leukaemia (M6b) and acute lymphocytic leukaemia (ALL). M0, M6b and ALL are all generally negative for expression of myeloperoxidase in immunohistochemistry (IHC), as is AMKL. The neoplastic cells in AMKL occasionally have a lymphoblast-like appearance similar to M0 and ALL (Brunning *et al.*, 2001). Furthermore, neoplastic multinucleate cells are observed in both M6b and AMKL, and are often positively stained by PAS (Brunning *et al.*, 2001). Megakaryoblasts do not express myeloperoxidase, but are labelled by one or more of the megakaryocyte-associated antigens CD41, CD61 and Von Willebrand Factor (Brunning *et al.*, 2001; Daniel and Arber, 2001). The cytological and immunohistochemical features of the neoplastic population in the present case were not consistent with M0, M6b or ALL.

Further differential diagnoses for AMKL with myelofibrosis, as described in the present case, include acute panmyelosis with myelofibrosis (APMF), blastic transformation of chronic myeloid leukaemia (CML) or idiopathic myelofibrosis (IMF). APMF is characterized by multi-lineage myeloid proliferation, with a less numerous population of blast cells than in acute megakaryoblastic leukaemia (Orazi *et al.*, 2005). The cells in APMF do not express megakaryocyte-related antigens, which is inconsistent with the findings in the present case. CML is a clonal bone marrow stem cell disorder with proliferation of mature granulocytes (Travis *et al.*, 1987; Bourantas *et al.*, 1998) whereas IMF is a clonal myeloproliferative disorder that is characterized by abnormal deposition of collagen within the bone marrow (Hirose *et al.*, 2001). Human patients with CML or IMF also develop terminal blastic transformation, and these blast cells have frequently been identified as megakaryoblasts (Travis *et al.*, 1987; Bourantas *et al.*, 1998; Hirose *et al.*, 2001). Although the present case most likely represents AMKL with myelofibrosis, it is difficult to entirely exclude the alternative interpretation of blastic transformation of CML or IMF. For this reason, the present case has been described as an AMKL (M7)-like disease.

To our knowledge, this is the first case of spontaneously arising AMKL-like disease in non-human primates. The affected monkey had SRV/D infection, which may have contributed to the development of the neoplastic disease (Guzman *et al.*, 1999). Alternatively, a genetic mechanism may be proposed as humans with Down's syndrome have predisposition to the development of AMKL associated with a somatic mutation in the gene encoding the GATA1 transcription factor protein (Shimizu *et al.*, 2008). Further cases of such leukaemia in non-human primates should be subject to genetic investigation.

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References

Akahoshi, M., Oshimi, K., Mizoguchi, H., Okada, M., Enomoto, Y. and Watanabe, Y. (1987). Myeloproliferative disorders terminating in acute megakaryoblastic leukemia with chromosome 3q26 abnormality. *Cancer*, **60**, 2654–2661.

Athale, U. H., Razzouk, B. I., Raimondi, S. C., Tong, X., Behm, F. G., Head, D. R., Srivastava, D. K., Rubnitz, J. E., Bowman, L., Pui, C. H. and Ribeiro, R. C. (2001). Biology and outcome of childhood acute megakaryoblastic leukemia: a single institution's experience. *Blood*, **97**, 3727–3732.

Bennett, J. M., Catovsky, D., Daniel, M. T., Flandrin, G., Galton, D. A., Gralnick, H. R. and Sultan, C. (1985). Criteria for the diagnosis of acute leukemia of megakaryocyte lineage (M7). A report of the French–American–British Cooperative Group. *Annals of Internal Medicine*, **103**, 460–462.

von Boros, J. and Korenyi, A. (1931). Uber einen fall von akuter megakaryocyblasten-leukamie, zugleich einige bemerkungen zum problem der akuten leukemie. *Zeitschrift für Klinische Medizin*, **118**, 679–718.

Bourantas, K. L., Repousis, P., Tsiara, S., Christou, L., Konstantinidou, P. and Bai, M. (1998). Chronic myelogenous leukemia terminating in acute megakaryoblastic leukemia. Case report. *Journal of Experimental and Clinical Cancer Research*, **17**, 243–245.

Brunning, R. D., Matutes, E., Flandrin, G., Vardiman, J., Bennett, J., Head, D. and Harris, N. L. (2001). Acute myeloid leukemias. Pathology and genetics of tumours of haematopoietic and lymphoid tissues. In: *World Health Organization Classification of Tumors*, E. S. Jaffe, N. L. Harris, H. Stein and J. W. Vardiman, Eds, IARC Press, Lyon, pp. 77–105.

