

**Prevalence of Toxoplasmosis among HIV/AIDS patients and Correlation of Radiological Investigations with Laboratory Findings**

**Abstract**

**Background:** Toxoplasmosis is a worldwide neglected tropical disease caused by the intracellular protozoan named *Toxoplasma gondii*, which also causes severe disease in immunocompromised patients. Among patients with HIV/ AIDS, cerebral involvement is more common and more serious than extra-cerebral toxoplasmosis. The definitive diagnosis is crucial for cerebral toxoplasmosis patients by directly demonstrating the presence of the tachyzoite form of *Toxoplasma gondii* in the cerebral tissues. The present study was undertaken to assess the prevalence of toxoplasmosis among HIV patients and role of radiological investigation in the diagnosis

**Material and Methods:** A prospective cross-sectional study was conducted at Department of Microbiology, Government Medical College and Hospital, Nagpur, Maharashtra, India. A total of 362 HIV positive patients attending ART clinic and provides informed consent were included in this study. Clinical history and relevant investigations of each patient was noted. Blood samples were then subjected for ELISA test to detect anti-toxoplasma IgM and IgG antibodies as per the manufacturer's instructions. Data was analyzed using SPSS version 21.

**Results:** Out of 362 HIV positive patients, 226 (62.43%) were males and 136 (37.57%) were females. Majority of the HIV positive patients, 359 (99.17%) were married and 313 (86.46%) were from urban area. Total 85 (23.48%) HIV positive patients were co-infected with toxoplasmosis. Both the ELISA and the CT-scan were simultaneously positive in 75 (20.72%) and negative in 172 (47.51%) cases. Out of these 85 HIV-toxoplasma co-infected patients, hyper density was seen in 13 (15.29%) patients, hypo density was present in 37 (43.52%) patients. Ring enhancement was observed among 25 (29.41%) cases.

**Conclusion:** We conclude from this study that the prevalence of toxoplasmosis in HIV positive patients was high. Radiological investigations were helpful in providing better localization of toxoplasmosis but less confirmatory than ELISA.

**Key words:** Toxoplasmosis, Prevalence, Sero-positivity, HIV/AIDS, ART Centre

34 **INTRODUCTION**

35 *Toxoplasma gondii* causes severe disease in immunocompromised patients where reactivation  
36 of latent infection causes symptomatic disease<sup>1, 2</sup>. In immunocompromised individuals who  
37 previously acquired latent infection can lead to reactivated toxoplasmosis with encephalitis.  
38 Toxoplasmic encephalitis and disseminated toxoplasmosis have been observed in patients  
39 with immunodeficiency due to various causes, such as Hodgkin's disease or  
40 immunosuppressive therapy because of other malignancies. Disseminated toxoplasmosis may  
41 also complicate transplantation of organs or bone marrow. This may result either from  
42 transplantation of an organ from a *Toxoplasma gondii* infected donor to a susceptible  
43 recipient or from reactivation of a latent *Toxoplasma gondii* infection in the recipient due to  
44 immunosuppressive treatment.<sup>3-5</sup>

45  
46 The prevalence of toxoplasmosis infection varied dependent on the geographical regions and  
47 socio-demographic characteristics. In European and other tropical regions, prevalence of  
48 toxoplasmosis is over 50%<sup>6</sup>. In US, majority of HIV-infected patients had antibodies against  
49 *T. gondii* and sero-prevalence data of HIV-infected patients was at the range of 3-22%<sup>7, 8</sup>. It  
50 was 9.8% in Hong Kong<sup>9</sup>, Nigeria 75.4%<sup>10</sup>, 58.4% in Tunisia<sup>11</sup>, 28.5% in Benin<sup>12</sup>, 40.2% in  
51 Senegal<sup>13</sup>, 74.5% in South Brazil<sup>14</sup>, 63.7% in Paris<sup>15</sup>, Kodym et al., reported 30% in Chezech  
52 republic<sup>16</sup>. Few studies in India observed sero-prevalence of 34.78% among HIV-positive  
53 patients<sup>17</sup>. Another study by Sucilathangam et al., observed 15% of Toxoplasma sero-  
54 positivity in HIV-positive people<sup>18</sup>.

