Epidemiology of Symptomatic Chiari Malformation in Tatarstan: Regional and Ethnic Differences in Prevalence

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BACKGROUND: Epidemiology can assess the effect of Chiari I malformation (CM1) on the neurological health of a population and evaluate factors influencing CM1 development.
OBJECTIVE: To analyze the regional and ethnic differences in the prevalence of CM1.
METHODS: The population of the Republic of Tatarstan (RT) in the Russian Federation was evaluated for patients with CM1 symptoms over an 11-yr period. Typical symptoms of CM1 were found in 868 patients. Data from neurological examination and magnetic resonance imaging (MRI) measurement of posterior cranial fossa structures were analyzed.
RESULTS: MRI evidence of CM1, defined as cerebellar tonsils lying at least 5 mm inferior to the foramen magnum, was found in 67% of symptomatic patients. Another 33% of symptomatic patients had 2 to 4 mm of tonsillar ectopia, which we defined as "borderline Chiari malformation type 1 (bCM1)." The period prevalence in the entire RT for symptomatic CM1 was 20:100 000; for bCM1 was 10:100 000; and for CM1 and bCM1 together was 30:100 000. Prevalence of patients with CM1 symptoms was greater in the northern than southern districts of Tatarstan, due to a high prevalence (413:100 000) of CM1 in the Baltasy region in one of the northern districts.
CONCLUSION: One-third of patients with typical symptoms of CM1 had less than 5 mm of tonsillar ectopia (bCM1). Assessments of the health impact of CM1-type symptoms on a patient population should include the bCM1 patient group. A regional disease cluster of patients with Chiari malformation was found in Baltasy district of RT and needs further study.

KEY WORDS: Chiari malformation type 1, Epidemiology, Population groups, Syringomyelia

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At the end of the 19th century, Professor Hans Chiari described the postmortem features of 4 types of craniocervical junction anomalies.[1,2] The Chiari I malformation (CM1) was initially described as deformed cerebellar tonsils herniating through the foramen magnum (FM) accompanied by hydrocephalus. Later, magnetic resonance imaging (MRI) showed noninvasively that CM1-related tonsillar herniation often occurs without hydrocephalus; therefore, hydrocephalus became a nonessential element of CM1.[3,4] Chiari's description of CM1 was further modified by an MRI diagnostic threshold requiring cerebellar herniation to extend at least 5 mm below the FM. Later, 2 subsets of patients with CM1-type semiology, CM0 and CM 1.5, were described based on their unique MRI findings.[5-10] Patients with CM0 had less than 2 mm of tonsillar ectopia and syringomyelia.[5-9] Patients with CM1.5 had brainstem descent in addition to the 5 mm of tonsillar descent seen in CM1 patients.[10]

Morphological measurements in many patients with CM1 revealed a small posterior fossa, a normal-sized hindbrain, and obliteration of the cererbrospinal fluid (CSF) of the cisterna magna by the cerebellar tonsils extending

ABBREVIATIONS: bCM1, borderline Chiari malformation type 1; **CL,** clivus; **CM1,** Chiari I malformation; **CSF,** cererbrospinal fluid; **FM,** foramen magnum; **MRI,** magnetic resonance imaging; **NDRT,** northern districts of Republic of Tatarstan; **PF,** posterior cranial fossa; **RT,** Republic of Tatarstan; **SDRT,** southern districts of Republic of Tatarstan; **SO,** supraoccipital bone

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below the FM. A primary genetic abnormality or secondary injury presumably impeded development of the cephalic paraxial mesoderm, causing premature fusion of the spheno-occipital synchondrosis. The latter stunted growth of the basiocciput (the inferior segment of the clivus) and supraocciput,[11-13] reduced posterior cranial fossa (PF) volume,[11,13-18] and led to herniation of the cerebellar tonsils and CM1.[19-21] Genetic factors were involved because 12% of symptomatic CM1 patients had a positive history of CM1; 21% of asymptomatic first-degree relatives of symptomatic CM1 patients had CM1 and/or syringomyelia.[15,22,23] Studies of families in the United States with more than 1 member affected by CM1 identified several plausible candidate genes for CM1.[17,24] The small posterior fossa trait, sometimes referred to as occipital hypoplasia, was more consistently inherited than tonsillar descent and CM1 expression.[7,24-26] In nonfamilial cases of CM1, posterior fossa dimensions may be influenced by the expression of many genes, as occurs with morphometric features such as height and head circumference.[27] Epigenetic modifications of somatic DNA and environmental factors could also restrict development of the posterior fossa and lead to CM1.[28-30]