Colbatzky, F. and Hermanns, W. (1993). Acute megakaryoblastic leukemia in one cat and two dogs. *Veterinary Pathology*, **30**, 186–194.

Daniel, A. and Arber, M. D. (2001). Realistic pathologic classification of acute myeloid leukemias. *American Journal of Clinical Pathology*, **115**, 552–560.

Ferrara, F. and Mirto, S. (1996). Serum LDH value as a predictor of clinical outcome in acute myelogenous leukaemia of the elderly. *British Journal of Haematology*, **92**, 627–631.

Fortgang, I. S., Didier, P. J. and Levy, L. S. (2000). B-cell leukemia in a rhesus macaque (*Macaca mulatta*) infected with simian immunodefieiency virus. *Leukemia and Lymphoma*, **37**, 657–662.

Guzman, R. E., Kerlin, R. L. and Zimmerman, T. E. (1999). Histologic lesions in cynomolgus monkeys (*Macaca fascicularis*) naturally infected with simian retrovirus type D: comparison of seropositive, virus-positive, nd uninfected animals. *Toxicologic Pathology*, **27**, 672–677.

Hara, M., Kikuchi, T., Ono, F., Takano, J., Ageyama, N., Fujimoto, K., Terao, K., Baba, T. and Mukai, R. (2005). Survey of captive cynomolgus macaque colonies for SRV/D infection using polymerase chain reaction assays. *Comparative Medicine*, **55**, 145–149.

Hirose, Y., Masaki, Y., Shimoyama, K., Sugai, S. and Nojima, T. (2001). Granulocytic sarcoma of megakaryoblastic differentiation in the lymph nodes terminating as acute megakaryoblastic leukemia in a case of chronic idiopathic myelofibrosis persisting for 16 years. *European Journal of Haematology*, **67**, 194–198.

Hubbard, G. B., Moné, J. P., Allan, J. S., Davis, K. J., 3rd, Leland, M. M., Banks, P. M. and Smir, B. (1993). Spontaneously generated non-Hodgkin's lymphoma in twenty-seven simian T-cell leukemia virus type 1 antibody-positive baboons (*Papio species*). *Laboratory Animal Science*, **43**, 301–309.

Koike, T. (1984). Megakaryoblastic leukemia: the characterization and identification of megakaryoblasts. *Blood*, **64**, 683–692.

Orazi, A., O'Malley, D. P., Jiang, J., Vance, G. H., Thomas, J., Czader, M., Fang, W., An, C. and Banks, P. M. (2005). Acute panmyelosis with myelofibrosis: an entity distinct from acute megakaryoblastic leukemia. *Modern Pathology*, **18**, 603–614.

Paramastri, Y. A., Wallace, J. M., Salleng, K. J., Wilkinson, L. M., Malarkey, D. E. and Cline, J. M. (2002). Intracranial lymphomas in simian retrovirus-positive *Macaca fascicularis*. *Veterinary Pathology*, **39**, 399–402.

Paredes-Aguilera, R., Romero-Guzman, L., Lopez-Santiago, N. and Trejo, R. A. (2003). Biology, clinical, and hematologic features of acute megakaryoblastic leukemia in children. *American Journal of Hematology*, **73**, 71–80.

Shimizu, R., Engel, J. D. and Yamamoto, M. (2008). GATA1-related leukaemias. *Nature Reviews Cancer*, **8**, 279–287.

Shukla, J., Rai, S. and Singh, V. P. (2004). Acute megakaryoblastic leukaemia: a clinico-haematological profile of five cases. *Indian Journal of Pathology and Microbiology*, **47**, 266–268.

Terui, T., Niitsu, Y., Mahara, K., Fujisaki, Y., Urushizaki, Y., Mogi, Y., Kohgo, Y., Watanabe, N., Ogura, M. and Saito, H. (1990). The production of transforming growth factor-beta in acute megakaryoblastic leukemia and its possible implications in myelofibrosis. *Blood*, **75**, 1540–1548.

Travis, W. D., Li, C. Y., Banks, P. M. and Nichols, W. L. (1987). Megakaryoblastic transformation of chronic granulocytic leukemia. *Cancer*, **60**, 193–200.

Wu, C. D., Medeiros, L. J., Miranda, R. N., Mark, H. F. and Rintels, P. (1996). Chronic myeloid leukemia manifested during megakaryoblastic crisis. *Southern Medical Journal*, **89**, 422–427.

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