55  
56 The initial presentation of toxoplasmic encephalitis in patients with AIDS may be subacute.  
57 Patients present with altered mental status (62%), headaches (59%), and fever (41%)  
58 associated with focal neurologic deficits. Progression of the infection can lead to confusion,  
59 drowsiness, seizures, hemiparesis, hemianopsia, aphasia, ataxia, and cranial nerve palsies.  
60 Motor weakness and speech disturbance are seen as the disease progresses. If not treated  
61 promptly, patients may progress to coma within days to weeks. Toxoplasmosis may rarely  
62 present as a rapidly fatal form of diffuse or global encephalitis with profound mental status  
63 changes, nausea, and vomiting, usually indicating elevated intracranial pressure.<sup>19-23</sup>

64  
65 Among patients with AIDS, cerebral involvement is more common and more serious than  
66 extra-cerebral toxoplasmosis. The definitive diagnosis is crucial for cerebral toxoplasmosis

67 patients by directly demonstrating the presence of the tachyzoite form of *Toxoplasma gondii*  
68 in the cerebral tissues. The presumptive diagnosis for cerebral toxoplasmosis, including the  
69 clinical presentations, radio-imaging findings, molecular and sero-diagnosis for Toxoplasma  
70 infection and good response to anti-toxoplasma therapy are widely accepted in clinical  
71 practice. The favorable outcome of cerebral toxoplasmosis is the improvement of clinical and  
72 radiological features after 2 to 3 weeks of initiated empirical therapy. The clinical diagnosis  
73 is a dilemma because cerebral toxoplasmosis mimics with other brain diseases making it  
74 difficult to diagnose. Differential diagnosis of AIDS-associated cerebral toxoplasmosis is  
75 extremely important and the local neuro-epidemiology and the degree of immunosuppression  
76 in the host are two key factors involved. Primary CNS lymphoma is the main differential  
77 diagnosis of cerebral toxoplasmosis reported from developed countries. While, focal forms of  
78 cerebral tuberculosis (tuberculoma and, less likely tuberculous brain abscess) allow for  
79 differential diagnosis of cerebral toxoplasmosis mainly in developing countries.<sup>24-26</sup>

80

81 Radio-imaging findings, either by computed tomography (CAT scan) or magnetic resonance  
82 imaging (MRI), are useful tools for the presumptive or empirical diagnosis of cerebral  
83 toxoplasmosis. Cerebral toxoplasmosis usually causes unifocal, and more frequently  
84 multifocal lesions, and less likely diffuse encephalitis. These findings are however not  
85 pathognomonic of cerebral toxoplasmosis. Radiological diagnosis can be classified as typical  
86 findings of hypodense lesions with ring enhancing and perilesional edema are observed in  
87 nearly 80% of cerebral toxoplasmosis cases.<sup>27</sup>

88

89 Cerebral toxoplasmosis poses a diagnostic problem that relies on classical serological  
90 methods to detect anti-toxoplasma immunoglobulins because clinical blood samples from  
91 patients with immunodeficiency can fail to produce sufficient titers of specific antibodies.  
92 Sero-evidence of toxoplasma infection, independent of antibody levels is generally seen in all  
93 patients before developing cerebral toxoplasmosis. Most cerebral toxoplasmosis patients have  
94 high titers of anti-toxoplasma IgG antibodies with high IgG avidity that provides serological  
95 evidence of infection and this also supports a conclusion that this is the result of a secondary  
96 reactivation of latent or chronic toxoplasma infection. Therefore, it is important to determine  
97 the toxoplasma sero-status in all HIV-infected patients in order to define the population at  
98 risk for cerebral toxoplasmosis. At the onset of cerebral toxoplasmosis, significant rises in  
99 anti-toxoplasma antibody titers are found in only a marginal number of these patients. The