Factors related to developing symptoms in CM1 patients include: (1) greater amounts of tonsillar herniation; (2) hypoplastic PF dimensions; (3) PF overcrowding characterized by constriction of CSF spaces including the cisterna magna; and (4) physiological measures of reduced and distorted CSF flow.[11,31-33] Symptoms of CM1 rarely improve spontaneously, but can if tonsillar ectopia decreases [34-36] from PF growth in children or other factors.[37-40] Tonsillar herniation greater than 12 mm almost invariably causes symptoms,[4] but lesser amounts of tonsillar herniation may or may not evoke symptoms. Therefore, factors other than tonsillar herniation must be involved in symptom production in this group. Some asymptomatic CM1 patients have "spacious" subarachnoid spaces and no crowding of neural structures.[41] Patients with typical CM1-symptoms but tonsillar herniation even less than the 5-mm threshold for CM1 often have MRI evidence of a small posterior fossa and hindbrain overcrowding and cine-MRI findings of abnormal CSF velocity/flow.[4,8,42-44] Some asymptomatic CM1 patients (incidental CM1) later became symptomatic [34-36] after minor trauma, Valsalva maneuver, and heavy manual labor.[15,45,46] Quantitative, imaging-based physiological factors may more accurately predict positive outcomes after surgery for CM1 than morphological measures.[11,13,17,24,31,47] Up to 40% of adults with CM1 and 12% to 23% of children with CM1 have syringomyelia.[15,34,36,48,49]

The CM0 malformation is characterized by clinical and MRI findings of cervical syringomyelia, a crowded posterior fossa, CSF obstruction around the FM, and less than 2 mm of tonsillar ectopia.[5-9,42,50-53] In one study, normal subjects had no more than 2 mm of tonsillar ectopia below the FM and more than 2 mm of ectopia was 100% sensitive in capturing patients with CM1-type symptoms.[3] Symptoms in patients with 2 to 4 mm of tonsillar descent below the FM may be identical to those with CM1.[34,43,44,51,54] Such symptomatic patients may be diagnosed with "variant CM1, borderline CM1, or Chiari I-like syndrome."[15,44,55]

Our current study investigated the prevalence and regional, ethnic, and gender distribution of symptomatic CM1 (Figure 1), Chiari I-like syndrome associated with minimal borderline tonsillar ectopia borderline Chiari malformation type 1 (bCM1), and CM-associated syringomyelia in the Republic of Tatarstan (RT). RT is a federal subject of the Russian Federation, found in the center of the East European Plain about 800 km east of Moscow. It lies between the Volga and Kama Rivers, and extends east to the Ural Mountains.

Currently, there are few epidemiologic studies of CM1 and Chiari1-like syndrome.[28,56,57] The existing research has detection bias because: (1) the prevalence of CM1 diagnosed by MRI criteria alone is considerably higher than CM1 diagnosed by coexistent CM1 semiology and MRI criteria; and (2) not all patients with CM1 semiology undergo MRI scanning.[28,57]

Previous reports suggest that CM1 has a female preponderance in the United States but not in Europe or Asia.[28] A regional preponderance of syringomyelia in some areas of the RT was previously reported.[56,58-60] The present study seeks to identify population groups in RT that are prone to developing symptomatic CM1, CM1-like syndrome (bCM1), and CM-associated syringomyelia.

