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| **Table 1. Neuroradiological assessment of presurgical MR imaging features across the entire medulloblastoma dataset stratified by molecular subtypes** | | | | | | | |
|  |  | Molecular Subtypes | | | | Total | *P* value |
|  |  | WNT | SHH | Group3 | Group4 |
| Location of the primary tumor | | | | | |  | <0.0001\*\*\*\*a |
| Midline vermis/fourth ventricle | | 79 (68.10%) | 90 (43.69%) | 54 (56.25%) | 186 (57.94%) | 409 (55.35%) | 0.0002\*\*\* |
| Fourth ventricle-uni-CPA | | 21 (18.10%) | 17 (8.25%) | 14 (14.58%) | 53 (16.51%) | 105 (14.21%) | 0.031\* |
| Fourth ventricle-bi-CPA | | 7 (6.03%) | 17 (8.25%) | 20 (20.83%) | 61 (19.00%) | 105 (14.21%) | <0.0001\*\*\*\* |
| Within CPA | | 2 (1.72%) | 2 (0.97%) | 1 (1.04%) | 1 (0.31%) | 6 (0.81%) | 0.308 |
| Cerebellar hemisphere&midline/fourth ventricle | | 6 (5.17%) | 35 (16.99%) | 7 (7.29%) | 14 (4.36%) | 62 (8.39%) | <0.0001\*\*\*\* |
| Cerebellar hemisphere | | 1 (0.86%) | 45 (21.84%) | 0 (0.00%) | 6 (1.87%) | 52 (7.04%) | <0.0001\*\*\*\* |
| Total | | 116 (100.00%) | 206 (100.00%) | 96 (100.00%) | 321 (100.00%) | 739 (100.00%) |  |
| Enhancement of the primary tumor | | | | | | | |
| The proportion of enhancementb | median (Q1, Q3) | 34.80% (13.60%,53.85%) | 21.85% (10.25%,37.85%) | 32.60% (19.45%,47.15%) | 14.40% (6.75%,28.30%) | 21.15% (8.82%, 38.43%) | <0.0001\*\*\*\* |
| mean (std) | 34.46% (22.09%) | 25.49% (18.92%) | 34.87% (19.82%) | 19.66% (16.96%) | 25.58% (19.74%) | <0.0001\*\*\*\* |
| The proportion of enhancement, stratified by three classes | none/minimal (<=10%) | 21 (18.26%) | 50 (24.51%) | 12 (12.63%) | 125 (39.18%) | 208 (28.4%) | <0.0001\*\*\*\* |
| heterogeneous (10%-50%) | 60 (52.17%) | 126 (61.76%) | 63 (66.32%) | 168 (52.66%) | 417 (56.9%) |  |
| diffuse (>50%) | 34 (29.57%) | 28 (13.73%) | 20 (21.05%) | 26 (8.15%) | 108 (14.7%) |  |
| Total | 115 (100.0%) | 204 (100.0%) | 95 (100.00%) | 319 (100.00%) | 733 (100.0%) |  |
| The intensity of enhancementc | none enhancement | 4 (3.48%) | 7 (3.43%) | 2 (2.11%) | 17 (5.33%) | 30 (4.1%) | 0.0035\*\* |
| lower enhancement | 45 (39.13%) | 106 (51.96%) | 35 (36.84%) | 177 (55.49%) | 363 (49.5%) |  |
| equal enhancement | 66 (57.39%) | 91 (44.61%) | 58 (61.05%) | 125 (39.18%) | 340 (46.4%) |  |
| Total | 115 (100.0%) | 204 (100.0%) | 95 (100.0%) | 319 (100.0%) | 733 (100.0%) |  |
| Tumor margin | | | | | | | |
| Well-defined | | 70 (60.34%) | 88 (43.14%) | 62 (64.58%) | 208 (64.80%) | 428 (58.07%) | <0.0001\*\*\*\* |
| Ill-defined | | 46 (39.66%) | 116 (56.86%) | 34 (35.42%) | 113 (35.20%) | 309 (41.93%) |  |
| Total | | 116 (100.00%) | 204 (100.00%) | 96 (100.00%) | 321 (100.00%) | 737 (100.00%) |  |
| Peritumoral edema | | | | | | | |
| Y |  | 49 (42.24%) | 110 (53.92%) | 44 (45.83%) | 132 (41.12%) | 335 (45.45%) | 0.032\* |
| N |  | 67 (57.76%) | 94 (46.08%) | 52 (54.17%) | 189 (58.88%) | 402 (54.55%) |  |