100 level of rising titers may occur before the onset of cerebral toxoplasmosis and it does not  
101 seem to predict the occurrence of cerebral toxoplasmosis. Anti-Toxoplasma IgM antibody, as  
102 measured by the indirect fluorescent or ELISA tests, is rarely found in cerebral toxoplasmosis  
103 patients. In cases of cerebral toxoplasmosis, a negative or low titer of serological results or  
104 even the absence of anti-toxoplasma antibodies does not exclude positive diagnosis and the  
105 anti-toxoplasma therapy should be started without delay if clinical and radiological  
106 presentations are consistent with cerebral toxoplasmosis. A positive serology result seems to  
107 be even less useful in areas where there is a high prevalence of toxoplasmosis in the general  
108 population, while a negative result does have a high negative predictive value.<sup>28-29</sup> Therefore,  
109 the present study was undertaken to assess the prevalence of toxoplasmosis among HIV  
110 patients and role of radiological investigation in the diagnosis.

111

## 112 **MATERIAL AND METHODS**

113

### 114 **Study design**

115 The present prospective hospital based study was conducted in the Department of  
116 Microbiology, Government Medical College and Hospital, Nagpur, Maharashtra, India. A  
117 total of 362 HIV positive patients included through following criteria attending ART clinic  
118 during this study period. The convenient sampling method was adopted and the demographic  
119 data were recorded on data collection sheet such as age, sex, marital status, occupation and  
120 residency, risk factors for HIV transmission, clinical and laboratory data on toxoplasmosis.

121

### 122 **Inclusion criteria**

123 All volunteered confirmed HIV/AIDS positive patients with CNS signs and symptoms  
124 suggestive of toxoplasmosis such as headache, fever, increased intracranial tension, seizure,  
125 altered sensorium, papilloedema, cerebellar signs were included in this study.

126

### 127 **Exclusion criteria**

128 Patients with immunocompromised status due to other than HIV infection were excluded  
129 from this study.

130

131 To maintain the strict confidentiality and to conceal the identity of the patient, coding system  
132 for sample was followed which was known only to investigator and password protected data

133 was stored electronically. After taking written informed consent, detailed clinical history and  
134 all relevant investigations (including radiological for the diagnosis of toxoplasmosis) of each  
135 patient was done and findings were noted as per standard predesigned and pretested clinical  
136 proforma.

137

138 Specimens of blood to provide the sera for ELISA test were taken by venipuncture. At least  
139 5 ml of blood was obtained to ensure that there will be enough serum for the test.  
140 Immediately blood was transferred from the syringe into dry stoppered sterile tube and  
141 allowed to clot. When the serum has separated, it was pipetted off into a sterile tube.<sup>30</sup> Serum  
142 samples were then subjected to ELISA test for detecting anti-toxoplasma IgM and IgG  
143 antibodies as per the manufacturer's instructions. Process was performed as per standard  
144 protocol.<sup>31</sup>

145

146 Data was compiled in MS Excel and checked for its completeness and correctness. Then it  
147 was analysed using SPSS version 21, quantitative tests were applied with p value of < 0.05  
148 was considered statistically significant for interpretation of the findings. Final diagnosis  
149 (based on ELISA) was compared with the radiological findings to assess the accuracy of  
150 radiological investigations. The prior ethical approval was sought for this study by the  
151 institutional ethics committee.

