

: ( )  
 가 .  
 : 가  
 189 100  
 4  
 가 가  
 : 74%(139/189) 38%(72/189)  
 가 , 90% 63%  
 (26% vs 10%,  $p<.05$ ; 62% vs 37%,  
 $p<.001$ ). 19%(36/  
 189), A1 7%(14/189), 58%(109/189), P1  
 7%(14/189) , 9%, A1 1%,  
 36%, P1 3% .  
 (19% vs 9%,  $p<.05$ ) , A1 (7% vs 1%,  $p<.05$ )  
 (58% vs 36%,  $p<.001$ ) .  
 A1 가  
 (19% vs 8%,  $p<.05$ ). P1 P1  
 가 (42% vs 27%,  $p>.05$ ) (7% vs 3%,  $p>.05$ ).  
 :  
 , A1  
 , A1 가 .


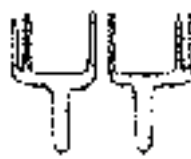


(circle of Willis) 가  
 가 가  
 가 가  
 (1-3) (5).  
 가 ( ) 가  
 가  
 가  
 (4). 가 가

<sup>1</sup>  
<sup>2</sup>

:  
 8 × 12 9 × 13  
 6 × 12  
 (petrous ridge)  
 1996 1025  
 가 420 2 가 ( )  
 189 100 ( )  
 189 156:33,  
 57 ( 17-79) 100 A1 - - A1  
 52:48, 46 ( 6-83) 가 4 가 (cross-filling)  
 CT(39%) MRI (61%)  
 CT MRI  
 가 89% 5  
 (0-26 ) (agenesis) 0  
 가 ( ; pericallosal artery)가  
 (retrograde) 가 , 1,  
 30% , 2, A1  
 30% , 3  
 , 39 가 가 4  
 (21%), 26 , . A1  
 16 , / 14 , A1 (agenesis)  
 / 가 12 , / 0, 가  
 5 , / 4 , / 2 1, 2,  
 50 , 70% 가 3  
 9 -P1 - P1 -  
 100 P1  
 (n=25), (n=17), 4  
 (n=15), (n=15), (n=11) , (agenesis)  
 (dissection), , (anterior)  
 CT(27%) MRI 0, P1  
 (73%) 가 36% choroidal artery) 가 1, P1  
 4 (1-10 ) 2, P1 가 3 P1  
 P2 P1  
 0, P2  
 1, P2 2, P2  
 3  
 Seldinger 5F head- (incomplete circle),  
 hunter (COOK, Bloomington, IN, U.S.A.) (complete circle)  
 Integris BN 3000 biplane (Phillips Medical System, Nederland) A1 가  
 가 가  
 7 cc 9 cc(7 × (balanced type)  
 9) (power injector) 2 (unbalanced type)  
 3 , 1 3 , 2 1  
 5 × 8

(5)	가 3-1-3	20%(38/189)	가
SPSS 7.5 for window	가	A1	
Pearson chi-square test, $2 \times 2$	가		3-0-3
(minimum expected value)가 5	14%(27/189), 2-3-3	12%(22/189), 2-1-3	9%(17/189), 1-3-3
Fisher's exact test, $p < .05$	3-3-3	8%(15/189), 2-2-3	1-2-3
가	6%(12/189, 11/189), 3-3-0	3-2-3	5%(10/189, 9/189)
	2-0-3	4%(7/189), 3-2-0	2%(4/189), 1-0-3
	1%(2/189)		
	가 139	A1	가
		가 81%(113/139)	가
		가 19%(26/139)	
74%(139/189)	A1	-	A1
		(Acom = 1)가 40%(55/139),	

Table 1. Incidence of Variations in the Anterior Circulation: Normal vs Atherosclerosis Group

	Type of Variations			
	complete (no agenesis)	agenesis of Acom	agenesis of A <sub>1</sub>	asymmetric A <sub>1</sub>
Representative type	 3 - 1 - 3	 3 - 0 - 3	 3 - 3 - 0	 3 - 3 - 1
Normal	90%(90/100)	9%(9/100)	1%(1/100)	8%(7/90)
Atherosclerosis	74%(139/189) (p = .001)	19%(36/189) (p = .025)	7%(14/189) (p = .02)	19%(26/139) (p = .021)





Note. complete = intact anterior half of the circle of Willis without agenesis of any segment,

Acom = anterior communicating artery, A<sub>1</sub> = A<sub>1</sub> segment of anterior cerebral artery,

asymmetric = one A<sub>1</sub> segment is significantly larger than the other, 3-1-3 = A<sub>1</sub>-Acom-A<sub>1</sub>,

p = p-value when compared with normal group

Table 2. Incidence of Variations in the Posterior Circulation: Normal vs Atherosclerosis Group

	Type of Variations			
	complete (no agenesis)	agenesis of one or both Pcom	agenesis of one or both P <sub>1</sub>	Pcom P <sub>1</sub>
Representative type	 1 - 3 - 3 - 1	 0 - 3 - 3 - 0	 1 - 3 - 0 - 3	 2 - 2 - 2 - 2
Normal	63%(63/100)	36%(36/100)	3%* (3/100)	27%(17/63)
Atherosclerosis	38%(72/189) (p < .001)	58%(109/189) (p < .001)	7%# (14/189)	42%(30/72)

Note. complete = intact posterior half of the circle of Willis without agenesis of any segment,

Pcom = posterior communicating artery, P<sub>1</sub> = P<sub>1</sub> segment of posterior cerebral artery,

= equal or larger in size, 1-3-3-1 = Pcom-P<sub>1</sub>-P<sub>1</sub>-Pcom,

p = p-value when compared with normal group,

\* = 2 patients were also counted as having agenesis of Pcom,

# = 6 patients were also counted as having agenesis of Pcom

(Acom=2 or 3)가 60%(84/139) .