| Total |  | 116 (100.00%) | 204 (100.00%) | 96 (100.00%) | 321 (100.00%) | 737 (100.00%) |  |
| Cystic change/necrosis | | | | | | | |
| Y |  | 85 (73.28%) | 147 (72.06%) | 71 (73.96%) | 262 (81.62%) | 565 (76.66%) | 0.047\* |
| N |  | 31 (26.72%) | 57 (27.94%) | 25 (26.04%) | 59 (18.38%) | 172 (23.34%) |  |
| Total |  | 116 (100.00%) | 204 (100.00%) | 96 (100.00%) | 321 (100.00%) | 737 (100.00%) |  |
| Hydrocephalus before surgery | | | | | | | |
| Y |  | 90 (68.18%) | 194 (76.68%) | 84 (73.04%) | 304 (78.55%) | 672 (75.76%) | 0.096 |
| N |  | 42 (31.82%) | 59 (23.32%) | 31 (26.96%) | 83 (21.45%) | 215 (24.24%) |  |
| Total |  | 132 (100.00%) | 253 (100.00%) | 115 (100.00%) | 387 (100.00%) | 887 (100.00%) |  |
| Intracranial solid metastasesd | | | | | | | |
| Y |  | 4 (3.48%) | 40 (19.61%) | 20 (21.05%) | 62 (19.44%) | 126 (17.19%) | 0.0004\*\*\* |
| N |  | 111 (96.52%) | 164 (80.39%) | 75 (78.95%) | 257 (80.56%) | 607 (82.81%) |  |
| Total |  | 115 (100.00%) | 204 (100.00%) | 95 (100.00%) | 319 (100.00%) | 733 (100.00%) |  |
| Note: aThe chi-square test was adopted and combined three CPA classes into one and two cerebellar classes into another when calculating the p-value.  bThe enhancement ratio quantifies the percentage of the primary tumor mass that exhibited enhancement.  cUsing the superior sagittal sinus enhancement as the reference, the primary tumor mass enhancement was categorized into three groups: avid, mild, or non-enhancing.  dThe complete assessment of signal patterns of intracranial solid metastases, encompassing ependymal and leptomeningeal metastases, is detailed in Table 2.  \**P* = 0.01-0.05, \*\**P* = 0.001-0.01, \*\*\*P = 0.0001-0.001, \*\*\*\**P* < 0.0001. The pearson chi-square test was adopted to calculate p-value if values in every cell are bigger than 5, else fisher exact test was used.  See also Figures S2, S5 and Table S1. | | | | | | | |

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| **Table 2. Patterns of intracranial solid metastases across the entire medulloblastoma dataset stratified by molecular subgroups** | | | | | | | | |
|  |  | Molecular subgroups | |  |  | Total |  | *P value* |
| WNT | SHH | Group3 | Group4 |  |
| Intracranial solid metastases | | | | | | | | |
| Y | | 4 (3.48%) | 40 (19.61%) | 20 (21.05%) | 62 (19.44%) | 126 (17.19%) |  | 0.0004\*\*\* |
| N | | 111 (96.52%) | 164 (80.39%) | 75 (78.95%) | 257 (80.56%) | 607 (82.81%) |  |  |
| Total | | 115 (100.00%) | 204 (100.00%) | 95 (100.00%) | 319 (100.00%) | 733 (100.00%) |  |  |
| Site of metastasesa | | | | | | | | |
| Ependymal metastases | | 1 (25.0%; 1/4) | 6 (15.0%; 6/40) | 2 (10.0%; 2/20) | 21 (33.9%; 21/62) | 30 (23.8%; 30/126) |  | 0.051 |
| 3rd V.I.R. metastases | | 2 (50.0%; 2/4) | 9 (22.5%; 9/40) | 8 (40.0%; 8/20) | 22 (35.5%; 22/62) | 41 (32.54%; 41/126) |  | 0.327 |