152

## 153 **RESULTS**

154 Out of these 362 HIV positive patients, 226 (62.43%) were males and 136 (37.57%) were  
155 females. Most of the HIV positive patients, 359 (99.17%) were married and only 3 (0.83%)  
156 were unmarried and 313(86.46%) were from urban area whereas 49 (13.54%) were from  
157 rural area. Majority of the patients were laborers 144 (39.78%) followed by house wives,  
158 skilled employee, drivers, farmers and others were 75 (20.72%), 64 (17.68%), 52 (14.91%),  
159 12 (3.31%) and 15 (4.14%) respectively. Total 85 (23.48%) HIV positive patients were co-  
160 infected with toxoplasmosis. 65 (17.96%) were males and 20 (5.52%) were females. All of  
161 the co-infected patients were married and 78 (21.55%) were from urban area whereas 7  
162 (1.93%) were from rural area. Majority of the co-infected patients were laborers 35 (9.67 %)  
163 followed by drivers, skilled employee, house wives, farmers and others were 17 (4.70%), 13  
164 (3.60%), 12 (3.31%), 3 (0.82%) and 5 (1.38%) respectively (Table 1).

165

166 **Table 1: Prevalence of Toxoplasmosis co-infection among HIV positive patients**  
 167 **according to socio-demography.**

168

<b>Variables</b>	<b>HIV Positive (%) N=362</b>	<b>IgG positive (%) (%), N=71</b>	<b>P value</b>	<b>IgM positive (%) (%), N=14</b>	<b>P value</b>	<b>IgG + IgM (%)</b>
<b>Age in Years</b>						
15-24	23 (6.32)	3 (0.82)	0.488	0 (0)	0.734	3 (0.82)
25-34	171(47.23)	32 (8.84)		6 (1.66)		38 (10.50)
35-44	133(36.74)	31 (8.56)		5 (1.38)		36 (9.94)
45-54	29(8.01)	5 (1.38)		2 (0.55)		7 (1.93)
55 and above	6 (1.66)	0 (0)		1 (0.28)		1 (0.28)
Total	362 (100)	71(19.61)		14 (3.86)		85 (23.48)
<b>Sex</b>						
Male	226 (62.43)	53 (14.72)	0.018*	12 (3.31)	0.093	65 (17.96)
Female	136 (37.57)	18 (4.97)		2 (0.55)		20 (5.52)
<b>Marital Status</b>						
Married	359 (99.17)	71 (19.61)	0.390	14 (3.86)	0.737	85 (23.48)
Unmarried	3 (0.83)	0 (0)		0 (0)		0 (0)
<b>Residence</b>						
Rural	49 (13.54)	6 (1.66)	0.162	1 (0.28)	0.531	7 (1.93)
Urban	313 (86.46)	65 (17.96)		13 (3.60)		78 (21.55)
<b>Occupation</b>						
Driver	52 (14.91)	15 (4.14)	0.488	2 (0.55)	0.749	17 (4.70)
Farmer	12 (3.31)	3 (0.82)		0 (0)		3 (0.82)
Laborer	144 (39.78)	28 (7.73)		7 (1.93)		35 (9.67)
Housewife	75 (20.72)	11 (3.03)		1 (0.28)		12 (3.31)
Skilled Employee	64 (17.68)	11 (3.03)		2 (0.55)		13 (3.60)
Others	15 (4.14)	3 (0.82)		2 (0.55)		5 (1.38)

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170

171 **Table 2: Prevalence of Toxoplasmosis co-infection among HIV positive patients**  
 172 **according to signs, symptoms and other risk factors.**

<b>Variables</b>	<b>IgG positive (%)</b>	<b>P value</b>	<b>IgM positive (%)</b>	<b>P value</b>	<b>IgG + IgM</b>
<b>Signs and symptoms</b>					
Headache	68 (18.78)	0.000*	12 (3.31)	0.019*	80 (22.10)
Fever	57 (15.75)	0.000*	12 (3.31)	0.013*	69 (19.06)
Increased	21 (5.80)	0.555	8 (2.20)	0.004*	29 (8.01)

