B3	25	4	24.0	14.8	5.5

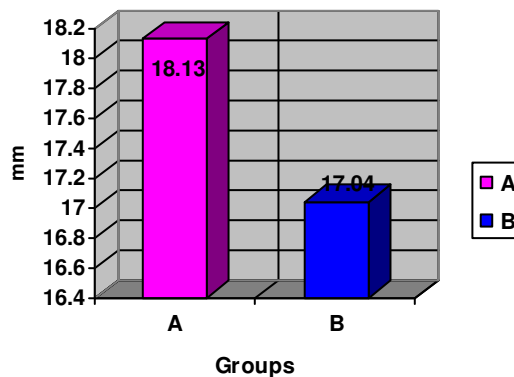


Figure 3. Bar diagram Illustrates mean R wave distribution in non smokers and smokers

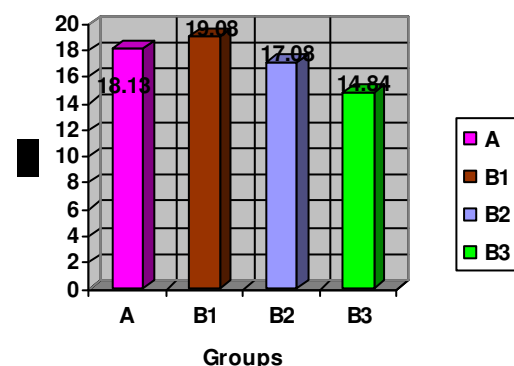


Figure 4. Bar diagram Illustrates mean R wave distribution in non smokers and different categories of smokers

Table VII: Statistical analysis of R wave (mm) (V₅) among different groups

Groups	P value	Remark
A vs B	0.363	Not Significant
A vs B1	0.494	Not Significant
A vs B2	0.457	Not Significant
A vs B3	0.035	Significant
B2 vs B3	0.117	Not Significant
B1 vs B3	0.008	Very Significant
B1 vs B2	0.145	Not Significant

S wave (mm) (v1)

The results are obtained by unpaired Student's "t" test are shown in Table VIII, IX and Fig 5, 6. The mean (\pm SD) amplitude of S wave (mm) was 10.7 (\pm 4.0) and 9.7 (\pm 4.8) mm in study group (smokers) and control group (non smokers) respectively. The means (\pm SD) amplitude of S wave (mm) were 11.7 (\pm 4.1), 12.0 (\pm 3.8), 8.6 (\pm 3.7) mm in B₁, B₂ and B₃ groups respectively. The mean amplitude of S wave (mm) was not significantly different ($p > 0.05$) in study group compared to that of control group. The results were not significantly different between group A and smoker's group B₁ ($p > 0.05$) and B₃ ($p > 0.05$). But the results was significantly different between group A and smoker's group B₂ ($p < 0.05$). Again the differences of amplitude of S wave (mm) between the smoker's groups B₁ vs. B₂ ($p > 0.05$), were not significant but B₂ vs. B₃ ($p < 0.001$) and B₁ vs B₃ ($p < 0.01$) were statistically highly significant and very significant respectively.

Table VIII: Distribution of S wave (mm) in different groups of subject

Group	N	Minimum	Maximum	Mean	Std. Dev
A	30	4	22	9.7	4.8
B	75	2	20	10.7	4.0
B ₁	25	5	20	11.7	4.1
B ₂	25	6	20	12.0	3.9
B ₃	25	2	14	8.6	3.7

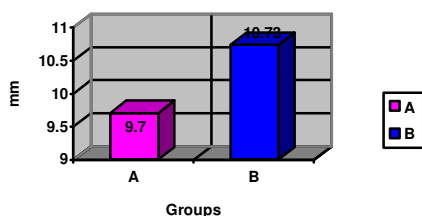


Figure 5. Bar diagram Illustrates mean S wave distribution in non smokers and smokers

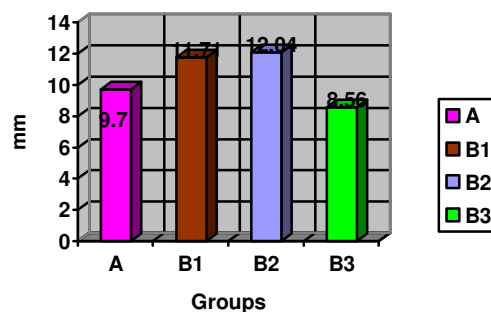


Figure 6. Bar diagram Illustrates mean S wave distribution in non smokers and different categories of smokers

Table IX: Statistical analysis of S wave (mm) (V₁) among different groups

Groups	p value	Remark
A vs B	0.26	Not Significant
A vs B ₁	0.12	Not Significant
A vs B ₂	0.05	Significant
A vs B ₃	0.34	Not Significant
B ₂ vs B ₃	0.001	Highly Significant
B ₁ vs B ₃	0.008	Very Significant
B ₁ vs B ₂	0.68	Not Significant