| Ependymal + 3rd. V.I.R. metastases | | 2 (50.0%; 2/4) | 13 (32.5%; 13/40) | 8 (40.0%; 8/20) | 33 (53.2%; 33/62) | 56 (44.4%; 56/126) |  | 0.205 |
| Supratentorial leptomeningeal metastases | | 1 (25.0%; 1/4) | 13 (32.5%; 13/40) | 3 (15.0%; 3/20) | 12 (19.4%; 12/62) | 29 (23.0%; 29/126) |  | 0.324 |
| Infratentorial leptomeningeal metastases | | 1 (25.0%; 1/4) | 21 (52.5%; 21/40) | 14 (70.0%; 14/20) | 21 (33.9%; 21/62) | 57 (45.2%; 57/126) |  | 0.017\* |
| Supratentorial + Infratentorial leptomeningeal metastases | | 2 (50.0%; 2/4) | 31 (77.5%; 31/40) | 14 (70.0%; 14/20) | 32 (51.6%; 32/62) | 79 (62.7%; 79/126) |  | 0.04\* |
| Signal patterns of ependymal metastases | | | | | | | | |
| Ependymal metastasesb | C-/D+ | 0 (0.0%) | 3 (50.0%) | 0 (0.0%) | 15 (71.4%) | 18 (60%) |  | 0.082 |
| C+/D+ | 1 (100.0%) | 3 (50.0%) | 2 (100.0%) | 5 (23.8%) | 11 (36.7%) |  | 0.055 |
| C+/NA | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (4.8%) | 1 (3.3%) |  | 1 |
| Total | 1 (100.0%) | 6 (100.0%) | 2 (100.0%) | 21 (100.0%) | 30 (100.0%) |  |  |
| 3rd V.I.R. metastases | C-/D+ | 0 (0.0%) | 1 (11.1%) | 0 (0.0%) | 7 (31.8%) | 8 (19.51%) |  | 0.255 |
| C+/D+ | 1 (50.0%) | 4 (44.4%) | 6 (75.0%) | 12 (54.5%) | 23 (56.10%) |  | 0.75 |
| C+/D- | 0 (0.0%) | 3 (33.3%) | 2 (25.0%) | 1 (4.5%) | 6 (14.63%) |  | 0.086 |
| C+/NA | 1 (50.0%) | 1 (11.1%) | 0 (0.0%) | 2 (9.1%) | 4 (9.76%) |  | 0.242 |
| Total | 2 (100.0%) | 9 (100.0%) | 8 (100.0%) | 22 (100.0%) | 41 (100.00%) |  |  |
| Ependymal and 3rd. V.I.R. metastases | C-/D+ | 0 (0.00%) | 4 (30.77%) | 0 (0.00%) | 18 (54.55%) | 22 (39.29%) |  | 0.010\* |
| C+/D+ | 1 (50.00%) | 6 (46.15%) | 6 (75.00%) | 13 (39.39%) | 26 (46.43%) |  | 0.3 |
| C+/D- | 0 (0.00%) | 3 (23.08%) | 2 (25.00%) | 1 (3.03%) | 6 (10.71%) |  | 0.068 |
| C+/NA | 1 (50.00%) | 1 (7.69%) | 0 (0.00%) | 3 (9.09%) | 5 (8.93%) |  | 0.237 |
| Total | 2 (100.00%) | 13 (100.00%) | 8 (100.00%) | 33 (100.00%) | 56 (100.00%) |  |  |
| C-/D+ pattern in ependymal and 3rd. V.I.R. metastasesc | | 0 (0.0%; 0/4) | 4 (10.0%; 4/40) | 0 (0.0%; 0/20) | 18 (29.03%; 18/62) | 22 (17.46%; 22/126) |  | 0.005\*\* |
| Signal patterns of leptomeningeal metastases | | | | | | | | |
| Supratentorial leptomeningeal metastases | C-/D+ | 0 (0.0%) | 1 (7.7%) | 0 (0.0%) | 0 (0.0%) | 1 (3.45%) |  | 1 |
| C+/D+ | 1 (100.0%) | 5 (38.5%) | 1 (33.3%) | 5 (41.7%) | 12 (41.38%) |  | 0.9 |
| C+/D- | 0 (0.0%) | 5 (38.5%) | 1 (33.3%) | 3 (25.0%) | 9 (31.03%) |  | 1 |
| C+/NA | 0 (0.0%) | 2 (15.4%) | 1 (33.3%) | 4 (33.3%) | 7 (24.14%) |  | 0.597 |
| Total | 1 (100.0%) | 13 (100.0%) | 3 (100.0%) | 12 (100.0%) | 29 (100.00%) |  |  |
| Infratentorial leptomeningeal metastases | C-/D+ | 0 (0.0%) | 1 (4.8%) | 0 (0.0%) | 0 (0.0%) | 1 (1.75%) |  | 1 |
| C+/D+ | 0 (0.0%) | 12 (57.1%) | 8 (57.1%) | 15 (71.4%) | 35 (61.40%) |  | 0.204 |
| C+/D- | 0 (0.0%) | 3 (14.3%) | 4 (28.6%) | 1 (4.8%) | 8 (14.04%) |  | 0.18 |
| C+/NA | 1 (100.0%) | 5 (23.8%) | 2 (14.3%) | 5 (23.8%) | 13 (22.81%) |  | 0.377 |