intracranial tension					
Seizure	6 (1.66)	0.898	5 (1.38)	0.000*	11(3.04)
Altered sensorium	4 (1.10)	0.573	3 (0.82)	0.024*	7 (1.93)
Papilloedema	6 (1.66)	0.095	3 (0.82)	0.001*	9 (2.49)
Cerebellar sign	2 (0.55)	0.547	0 (0)	-	2 (0.56)
<b>History of pet contact</b>					
Yes	37 (10.22)	0.000*	6 (1.66)	0.002*	43 (11.88)
No	34 (9.40)		8 (2.20)		42 (11.60)
<b>History of meat ingestion</b>					
Yes	54 (14.91)	0.000*	13 (3.600)	0.000*	67 (18.50)
No	17 (4.70)		1 (0.28)		18 (4.98)
<b>Past history of Toxoplasmosis</b>					
Yes	5 (1.38)	0.000*	0 (0)	-	5 (1.38)
No	66 (18.23)		14 (3.87)		80 (22.10)
<b>Mode of Transmission</b>					
STD	64 (17.68)	0.487	12 (3.31)	0.516	76 (20.10)
Blood transfusion	0 (0)		0 (0)		0 (0)
Unknown	7 (1.93)		2 (0.55)		9 (2.49)
<b>CD4 cell count</b>					
<100	20 (5.52)	0.227	2 (0.55)	0.292	22 (6.08)
101-200	10 (2.76)		3 (0.82)		13 (3.60)
201-500	28 (7.73)		9 (2.49)		37 (10.22)
>501	13 (3.59)		0 (0)		13 (3.60)
<b>Response to treatment</b>					
Yes	51 (14.10)	0.000*	12 (3.31)	0.000*	63 (17.40)
No	20 (5.52)		2 (0.55)		22 (6.08)

173

174 As shown in **table 2**, the toxoplasmosis co-infection among HIV positive patients according  
175 to signs, symptoms and other risk factors was assessed. The signs and symptoms associated  
176 with co-infection showed that majority of the patients had headache (**80 (22.10%) and fever**  
177 **(69 (19.06%). Whereas, 29 (8.01%), 11(3.04%), 7 (1.93%), 9 (2.49%) and 2 (0.56%)** co-  
178 infected patients had symptoms of increased intracranial tension, seizure, altered sensorium,  
179 papillo-edema and cerebellar signs respectively. Almost half of the patients (43 (11.88%) had  
180 history of pet contact, 67 (18.50%) history of meat ingestion and 5 (1.38%) had past history  
181 of toxoplasmosis, which were statistically significant. Mode of transmission was through

182 sexual contact among 76 (20.10%), whereas, among 9 (2.49%) patients the transmission was  
 183 unknown. Decreased CD4 cell count was observed <100 among 22 (6.08%), 101-200, 201-  
 184 500 and >501 CD4 cells among 13 (3.60%), 37 (10.22%) and 13 (3.60%) respectively.  
 185 However, majority of the patients, 63 (17.40%) responded to treatment.

186

187 **Table 3: Correlation between radiological features in CT-scan head and ELISA for**  
 188 **anti-toxoplasma antibodies**

Radiology	ELISA		Total (%)
	Positive (%)	Negative (%)	
Positive	75 (20.72)	105 (29.00)	180 (49.72)
Negative	10 (2.76)	172 (47.51)	182 (50.28)
Total (%)	85 (23.48)	277 (76.52)	362 (100)

189 McNemars  $\chi^2$  test=78.48 (Software used: Stata ver.10.0), Odd's Ratio =12.29, 95%  
 190 Confidence Interval = (5.84-26.53); p value <0.0001 considered significant.

191

192 The correlation between the ELISA sero-positivity and radiological feature is shown in **Table**  
 193 **3 and 4**, both the ELISA and the CT-scan were simultaneously positive in 75 (20.72%) and  
 194 negative in 172(47.51%) cases, the overall correlation seen in 247(68.23%). Strong  
 195 association between ELISA and CT-scan by McNemars  $\chi^2$  test was found. 10 (2.76%) cases  
 196 were positive by ELISA and negative by radiological examination for toxoplasma. The Odds  
 197 ratio was found to be 12.29 with 95% CI = (5.84-26.53) which was found to be statistically  
 198 significant.