METHODS

The study was conducted at the Hospital of RT (Figure 2). Patient consent was not required because this retrospective study presents only aggregated archival data. An institutional review board approved this study. In our epidemiological research, we followed STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) rules. This hospital cares for the entire RT population. It is a large, integrated tertiary medical center with 1300 inpatient beds, including 50 neurological and 80 neurosurgical beds, and weekday visits for 100 to 120 referred neurological and neurosurgical outpatients. The population of adults in RT during the study was 2876 000, with an ethnic mix of 54% Tatars, 39% ethnic Russians, and 7% others.[61-63] The ethnic mix seen by the neurological and neurosurgical departments was 58% Tatars, 40% ethnic Russians, and 2% others. Patients lived in one of the 44 separate districts of RT, or Kazan city, the capital of RT (Figure 2).

In the first stage of the study, we analyzed archival data of patients hospitalized in our clinic between January 1998 and December 2008. During the study period, data were processed from 29 008 hospitalizations to select cases with ectopia of the cerebellar tonsils and CM1-like symptoms, including: (1) CM1-type headaches, such as suboccipital headache, pseudotumor headache with visual phenomena, and cough headache; (2) dizziness; and (3) symptoms of cervical syringomyelia.[15,64] Patients who had secondary causes of cerebellar herniation such as craniosynostosis and tumors were excluded. A total of 868 patients with tonsillar ectopia and CM1-like symptoms were found. We documented age, gender, nationality, residency in RT, district (Northern, Southern, or other), radiological, physical, and neurological findings (Tables 1-4).

MRI was performed using 1.0 and 1.5 T scanners (EXCITE, GE Healthcare, Waukesha, Wisconsin). One trained researcher (A.F.) took linear measurements of the PF structures on a midsagittal T1-weighted

