Synchronous Quadruple Primary Neoplasms: Glioblastoma, Neuroendocrine Tumor, Schwannoma and Sessile Serrated Adenoma in a Patient with History of Prostate Cancer

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Abstract. *Quadruple synchronous primary neoplasms are exceedingly rare with only one case reported in the English literature. We herein report a case of synchronous quadruple primary neoplasms in a 70-year-old Arabic male with a history of prostate cancer who presented to our hospital for work-up of a brain mass found at an outside hospital. Subsequent ^{18}Fluorodeoxyglucose (FDG) positron emission tomography demonstrated a 5.9-cm temporoparietal mass and three additional lesions, each with increased maximum standardized uptake value (SUV_{max}). Histologic examination, immunohistochemistry and cytogenetic analyses of the lesional tissue revealed four primary neoplastic lesions: primary glioblastoma, inguinal schwannoma, well-differentiated neuroendocrine tumor of the terminal ileum and an appendiceal sessile serrated adenoma/polyp. This case is unique among previous reports as our patient presented with four primary neoplasms synchronously. To the best of our knowledge, this combination of synchronous multiple primary neoplasms has not been reported in the English literature.*

At the turn of the 19th century, Billroth first described multiple primary malignant neoplasms (MPMN) occurring in a single patient (1). Since then, many combinations of multiple primary cancers, involving either single or multiple organs, have been documented. In 1932, Warren and Gates proposed the now widely accepted criteria for the diagnosis of MPMN: each neoplastic lesion must have a histologic picture of malignancy; each must be anatomically distinct from the others; and the possibility of one being a metastasis of the other must be excluded (2).

Multiple primary cancers are classified as either synchronous or metachronous depending on the time of diagnosis, not the genesis of the neoplasm. Synchronous cancers have been defined as those that occur in a single patient that are diagnosed either simultaneously (3) or within 6 months of each other (4). Metachronous cancers have been defined as those that occur in a single patient that are diagnosed at least 6 months apart (4).

The prevalence of multiple primary cancers has grown due to improved cancer survivorship and more sensitive diagnostic techniques. A literature review of 1,104,269 cancer patients concluded that the prevalence of multiple primary cancers is between 0.73% and 11.7% (4). Synchronous cancers are even more rare, only found in 18.4-25.3% of those with multiple primary cancers (5-6). Furthermore, it has been reported that 2-12% of all patients with two metachronous or synchronous cancers go on to develop a third or fourth neoplasia (7). We herein report a case of a 70-year-old Arabic man with synchronous quadruple primary neoplasias with the aim to increase clinicians' awareness of multiple neoplasms in a single patient, as well as discuss the clinical utility of ^{18}Fluorodeoxyglucose (FDG) positron emission tomography (FDG-PET) in detecting synchronous multiple primary cancers.

Case Report

A 70-year-old Arabic male was found to have a left temporoparietal mass on computed tomography (CT) after presenting to an outside hospital with a two-month history of worsening aphasia and confusion. He presented to our hospital for further management of the mass. His past medical history is significant for prostate cancer four years status post complete prostatectomy, a right-sided stroke, cerebral hemorrhagic infarction and type II diabetes mellitus. The patient's family history is significant for his father who had lung cancer and mother, had colon cancer.

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Key Words: Synchronous, multiple primary malignant neoplasms, glioblastoma, glioblastoma multiforme, neuroendocrine tumor, sessile serrated adenoma/polyp, schwannoma.