199 **Table 4: Comparative evaluation of Radiological test with ELISA**

200

Statistic	Formula	Value	95% CI
Sensitivity	$\frac{a}{a + b}$	88.24%	79.43% to 94.21%
Specificity	$\frac{d}{c + d}$	62.09 %	56.10% to 67.83%
Positive Likelihood Ratio	$\frac{\text{Sensitivity}}{100 - \text{Specificity}}$	02.33	1.96 to 2.76
Negative Likelihood Ratio	$\frac{100 - \text{Sensitivity}}{\text{Specificity}}$	00.19	0.11 to 0.34
Positive Predictive Value	$\frac{a}{a + c}$	41.67% (*)	34.38% to 49.23%



Negative Predictive Value	$\frac{d}{b+d}$	94.51 % (*)	90.13% to 97.33%
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201 Note: a-true positive, b-false positive c-false negative, d-true negative<sup>32</sup>

202 **Table 5: Radiological features in HIV-toxoplasmosis co-infected patients (N=85).**

203

Radiological features	No. of cases (%)	p-value
Only Hyperdensity	13(15.29)	0.408
Only Hypodensity	37(43.52)	0.026*
Only Ring-enhancement	25(29.41)	0.000 *
Hyperdensity + Ring-enhancement	04(4.70)	0.384
Hypodensity + Ring-enhancement	06(7.05)	0.280
Total (%)	85(100)	-

204

205 As shown in table 5 the radiological features suggestive of toxoplasmosis in HIV-  
 206 toxoplasmosis co-infected patients in the CT-scan head. **Out of these 85 HIV-toxoplasma co-**  
 207 **infected patients, only hyper density was seen in 13(15.29%) patients, only hypo-density was**  
 208 **present in 37 (43.52%) patients.** Whereas, 25 (29.41%) cases showed only ring enhancement  
 209 as the radiological feature. Only 4 (4.70%) patients had hyper density and ring-enhancement  
 210 features. Whereas, 6(7.05%) cases showed hypo density and ring-enhancement. Only hypo  
 211 density and only ring-enhancement were the radiological features which were found to be  
 212 statistically significant (p<0.05).

213

## 214 DISCUSSION

215 Toxoplasmosis is the most common opportunistic infection in HIV-infected patients. A high  
 216 seroprevalence of anti-*Toxoplasma gondii* IgG antibody has been reported in HIV-infected  
 217 subjects<sup>32,33,34,35</sup>. **To our understanding**, there is no adequate information on the prevalence of  
 218 *Toxoplasma gondii* infection in HIV/AIDS patients in India. **In our study**, the seroprevalence  
 219 of *Toxoplasma gondii* showed 23.48%. The co-infection occurred most among married male  
 220 from urban population with the history of pet contact, meat ingestion and unsafe sexual  
 221 activity. This rate is almost comparable with the other studies reported elsewhere such as  
 222 study by Holliman 1990<sup>36</sup>, in which the seropositivity of toxoplasmosis found to be 26.06%,  
 223 Sykora et al 1992 found seropositivity of toxoplasmosis 29.8% in HIV positive patients<sup>37</sup>.  
 224 Brindle et al 1991 found seropositivity of toxoplasmosis to be 22%<sup>38</sup>. Oksenhendler et al.,

225 1994 found that 25.4% was seropositivity rate<sup>39</sup>. Similarly, Minkoff et al 1997 found that  
226 20.2% was the seroprevalence of toxoplasmosis<sup>40</sup>. Millogo et al 2000 found seropositivity in  
227 25.4%<sup>41</sup>. The seropositivity was found as 67.8%, 23.2%, 22.4%, & 21% by studies conducted  
228 by different authors like Sukthana et al 2000, Nissapatorn et al 2001 and Nissapatorn et al  
229 2002, respectively<sup>42, 43, 44</sup>. Also, Hari et al 2007, Akanmu et al 2010 and Oshinaike et al 2010,  
230 carried out study to find out seroprevalence of toxoplasmosis and found out to be 8%, 54%  
231 and 85.5% respectively<sup>45, 46, 47</sup>. Our study demonstrates that the high prevalence of  
232 *Toxoplasma gondii* co-infection in HIV/ AIDS patients suggesting that HIV-infected  
233 populations should be protected from *Toxoplasma gondii* infection to reduce the prevalence  
234 and morbidity and burden of the disease.