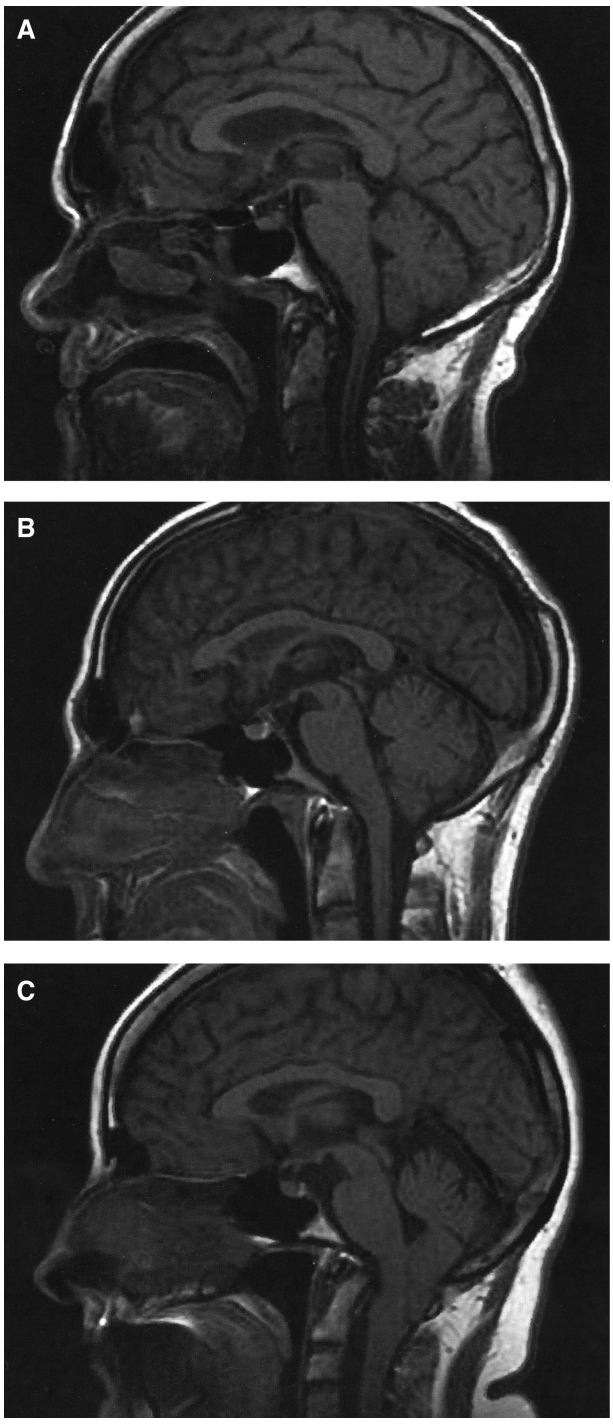

FIGURE 1. *Typical Chiari I (CM1), bCM1, and Chiari 0 malformation (CM0) on the sagittal cut MRI scans (from RT population).* **A**, *M70, CM0 with syringomyelia (the tonsils are at the level of the FM).* **B**, *F40, bCM1 with syringomyelia (tonsillar herniation = 3 mm).* **C**, *F41, CM1 without syringomyelia (tonsillar herniation = 17 mm).*

image. Measurements were defined as follows: (1) clivus (CL) length was the length of a line drawn from the dorsum sella to the basion; (2) supraoccipital bone (SO) was the distance between the opisthion and the internal occipital protuberance; (3) the McRae line was the line connecting the opisthion and basion; and (4) tonsillar herniation was the distance from the McRae line to the most inferior extent of the cerebellar tonsils. The diagnosis of CM1 was given to all symptomatic patients with one or both cerebellar tonsils extending 5 mm or more below the FM, with and without syringomyelia.[3,4] Tonsillar herniation was commonly asymmetrical.[65-67] All symptomatic patients with one or both cerebellar tonsils extending 2 to 4 mm below the FM (Figure 1), with and without syringomyelia, were diagnosed with bCM1.[3,4] CM0 patients were not included in this study.[42]

In the second phase of the study (after detecting regional differences in the CM prevalence), we performed a more extensive MRI morphometric study of 228 of the 868 patients. This included 200 patients from different districts of RT (male/female 108/92, mean age 43 ± 13 yr, Tatars 79%) and 28 patients from the Baltasy district (male/female 12/16, mean age 41 ± 15 yr, Tatars 100%) to measure the length of their posterior fossa bones (CL, SO). We also measured the length of the posterior fossa bones in a control group of 100 individuals (male/female 39/61, mean age 47 ± 7 yr, Tatars 58%) who had previously undergone brain MRI after presenting with (1) nonspecific symptoms and no neurological impairment or (2) symptoms suggestive of multiple sclerosis or other conditions not affecting intracranial volume or PF anatomy.

Measurements from CM patients and control subjects were compared using the *U*-test (IBM SPSS Statistics 23, Armonk, New York). *P* values $< .05$ were considered statistically significant.

RESULTS

The Period Prevalence of CM1 and bCM1 for the Entire RT

The period prevalence of CM1 and bCM1 for the entire RT population was 30:100 000. Further analysis of the 868 RT patients showed that 118 (13.6%) were from 4 northern districts of Republic of Tatarstan (NDRT) with a population of 95 000 (Figure 2; Table 2) and 53 (6.1%) were from 4 southern districts of Republic of Tatarstan (SDRT) with a population of 104 000.[61-63] The period prevalence of symptomatic CM1 and bCM1 patients in NDRT was therefore significantly more (122:100 000) than in SDRT (49:100 000; Figure 2, Table 2). Syringomyelia, a disorder often associated with CM1 and bCM1, was previously reported to be more prevalent in NDRT than SDRT.[56] The proportion of ethnic Tatars among CM1 and bCM1 patients in NDRT was 87% and in SDRT was 70%, whereas the proportion of ethnic Tatars in the entire population of NDRT compared to SDRT was 87% and SDRT was 41%, respectively (Table 2).