| Total | 1 (100.0%) | 21 (100.0%) | 14 (100.0%) | 21 (100.0%) | 57 (100.00%) |  |  |
| Supratentorial and infratentorial leptomeningeal metastases | C-/D+ | 0 (0.0%) | 2 (6.5%) | 0 (0.0%) | 0 (0.0%) | 2 (2.5%) |  | 0.517 |
| C+/D+ | 1 (50.0%) | 16 (51.6%) | 8 (57.1%) | 20 (62.5%) | 45 (57.0%) |  | 0.547 |
| C+/D- | 0 (0.0%) | 6 (19.4%) | 4 (28.6%) | 4 (12.5%) | 14 (17.7%) |  | 0.637 |
| C+/NA | 1 (50.0%) | 7 (22.6%) | 2 (14.3%) | 8 (25.0%) | 18 (22.8%) |  | 0.654 |
| Total | 2 (100.0%) | 31 (100.0%) | 14 (100.0%) | 32 (100.0%) | 79 (100%) |  |  |
| Note: "C-/D+" denotes cases with diffusion restriction but minimal or no postcontrast enhancement, while "C+/NA" indicates postcontrast enhancement with unavailable diffusion information due to the absence of a DWI sequence.  aThe percentage and corresponding p-value for each metastatic site (categorized into 6 classes as listed below) were computed specifically among subjects exhibiting intracranial solid metastases. bThe percentage and corresponding p-value for each signal pattern of ependymal metastases were computed among subjects exhibiting ependymal metastases. cThe percentage and corresponding p-value were computed within subjects exhibiting intracranial solid metastases. dPercentages may exceed 100% due to certain subjects exhibiting two metastases with different signal patterns.  \**P* = 0.01-0.05, \*\**P* = 0.001-0.01, \*\*\*P = 0.0001-0.001, \*\*\*\**P* < 0.0001. The pearson chi-square test was adopted to calculate p-value if values in every cell are bigger than 5, else fisher exact test was used. Key abbreviation: 3rd. V.I.R. = the third ventricular infundibular recess.  See also Figure S3. | | | | | | | | |

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| **Table 3. Association of clinicopathological features and the collective molecular subgroups with a focus on the Asian population** | | | | | | |
|  | Molecular Subtypes | | | | Total | *P* value |
|  | WNT | SHH | Group3 | Group4 |
| Frequency N (%) | 132 (14.88%) | 253 (28.52%) | 115 (12.97%) | 387 (43.63%) | 887 (100.00%) |  |
| Age | | | | | | |
| mean (SD) | 10.077 (4.812) | 10.370 (10.911) | 7.359 (5.058) | 8.713 (4.801) | 9.214 (7.190) | 0.0004\*\*\* |
| median (Q1, Q3) | 9 (7, 12) | 7 (4, 12) | 6.2 (4, 9.5) | 8 (6, 11) | 8 (5, 11) |  |
| Sex | | | | | | |
| M | 58 (43.94%) | 165 (65.22%) | 78 (67.83%) | 277 (71.58%) | 578 (65.16%) | <0.0001\*\*\*\* |
| F | 74 (56.06%) | 88 (34.78%) | 37 (32.17%) | 110 (28.42%) | 309 (34.84%) |  |
| Total | 132 (100.00%) | 253 (100.00%) | 115 (100.00%) | 387 (100.00%) | 887 (100.00%) |  |
| Race | | | | | | |
| Asian | 124 (93.94%) | 220 (86.96%) | 94 (81.74%) | 336 (86.82%) | 774 (87.26%) | 0.0656 |
| Black or African American | 1 (0.76%) | 0 (0.00%) | 0 (0.00%) | 4 (1.03%) | 5 (0.56%) |  |
| White | 5 (3.79%) | 21 (8.30%) | 16 (13.91%) | 37 (9.56%) | 79 (8.91%) |  |