T wave (mm) (LII)

The results are obtained by unpaired student's "t" test are shown in Table X, XI and Fig 7, 8. The mean (\pm SD) amplitude of T wave was 3.3 (\pm 1.3) and 3.8 (\pm 1.2) mm in study group (smokers) and control group (non smokers) respectively. The means (\pm SD) T wave (mm) were 3.8 (\pm 1.5), 3.1 (\pm 1.2), 3.0 (\pm 1.2) mm B₁, B₂, B₃ groups respectively. The mean T wave (mm) was not significantly different ($P > 0.05$) in study group compared to that of control group. The results was not significant between group A and smoker's group B₁ ($p > 0.05$), but significant between A and B₂ ($p < 0.05$) and B₃ ($p < 0.05$) respectively. Again the differences of mean T wave (mm) among the smoker's groups B₁ vs. B₂ ($p > 0.05$), B₂ vs. B₃ ($p > 0.05$) were not statistically significant but B₁ vs B₃ ($p < 0.05$) were statistically significant.

Table X: Distribution of T wave (mm) in different groups of subject.

Group	N	Minimum	Maximum	Mean	Std. Deviation
A	30	1.5	6.0	3.8	1.2
B	75	1.0	7.0	3.3	1.3
B1	25	1.5	7.0	3.8	1.5
B2	25	1.0	5.0	3.1	1.2
B3	25	1.0	6.0	3.0	1.2

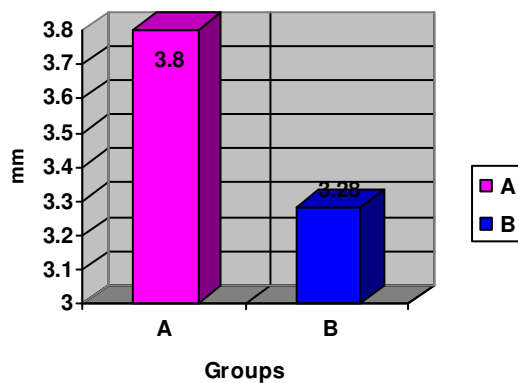


Figure 7. Bar diagram illustrates mean T wave distribution in non smokers and smokers

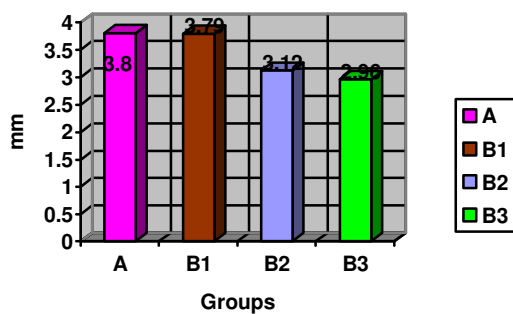


Figure 8. Bar diagram Illustrates mean T wave distribution in non smokers and different categories of smokers

Table XI: Statistical analysis of T wave (mm) (LII) among different groups

Groups	p value	Remark
A vs B	0.065	Not Significant
A vs B1	0.982	Not Significant
A vs B2	0.036	Significant
A vs B3	0.011	Significant
B2 vs B3	0.635	Not Significant
B1 vs B3	0.035	Significant
B1 vs B2	0.085	Not Significant

P-R interval (sec) (LII)

The results are obtained by unpaired Student's "t" test are shown in Table XII, XIII and Fig 9, 10. The mean (\pm SD) duration of P-R interval (sec) was 0.16 (\pm 0.02) and 0.17 (\pm 0.02) (sec) in study group (smokers) and control group (non smokers) respectively. The means (\pm SD) duration of P-R interval (sec) were 0.16 (\pm 0.02), 0.16 (\pm 0.02), 0.15 (\pm 0.02) sec in B₁, B₂ and B₃ groups respectively. The mean P-R interval (sec) was significantly different ($P < 0.05$) in study group compared to that of control group. The results was not significant between group A and smoker's group B₁ ($p > 0.05$), but significant between A and B₂ ($p < 0.05$), and B₃ ($p < 0.05$) respectively. Again the differences of mean P-R interval (sec) among the smoker's groups B₁ vs. B₂ ($p > 0.05$), B₂ vs. B₃ ($p > 0.05$) and B₁ vs B₃ ($p > 0.05$) were not statistically significant.