The Period Prevalence of CM1 and bCM1 for the Baltasy District

Of the 118 CM1 and bCM1 patients from the NDRT, 95 inhabited its Baltasy district (Figure 2), of whom 33 (35%) were first-degree relatives from 13 families. The 33 familial cases included 23 (64%) with CM1 and 10 (36%) with bCM1. The population of adults in the entire Baltasy district during this

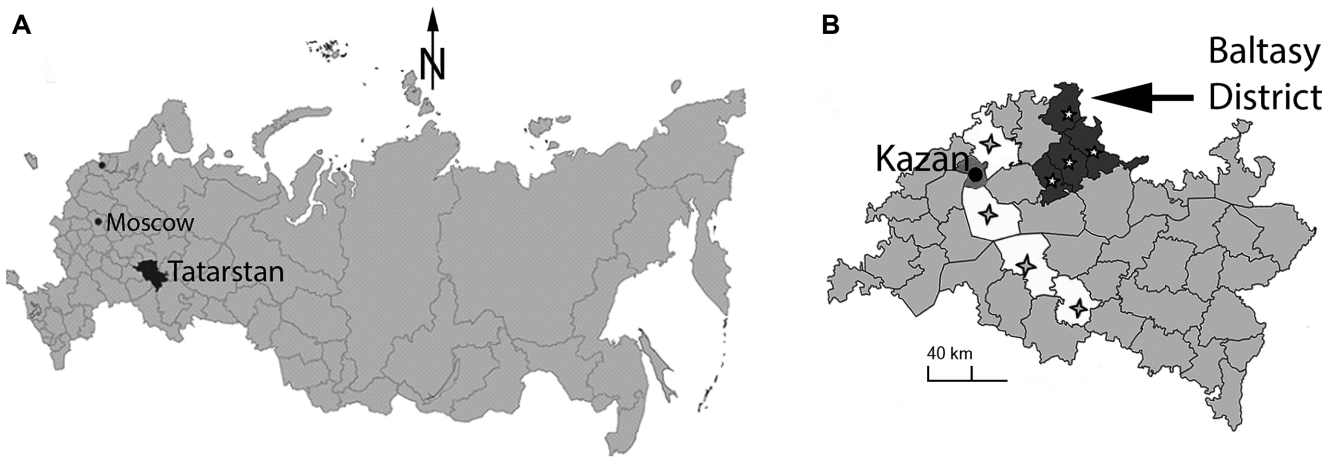

FIGURE 2. *Maps of the Russian Federation, RT, and Baltasy district.* **A**, *Map of the Russian Federation. Tatarstan is shown in black. Kazan, the capital of The RT, is found 720 km East-Southeast of Moscow.* **B**, *Map of Tatarstan. The southern districts of Tatarstan are shown in white with crosses and the northern districts in dark gray with stars. The Baltasy district (arrow) is Northeast of Kazan and on the northern border of Tatarstan.*

TABLE 1. Population of Adult Patients With CM1 and bCM1 in Hospital of RT Between January 1998 and December 2008

	Male (n = 438)	Female (n = 430)	All (n = 868)
Age, years	41 ± 15	44 ± 13	43 ± 13
Tatars, n (%)	319 (73%)	292 (68%)	611 (70%)
Russians, n (%)	101 (23%)	122 (28%)	223 (26%)
Others, n (%)	18 (4%)	16 (4%)	34 (4%)
Syringomyelia, n (%)	212 (48%)	150 (35%)	362 (42%)

TABLE 2. Characteristics of Northern and Southern (Control) Districts of RT

	Northern districts	Southern districts
Adults (during 2002)		
Tatars (n, %)	83 000 (87%)	44 000 (41%)
Non-Tatars (n, %)	12 000 (13%)	61 000 (59%)
Total adult population	95 000	104 000
Frequency of referral to our center, per 1000 adult inhabitants	29	28
Patients with CM (n, %):		
Tatars	103 (87%)	37 (70%)
Non-Tatars	15 (13%)	16 (30%)
Total	118	53
Patients with CM and Syringomyelia (n, % of CM):		
Tatars	54 (52%)	17 (46%)
Non-Tatars	4 (27%)	5 (31%)
Total	58 (49%)	22 (42%)
Period prevalence of CM, per 100 000 adult inhabitants:		
Tatars	124	76
Non-Tatars	112	26
Total RT population	122	49