가  
19%(36/189) 3-0-3 27 , 2-0-3 7 , 1-0-3 2  
. A1 7%(14/189) 3-3-0 10 , 3-2-0  
4 .

가  
38%(72/189) . -P1 - P1 -  
가 0-3-3-0

29%(54/189) 가  
, P1 (adult type)  
1-3-3-

1 21%(40/189), 0-3-3-1 18%(33/189), 0-3-1-3  
2-2-2-2 4%(7/189), 0-3-0-30 1-3-2-2 3%(6/189,  
5/189) .

72 P1 42%(30/72),  
P1 58%(42/72) .

가  
58%(109/189) 가 54 , 가 55  
. P1 (fetal circulation)

7%(14/189) 가 11 ,  
가 3 6 (3%) 0-3-0-3  
P1

(Table 1,2)

가 . 26% 62%  
가  
10% 37%  
(26% vs 10%, p<.05; 62% vs 37%, p<.001).

가 3-1-3  
(20% vs 27%).  
3-0-3 (14%)  
8%

19% 9% (p<.05)  
A1  
(7% vs 1%, p<.05).

(58% vs 36%, p<.001)  
가 0-3-3-0 (29%) 1-  
3-3-1 (21%) 1-3-3-1  
(39%) 가 0-3-3-0 (16%)

, A1 ,  
가  
(Acom=1, 40% vs 39%; Acom=2 or 3, 60% vs 61%;  
p>.05), P1 가 (7% vs 3%, p>.05). RI

가  
A1 가  
가 19%,  
가 81%  
92% A1  
(19% vs 8%, p<.05). P1

42%, 27% 가  
(p>.05).

9-  
53%(1,3,4,6) 가 . 100

가 90%, 63%  
가  
59% . 9%, A1

1%, 36%, P1 ( (5).  
(hypoplasia)  
, P1 A1  
가 가  
A1

(7,8).

가 A1 가 P1  
가 가  
가 (6).

가 가  
가 Schomer 가  
가 (<1cm)  
(9).

(58% vs 36%, p<.001)

A1  
가

- 655

## Angiographic Analysis of the Circle of Willis: Comparison between Atherosclerosis and Normal Groups<sup>1</sup>

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**Purpose :** To determine differences in angiographic variations of the circle of Willis between atherosclerosis and normal groups.

**Materials and Methods :** In 289 patients we reviewed complete cerebral angiograms obtained using biplane digital subtraction angiography. Atherosclerosis was diagnosed in 189 patients, while 100 were normal. Patients were divided into four subgroups according to the relative size of each segment and the presence of cross-filling of opposite-sided vessels. When the circle was completely present, we determined whether or not it was balanced, and statistically compared variation patterns between the two groups.

**Results :** In the atherosclerosis group, the anterior half of the circle was complete in 74% of cases (139/189), and the posterior half in 38% (72/189). In the normal group, the anterior half was complete in 90% of cases, and the posterior half in 63%. An incomplete circle was more common in the atherosclerosis group than among normal subjects (26% vs 10%,  $p < .05$ ; 62% vs 37%,  $p < .001$ ).

In the atherosclerosis group with incomplete circle, agenesis was found in the anterior communicating artery in 19% of cases (36/189), the A1 segment in 7% (14/189), the posterior communicating artery in 58% (109/189), and the P1 segment in 7% (14/189). In the normal group with incomplete circle, agenesis was seen in the anterior communicating artery in 9% of cases, in the A1 segment in 1%, in the posterior communicating artery in 36%, and in the P1 segment in 3%. Agenesis of the anterior communicating artery (19% vs 9%,  $p < .05$ ), the A1 segment (7% vs 1%,  $p < .05$ ), or the posterior communicating artery (58% vs 36%,  $p < .001$ ) was more common in the atherosclerosis group than in the normal group. Unbalanced type with a size discrepancy between A1 segments was also more common in the atherosclerosis group (19% vs 8%,  $p < .05$ ). There was no significant difference between the two groups regarding posterior communicating arteries equal to or larger than the P1 segment (42% vs 27%,  $p > .05$ ) and agenesis of the P1 segment (7% vs 3%,  $p > .05$ ).

**Conclusion :** An incomplete and unbalanced circle of Willis was more common in the atherosclerosis group than in the normal group. Agenesis of the anterior communicating artery, the A1 segment, or the posterior communicating artery was common in the atherosclerosis group, as was size discrepancy between A1 segments.

**Index words :** Cerebral blood vessels, angiography  
Cerebral blood vessels, anatomy  
Atherosclerosis, intracranial

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