235

236 In the present study, both the ELISA and the CT-scan were simultaneously positive in 75  
237 (20.72%) and negative in 172 (47.51%) cases, the overall correlation seen in 247 (68.23%).  
238 In fact we found strong association between ELISA and CT-scan by McNemars  $\chi^2$  test.  
239 Software used for the analysis of the data was Stata ver.10.0. Also, p=0.000 was found to be  
240 highly significant. A study was done by Venugopal A et al 2012, among AIDS patients in a  
241 tertiary care hospital in Mangalore, India<sup>48</sup>. It was a retrospective study done by reviewing  
242 medical records of HIV-positive diagnosed with toxoplasmosis from Jan 2000 to Dec 2010.  
243 Diagnosis was based on clinical features, demonstration of elevated IgG by ELISA and  
244 associated CT-scan findings. 2826 HIV positives attended Infections Disease Cell from 2000  
245 –2010, of which 33 (1.12%) had CNS toxoplasmosis. Mean level of IgG was 255.69. CT /  
246 MRI finding of ring enhancing lesion or cerebritis was seen in 79 % of the cases with 18% of  
247 lesions in both basal ganglia and parietal lobes. Cerebritis was most common lesion in  
248 CT/MRI, seen in 16 cases while ring enhancing lesions were seen in 10 cases. 82% improved  
249 with treatment and 18% died of complications. The possibility of cerebral toxoplasmosis  
250 should be considered in every HIV-positive patient with neurological symptoms parietal lobe  
251 lesions were common in their study, contrary to other existing data which say toxoplasma  
252 lesions are usually midline lesions.

253

254 In the present study, out of these 85 HIV-toxoplasma co-infected patients, only hyperdensity  
255 was seen in 13(15.29%) patients, only hypodensity was present in 37 (43.52%) patients  
256 whereas 25 (29.41%) cases showed only ring enhancement as the radiological feature. The  
257 patients had both hyperdensity & ring-enhancement features were 4 (4.70%). Whereas, 6

258 (7.05%) cases showed hypodensity and ring-enhancement simultaneously. **Similar**  
259 **radiological features were reported by other studies. In a study done by Vidal et al 2005, they**  
260 **found that** typical findings of hypodense lesions with ring enhancing and perilesional edema  
261 were present in nearly 80% of cerebral toxoplasma patients<sup>23</sup>. And in nearly 20% cases a  
262 typical pattern of hypodense lesions without contrast enhancing and with an expansive effect,  
263 cerebral toxoplasma patients without focal lesions and MRI demonstrating focal lesions and  
264 diffuse cerebral encephalitis without visible focal lesions was found. An another study  
265 showed that in patients with toxoplasma encephalitis various lesions found were hypodense  
266 lesion with ring-enhancing and perilesional edema, nodular enhancing and perilesional edema  
267 and ring-enhancing lesion with small, enhancing asymmetric nodule along wall of the lesions  
268 <sup>28</sup>.

269

## 270 **CONCLUSION**

271 We conclude that the prevalence of toxoplasmosis in HIV positive patients was high,  
272 especially among married male patients from urban area having contact with pet animals,  
273 history of meat ingestion and major transmission by unsafe sexual activities. The most  
274 common symptoms observed among study participants were headache, fever, increased  
275 intracranial tension and seizure. Although radiological investigations were helpful in  
276 providing better localization of toxoplasmosis but less confirmatory than ELISA. So  
277 combination of modalities should be used in diagnosis of toxoplasmosis for appropriate  
278 management.

279

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