Table XII: Distribution of P-R interval (sec) in different groups of subject

Group	N	Minimum	Maximum	Mean	Std. Deviation
A	30	0.12	0.20	0.17	0.02
B	75	0.10	0.20	0.16	0.02
B1	25	0.12	0.20	0.16	0.02
B2	25	0.12	0.20	0.16	0.02
B3	25	0.10	0.20	0.15	0.02

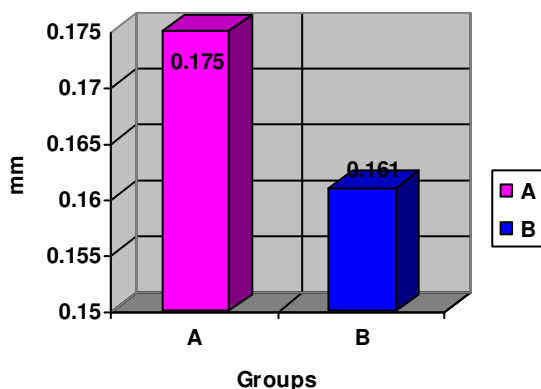


Figure 9. Bar diagram Illustrates mean P-R interval distribution in non smokers and smokers

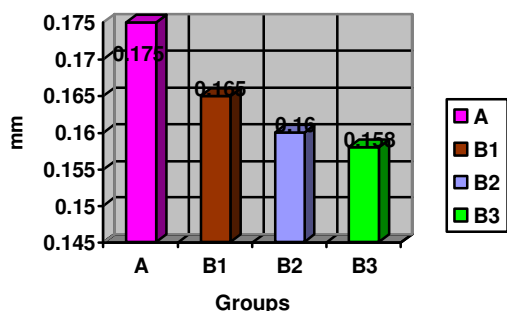


Figure 10. Bar diagram Illustrates mean P-R interval distribution in non smokers and different categories of smokers

Table XIII: Statistical analysis of P-R interval (sec) (LII) among different groups

Groups	p value	Remark
A vs B	0.012	Significant
A vs B1	0.110	Not Significant
A vs B2	0.030	Significant
A vs B3	0.017	Significant
B2 vs B3	0.756	Not Significant
B1 vs B3	0.409	Not Significant
B1 vs B2	0.595	Not Significant

Discussion

In this study, the association of presence of P pulmonale was not statistically significant in smokers and non smokers ($p > 0.05$). But eight percent smokers showed P pulmonale on their ECG. Our result is in agreement with what Sharma et al found.⁶ Ahn Von found that cigarette smoking during hypoxia increased the amplitude of the P waves.⁸ This might be due to development of cor pulmonale subsequently producing right atria hypertrophy as a result of chronic smoking.⁶

There is no significant change in the mean (\pm SD) duration of QRS complex in smokers and non smokers ($p > 0.05$). But the result is significant between group A and group B3 ($p < 0.05$). This finding is also consistent with those reported by Robert et al.⁹ Robert found significant change in duration of QRS complex after 30 minutes of smoking. Chatterjee (1989) also found increased duration of QRS complex and noted that aging affects electrocardiographic wave patterns and aging effect is modified by long term smoking.¹⁰

There is no significant change in the mean (\pm SD) amplitude of R wave in smokers and non smokers ($p > 0.05$). But the result is significant between group A and group B3 ($p < 0.05$). The mean (\pm SD) amplitude of R wave is very significant between B1 and B3 ($p < 0.01$). There are no significant change in the mean (\pm SD) amplitude of S wave in smokers and non smokers ($p > 0.05$). But the result is significant between group A and group B2 ($p < 0.05$) and very significant between group B1 and group B3 ($p < 0.01$). The mean (\pm SD) amplitude of R wave is highly significant between B2 and B3 ($p < 0.001$). Our result is in agreement with Chatterjee et al.

There is no significant change in the mean (\pm SD) amplitude of T wave in smokers and

non smokers ($p > 0.05$). But the result is significant between group A and group B2 ($p < 0.05$) and B3 ($p < 0.05$). The mean (\pm SD) amplitude of T wave is significant between B1 and B3 ($p < 0.05$) also. Our result is in agreement with Chatterjee et al (1989), Baden et al (1982) and Ahn Von (1954) whom also found that tobacco smoking or injection of nicotine during hypoxia increased heart rate and the decreased the amplitude of T or flattened the T wave was due chiefly to increased sympathetic tone and probably due to increased adrenal secretion.^{10,5,8}

Baden et al (1982) found that R, S and T wave amplitudes decreased at greater rates in smokers than non smokers.⁵ The mechanism for the decrease in R, S and T wave amplitude is unknown. It might be that smoking has a direct effect on ventricular electrical activity. An alternative explanation is that smoking results in acceleration of atherosclerosis, which in turn leads to non-specific R, S and T wave changes.

There is significant change in the mean (\pm SD) duration of P-R interval in smokers when compared to non smokers ($p < 0.05$). The result is also significant between group A and group B2 ($p < 0.05$) and B3 ($p < 0.05$). P-R interval duration was shorter in current smokers than in former or never smokers found by Baden, Weiss, Thomas and Sparrow (1982).⁵ The same result was found by Mujtaba (1977).¹¹ The probable cause of shorter P-R interval is due to faster heart beat among the smokers.

Conclusion

From the statistical analysis of the results obtained in the present study and their comparison with those of published reports, it may be concluded that, smoking causes no significant change in ECG.

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