

1 **Retrospective analysis of magnetic resonance imaging for differentiating intraligamentous**
2 **leiomyomas from subserosal leiomyomas**

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13 **Running Title:** Uterine leiomyomas on MRI

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30 **Condensation**

- 31 The position of the ipsilateral ovary in association with the main leiomyoma on MRI is helpful for the
- 32 differentiation of intraligamentous leiomyomas from subserosal leiomyomas.

33 Dear editor, uterine leiomyomas are among the most common gynecologic benign tumors in women of
34 reproductive age. Increased uterine size and deformity of the uterine cavity caused by leiomyomas are
35 related to compression-associated symptoms and infertility [1]. Procedures for surgical management of
36 uterine leiomyomas, such as hysterectomy and myomectomy, have been introduced. The precise mapping
37 of the number, size, and localization of uterine leiomyomas is required for myomectomy as a fertility-
38 sparing surgery. However, intraligamentous leiomyomas, located in the broad ligament, are sometimes
39 difficult to treat with myomectomy since there is a possible risk of heavy bleeding and damage to the ureter
40 adjacent to the intraligamentous leiomyomas [2]. A method to distinguish intraligamentous leiomyomas
41 from subserosal leiomyomas, which are much easier to treat with myomectomy, has yet to be established.

42 We analyzed 82 patients who underwent laparoscopic or abdominal myomectomy at Nagoya University
43 Hospital from 2004 to 2015. The study was approved by the institutional ethics committee. We included
44 patients with > 5 cm intraligamentous (n = 25) or subserosal leiomyomas (n = 57). Locations of the
45 leiomyomas were classified by surgical records and/or videos. Magnetic resonance imaging (MRI) was
46 performed using six different scanners (Visart, Toshiba Medical Systems, Tokyo, Japan; Avant, Aera,
47 Skyra, Verio, and Trio, Siemens Medical Solutions, Erlangen, Germany). We classified the positions of the
48 leiomyomas in comparison with the position of the ipsilateral ovary using the following procedure. The
49 planes corresponding to the upper limit, lower limit, and maximum diameter of the leiomyoma were
50 identified on T2-weighted images. The cases were classified as group “UU,” group “UM,” group “LM,”

51 and group “LL” when the ipsilateral ovary was located above the upper limit of the leiomyoma, between
52 the upper limit and the maximum diameter of the leiomyoma, between the maximum diameter and lower
53 limit of the leiomyoma, and below the lower limit of the leiomyoma, respectively. A schematic illustration
54 and examples for each class are shown in Fig. 1.

55 There were no statistically significant differences in age (38.1 ± 6.0 versus 36.4 ± 4.0 years) or size of
56 the largest leiomyoma (88.0 ± 33.2 mm versus 95.0 ± 31.8 mm) between the intraligamentous leiomyoma
57 group and the subserosal leiomyoma group. The numbers of cases in the classifications were as follows:
58 24 in the UU+UM of the intraligamentous leiomyoma group, 1 in the LM+LL of the intraligamentous
59 leiomyoma group, 17 in the UU+UM of the serosal leiomyoma group, and 40 in the LM+LL of the
60 subserosal leiomyoma group. In 24 out of 25 patients with intraligamentous leiomyomas, the ovary was
61 located above the horizontal plane corresponding to the maximum diameter of leiomyoma. In patients with
62 subserosal leiomyomas, the ipsilateral ovary was located below the horizontal plane corresponding to the
63 maximum diameter of the leiomyoma in 40 out of 57 patients. We found a significant difference in the
64 classification of the ovary position between leiomyoma types ($P < .01$, chi-square test).

65 Although it has been shown that MRI is superior to ultrasonography in the exact mapping of uterine
66 leiomyomas [3-5], no method for the differentiation of subserosal and intraligamentous leiomyomas has
67 been established. Our results demonstrated high sensitivity (96.0%) with only one false-negative case out
68 of 25 patients with intraligamentous leiomyomas. In this case, the intraligamentous leiomyoma was rather

69 small (5.2 cm). In contrast, the specificity was limited (40/57, 70.2%). Possible reasons for the false-
70 positive findings are the relatively smaller size of leiomyomas located at a more caudal location and/or
71 dislocation of the uterus caused by multiple leiomyomas. In conclusion, our findings may be helpful in
72 differentiating intraligamentous leiomyomas from subserosal leiomyomas, although further study is
73 required.

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90 **Figure Legends**

91 **Fig 1.** Schematic illustration for the positions of the ovary and leiomyoma on horizontal and sagittal
92 magnetic resonance images. (UU) Ipsilateral ovary was located above the superior limit of the leiomyoma;
93 (UM) ipsilateral ovary was located between the superior limit and the maximum diameter of the
94 leiomyoma; (LM) ipsilateral ovary was located between the maximum diameter and the inferior limit of
95 the leiomyoma; (LL) ipsilateral ovary was located below the inferior limit of the leiomyoma. White
96 arrowheads indicate ipsilateral ovaries.