period was 23 000, with an ethnic composition of 84% Tatars, 10% Russians, and 6% others. Period prevalence of symptomatic CM1 and bCM1 patients in the Baltasy district was 413:100 000 (CM1 275:100 000; bCM1 138:100 000). The higher period prevalence in the Baltasy district more than accounted for the higher period prevalence of symptomatic CM1 and bCM1 in NDRT compared to SDRT, with the period prevalence in NDRT outside the Baltasy district being 32 per 100 000 compared to 49 per 100 000 in SDRT. The mean lengths of CL and SO in the CM1 patients in Baltasy were similar to CM1 patients in other RT regions and countries (Tables 5 and 6), but the mean length of CL in the bCM1 patients in Baltasy was significantly shorter than in other RT regions (respectively, 35 mm and 40 mm; $P = .002$).

Clinical and Radiological Findings

Tonsillar descent in the evaluated 200 patients with CM symptoms met the CM1 threshold (5 mm or more tonsillar ectopia) in 134 (67%) and the bCM1 threshold (2-4 mm of tonsillar ectopia) in 66 (33%; Table 5). There were 108 males, 61 (56%) with CM1, of whom 35 (57%) had syringomyelia; and 47 (44%) with bCM1, of whom 17 (36%) had syringomyelia (Table 4). There were 92 females, 73 (79%) with CM1, of whom 33 (45%) had syringomyelia; and 19 (21%) with bCM1, of whom 8 (42%) had syringomyelia (Table 4). The frequency and types of symptoms in the CM1 and bCM1 subgroups were similar

TABLE 3. Results of Clinical Study of Patients With CM1 and bCM1

	bCM1 (n = 66)	CM1 (n = 134)	All (n = 200)
Age, years	42 ± 16	44 ± 12	43 ± 13
M/F	47/19	61/73	108/92
All CM-related headaches, n (%)	58 (88%)	115 (86%)	173 (87%)
Suboccipital headache	32 (48%)	69 (51%)	101 (50%)
Pseudotumor headache with visual phenomena	27 (41%)	51 (38%)	78 (39%)
Cough headache	7 (11%)	19 (14%)	26 (13%)
Dizziness, n (%)	26 (39%)	77 (57%)	103 (52%)
Syringomyelia, n (%)	25 (38%)	68 (51%)	93 (46%)
Numbness, n (%)	22 (33%)	50 (37%)	72 (36%)
Paresthesia, n (%)	18 (27%)	42 (31%)	60 (30%)

TABLE 4. Characteristics of Patients With CM1 and bCM1

	Male (n = 108)	Female (n = 92)	All (n = 200)
Age, years	41 ± 15	47 ± 11	43 ± 13
Tatars, n (%)	85 (79%)	73 (79%)	158 (79%)
Non-Tatars, n (%)	23 (21%)	19 (21%)	42 (21%)
CM 1, n (%)	61 (56%)	73 (79%)	134 (67%)
CM 1 with syrinx, n (%)	35 (32%)	33 (36%)	68 (34%)
bCM1, n (%)	47 (44%)	19 (21%)	66 (33%)
bCM1 with syrinx, n (%)	17 (16%)	8 (9%)	25 (13%)

(Table 3).[44] Valsalva-related and other typical headaches were identified in 86% of CM1 and 88% of bCM1 patients. The MRI measurements for these 200 patients showed that the clivus and supraocciput lengths were significantly shorter in the CM1 group compared to the control group (Table 5). The cisterna magna was small or obliterated in all patients in the CM1 and bCM1 subgroups, but was preserved in controls.[15,44]

DISCUSSION

Ethnic Differences

This study of the RT population enrolled 868 patients with symptomatic CM1, CM1-like syndrome (bCM1), and CM-associated syringomyelia over an 11-yr period. The predominant ethnic group affected was Tatars, consisting of 70% of RT patients, including 70% of SDRT, 87% of NDRT, and 91% of Baltasy district patients. Tatars was disproportionally affected by CM compared to their percentage in the population in all but NDRT because they make up 54%, 41%, 87%, and 84% of the population of RT, SDRT, NDRT, and Baltasy district, respectively. Referral patterns cannot account for this disparity because the proportion of Tatars referred to the Hospital of RT reflected the proportion of Tatars in the population. Syringomyelia is more