| Other or Not Reported | 2 (1.52%) | 12 (4.74%) | 5 (4.35%) | 10 (2.58%) | 29 (3.27%) |  |
| Total | 132 (100.00%) | 253 (100.00%) | 115 (100.00%) | 387 (100.00%) | 887 (100.00%) |  |
| Tumor texture | | | | | | |
| Hard | 11 (9.02%) | 47 (22.07%) | 20 (21.28%) | 51 (15.18%) | 129 (16.86%) | 0.0018\*\* |
| Mixed | 17 (13.93%) | 52 (24.41%) | 17 (18.09%) | 73 (21.73%) | 159 (20.78%) |  |
| Soft | 94 (77.05%) | 114 (53.52%) | 57 (60.64%) | 212 (63.10%) | 477 (62.35%) |  |
| Total | 122 (100.00%) | 213 (100.00%) | 94 (100.00%) | 336 (100.00%) | 765 (100.00%) |  |
| Histological Subtypes | | | | | | |
| Classic | 106 (91.38%) | 84 (37.50%) | 67 (78.82%) | 269 (82.52%) | 526 (70.04%) | <0.0001\*\*\*\* |
| DN | 4 (3.45%) | 103 (45.98%) | 8 (9.41%) | 48 (14.72%) | 163 (21.70%) |  |
| LCA | 2 (1.72%) | 12 (5.36%) | 9 (10.59%) | 8 (2.45%) | 31 (4.13%) |  |
| MBEN | 4 (3.45%) | 25 (11.16%) | 1 (1.18%) | 1 (0.31%) | 31 (4.13%) |  |
| Total | 116 (100.00%) | 224 (100.00%) | 85 (100.00%) | 326 (100.00%) | 751 (100.00%) |  |
| LCA-enrichment (%) | 1.72% | 5.36% | 10.59% | 2.45% | 4.03% | 0.0055\*\* |
| Extent of tumor resection | | | | | | |
| GTR | 74 (57.81%) | 133 (56.36%) | 56 (53.85%) | 195 (55.40%) | 458 (55.85%) | 0.9314 |
| NTR | 47 (36.72%) | 90 (38.14%) | 39 (37.50%) | 131 (37.22%) | 307 (37.44%) |  |
| STR | 7 (5.47%) | 13 (5.51%) | 9 (8.65%) | 26 (7.39%) | 55 (6.71%) |  |
| Total | 128 (100.00%) | 236 (100.00%) | 104 (100.00%) | 352 (100.00%) | 820 (100.00%) |  |
| Radiotherapy | | | | | | |
| Y | 114 (95.00%) | 180 (82.19%) | 71 (80.68%) | 295 (93.35%) | 660 (88.83%) | <0.0001\*\*\*\* |
| N | 6 (5.00%) | 39 (17.81%) | 17 (19.32%) | 21 (6.65%) | 83 (11.17%) |  |
| Total | 120 (100.00%) | 219 (100.00%) | 88 (100.00%) | 316 (100.00%) | 743 (100.00%) |  |
| Chemotherapy | | | | | | |
| Y | 98 (85.96%) | 186 (85.71%) | 65 (78.31%) | 275 (89.00%) | 624 (86.31%) | 0.001\*\*\* |
| N | 16 (14.04%) | 31 (14.29%) | 18 (21.69%) | 34 (11.00%) | 99 (13.69%) |  |
| Total | 114 (100.00%) | 217 (100.00%) | 83 (100.00%) | 309 (100.00%) | 723 (100.00%) |  |
| Survival probability | | | | | | |
| 1-year OS (%) | 96.1% | 90.3% | 76.6% | 91.7% | 90.9% | 0.00014\*\*\* |
| 2-year OS (%) | 91.7% | 79.3% | 70.6% | 86.1% | 83.9% |  |
| 3-year OS (%) | 91.7% | 68.0% | 67.9% | 74.7% | 75.6% |  |
| 4-year OS (%) | 88.3% | 63.5% | 64.2% | 68.7% | 71.0% |  |
| 5-year OS (%) | 88.3% | 59.8% | 64.2% | 65.2% | 68.0% |  |
| Survival status | | | | | | |
| Alive | 124 (93.94%) | 197 (77.87%) | 84 (73.04%) | 315 (81.40%) | 720 (81.17%) | 0.0001\*\*\*\* |
| Decease | 8 (6.06%) | 56 (22.13%) | 31 (26.96%) | 72 (18.60%) | 167 (18.83%) |  |
| Total | 132 (100.00%) | 253 (100.00%) | 115 (100.00%) | 387 (100.00%) | 887 (100.00%) |  |
| Note: \**P* = 0.01-0.05, \*\**P* = 0.001-0.01, \*\*\**P* = 0.001-0.0001, \*\*\*\**P* = <0.0001. The pearson chi-square test was adopted to calculate p-value.  See also Table S10. | | | | | | |