TABLE 5A. Results of Radiological Study SO in Patients With CM1 and bCM1

Groups of patients, n	SO, mm (M ± m)	P[a]
CM1 (RT), 134	38 ± 5	.0001
bCM1 (RT), 66	40 ± 4	.059
CM1 (Baltasy district), 18	37 ± 6	.001
bCM1 (Baltasy district), 10	38 ± 3	.013
Control group, 100	42 ± 5	

[a]Statistical significance of differences with control group (Mann–Whitney test).

TABLE 5B. Results of Radiological Study CL in Patients With CM1 and bCM1

Groups of patients, n	CL, mm (M ± m)	P[a]
CM1 (RT), 134	38 ± 4	.0001
bCM1 (RT), 66	40 ± 4	.068
CM1 (Baltasy district), 18	37 ± 6	.0001
bCM1 (Baltasy district), 10	35 ± 4	.0001
Control group, 100	41 ± 4	

[a]Statistical significance of differences with control group (Mann–Whitney test).

prevalent in Ethnic Tatars than in other ethnic groups in RT and neighboring regions of the Russian Federation, which may result because Tatars are more likely to have CM1 and bCM1, which predispose to syringomyelia.[56,68,69]

Clinical–Radiological Associations

In the second phase group of 200 patients, 66 (33%) had bCM1 (tonsillar descent of 2-4 mm) and 134 (67%) had CM1 (tonsillar descent of 5 mm or more). The proportion (33%) of patients with symptoms typical of CM1 but tonsillar ectopia less than 5 mm (bCM1) was much greater in our study compared to other studies (7%-9%).[15,70] Milhorat reported that in 364 patients with typical CM1 symptoms, 32 (9%) had tonsillar ectopia less than 5 mm.[15] In another study of 200 CM1 patients, 14 (7%) had tonsillar descent of 3 mm or less below the FM.[70] The percentage of symptomatic bCM1 (33%) in our study was considerably higher than in these other studies, possibly reflecting a higher proportion of patients with a small PF in our population. The case-control evaluation of posterior fossa measurements revealed similar changes in bone phenotype in CM1 and bCM1, manifested as reduced posterior fossa bone lengths (Tables 5 and 6). Symptoms and MRI evidence of PF hypoplasia were identical in CM1 and bCM1 patients, differing only in the extent of tonsillar descent (Table 4).

Geographical Differences

Ethnic, racial, and geographical differences in the prevalence of tonsillar ectopia were studied in other countries. In Japan,

TABLE 6. Linear Measurements of CL and SO in CM1 Patients and Control Group Compared to Findings in Other Studies

	CM1			Control		
Region or Country	n	CL, mm	SO, mm	n	CL, mm	SO, mm
Baltasy district	28	37 ± 6	37 ± 6	100	41 ± 4	42 ± 5
RT	200	38 ± 4	38 ± 5	100	41 ± 4	42 ± 5
Milhorat (USA)[15]	50	37 ± 4	38 ± 6	50	40 ± 5	42 ± 5
Karagoz (Turkey)[18]	22	36 ± 7	38 ± 5	21	40 ± 4	41 ± 7
Heiss (USA)[20]	48	39 ± 3	40 ± 4	18	43 ± 4	42 ± 4

tonsillar ectopia 1 to 4 mm below FM occurred in only 12 of 5000 subjects (0.24%).[43] In a study of 200 American patients with clinical signs or symptoms unrelated to CM1, 14% had tonsils extending 1 to 3 mm below the FM.[3] In a multicenter European-American study of 600 normal individuals, more than 5% had tonsils 1 to 5 mm below FM, while only 0.5% had greater than 5 mm of tonsillar ectopia.[47] Based on these studies, it appears that the prevalence of tonsillar ectopia in the 1 to 5 mm range is much greater (5%-14%) in the Euro-American population than in Japan (0.24%). This conclusion agrees with observations that tonsillar position is generally higher in Japanese than Americans.[43] The higher position of the cerebellar tonsils in the Japanese population could explain why Japanese are affected less often than Europeans by CM1 and bCM1-related obstruction of CSF pathways at the FM, leading to a lower prevalence of syringomyelia in Japan (1.9 per 100 000) than in England or New Zealand (8.4 and 8.2 per 100 000, respectively).[71-73] In the US and European populations, 0.77% to 0.90% of normal adults and 0.97% to 3.6% of children undergoing MRI scanning have cerebellar tonsillar ectopia of 5 mm or more, which is radiologically diagnostic of CM1.[22,34,36,74,75] The estimated prevalence of symptomatic CM1 in the general American population is 9 to 36 cases per 100 000.[28] Closer examination of our CM1 patients showed a prevalence of CM1 in the entire RT of 20 per 100 000, which is similar to that of the American population. Our study included separate CM1 and bCM1 subgroups while the CM1 group in the studies mentioned above, in fact had 7% to 9% of bCM1 cases. Patients in the bCM1 group had symptoms compatible with CM1, tonsillar herniation less than 5 mm, and PF hypoplasia, consistent with a variant of CM1.[7,26,44] Determining population prevalence accurately requires evaluation of every individual within a population. The prevalence of symptomatic CM1 would have been higher if all symptomatic or minimally symptomatic patients sought medical care at our center during the study.

Regional "Clusters" of CM1 and Syringomyelia

The prevalence of symptomatic CM1 in the Baltasy district was much higher than in other regions of the RT. The prevalence of adults with symptomatic CM1 in the Baltasy district of NDRT was over 10 times that of the rest of the RT. Clusters of CM1 and syringomyelia in other regions and ethnic groups have been reported. A higher prevalence of syringomyelia was noted in one area of Germany and regions of Russia with a large proportion of Tatars.[56,60,68,69,76] Increased prevalence of CM1, basilar impression and syringomyelia was found in Northeastern Brazil and in some states in India.[77,78] In New Zealand, the prevalence of CM1-associated syringomyelia was greater among Maori and Pacific people than in those of European descent.[72] Familial clustering of CM1 patients in the state of Utah supported a genetic predisposition to CM1 in those American families.[79]

CONCLUSION

Epidemiological studies can measure the prevalence of CM1 symptoms in different countries and regions. In this study, two-thirds of patients with CM1 symptomatology had 5 mm or more tonsillar ectopia and met the MRI diagnostic standard for CM1. Another one-third of patients who manifested CM1-type symptoms had only 2 to 4 mm of tonsillar ectopia. A regional disease cluster with a high prevalence of symptomatic CM1 and bCM1 patients and a Tartar ethnic preponderance was found in the Baltasy district of RT. In that district, about one-third of affected patients had an affected first-degree relative. Further study of this disease cluster for genetic and environmental factors predisposing to CM1 and bCM1 is necessary.

Disclosures

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COMMENTS

If we are to eventually understand the etiologies of congenital malformations with coexisting familial and environmental predispositions, a thorough analysis of epidemiological factors along with cultural, ethnic, dietary, and other influences is required. Understanding geographic influences, especially in endemic regions in industrialized and developing countries alike, carries special significance and may point to non-Mendelian heritable factors yet to be identified. This article is a step forward in that direction.

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The authors detail a group of individuals in central Asia that appear to have a high incidence of Chiari I Malformations, syrinx associated with the CIM, and a diminished posterior fossa volume. In addition to the patients with more than 5 mm of caudal descent of their cerebellar tonsils and a syrinx, the authors have included a group with less than 5 mm of descent, no syrinx, and predominantly subjective symptoms. In the setting of a high prevalence Tartar population, inclusion of the less objective group of patients seems reasonable. Using these same, less objective, criteria of tonsillar descent less than 5 mm, no syrinx and totally subjective clinical symptoms to recommend surgery to other populations is problematic.

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