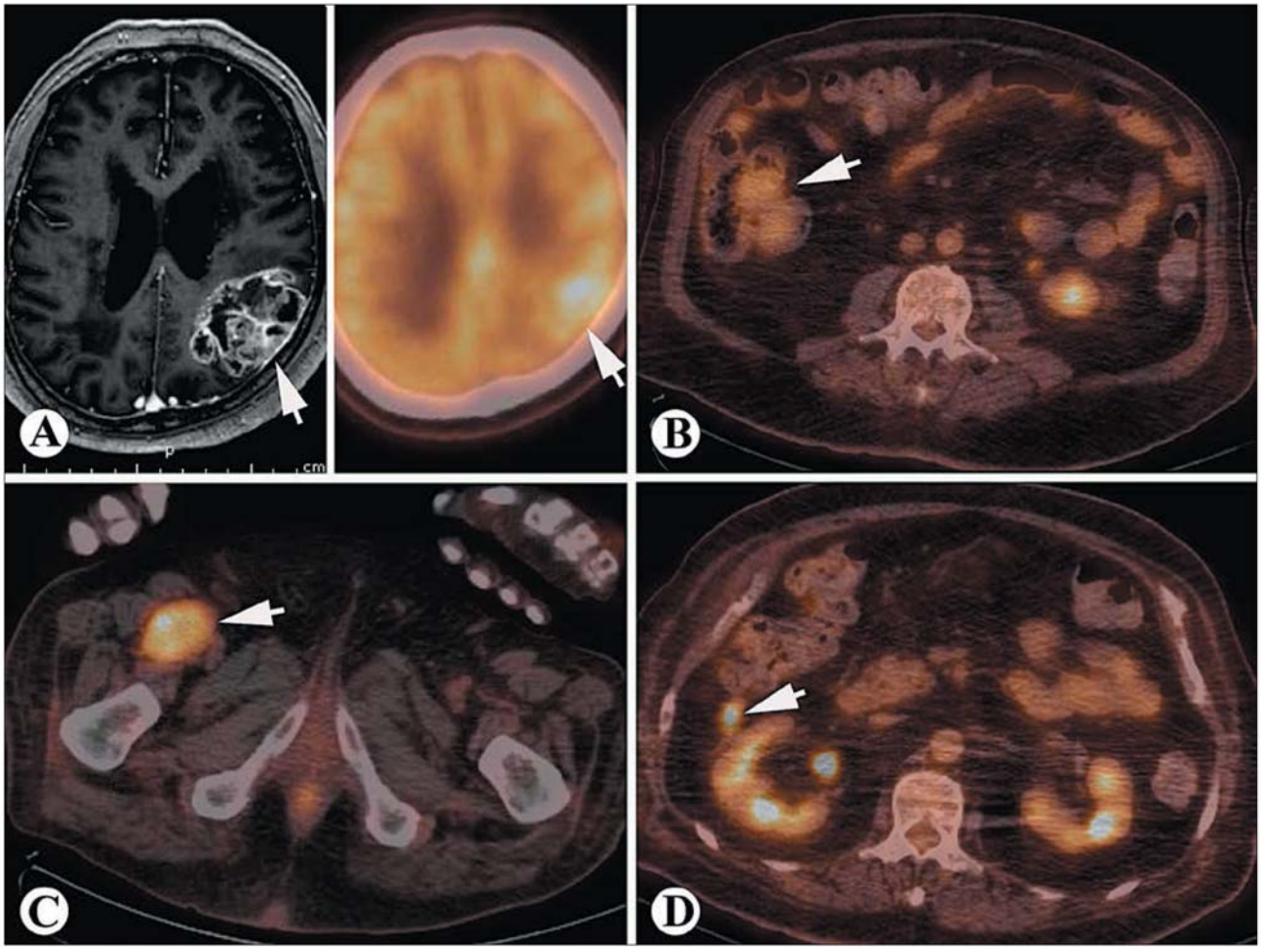

Figure 1. *Radiologic examination of the four primary lesions. (A) An MRI with contrast turbo-field echo (TFE) and sensitivity encoding (SENSE) of the glioblastoma (white arrowhead) shows diffuse T1 and T2 enhancement with internal susceptibility consistent with blood products and/or calcification (left) and FDG-PET/CT of the glioblastoma (white arrowhead) showing intense FDG uptake with SUV_{max} 11.9 (right); (B) FDG-PET/CT of the NET (white arrowhead) near the ileocecal valve showing increased FDG uptake with SUV_{max} 3.7; (C) FDG-PET/CT of the inguinal schwannoma (white arrowhead) showing intense FDG uptake with SUV_{max} 11.8; (D) FDG-PET/CT of the appediceal SSA/P (white arrowhead) showing intense FDG uptake with SUV_{max} 7.1.*

On initial neurological examination, the patient was awake, alert and oriented only to his name after much prompting. A coarse intention tremor and mild paresis was also present in his left upper- and lower-extremities. No skin lesions were noted. The rest of his clinical examination was unremarkable.

Magnetic resonance imaging (MRI) of the head was performed with and without contrast, which revealed a large left temporoparietal mass that measured approximately 5.3-cm in anterior-posterior dimension, 4.8-cm in transverse dimension and 5.9-cm in craniocaudal dimension. The lesion had heterogeneous T1 and T2 signal with areas of T2 hypointensity consistent with intra-lesional hemorrhage and/or calcification (Figure 1A, left). The radiological impression was metastatic disease or primary glial neoplasm.

CT of the chest, abdomen and pelvis with contrast was also performed to evaluate for metastatic disease. CT of the abdomen showed a short segment intussusception at the ileocecal valve with bowel wall thickening. An underlying mass near the ileocecal valve was radiographically suspected to have caused the intussusception. An enlarged right 3.5-cm inguinal soft tissue lesion was also identified and suspected to be lymph node metastasis.

The patient then underwent whole-body positron emission topography/computed tomography (PET/CT) with ^{18}Fluorodeoxyglucose (FDG) metabolic mapping to further characterize the previous CT findings. The previously identified left temporoparietal mass demonstrated an increased metabolic activity with SUV_{max} 11.9 compared to the surrounding brain parenchyma with SUV_{max} 9.2 (Figure 1A, right). The previously

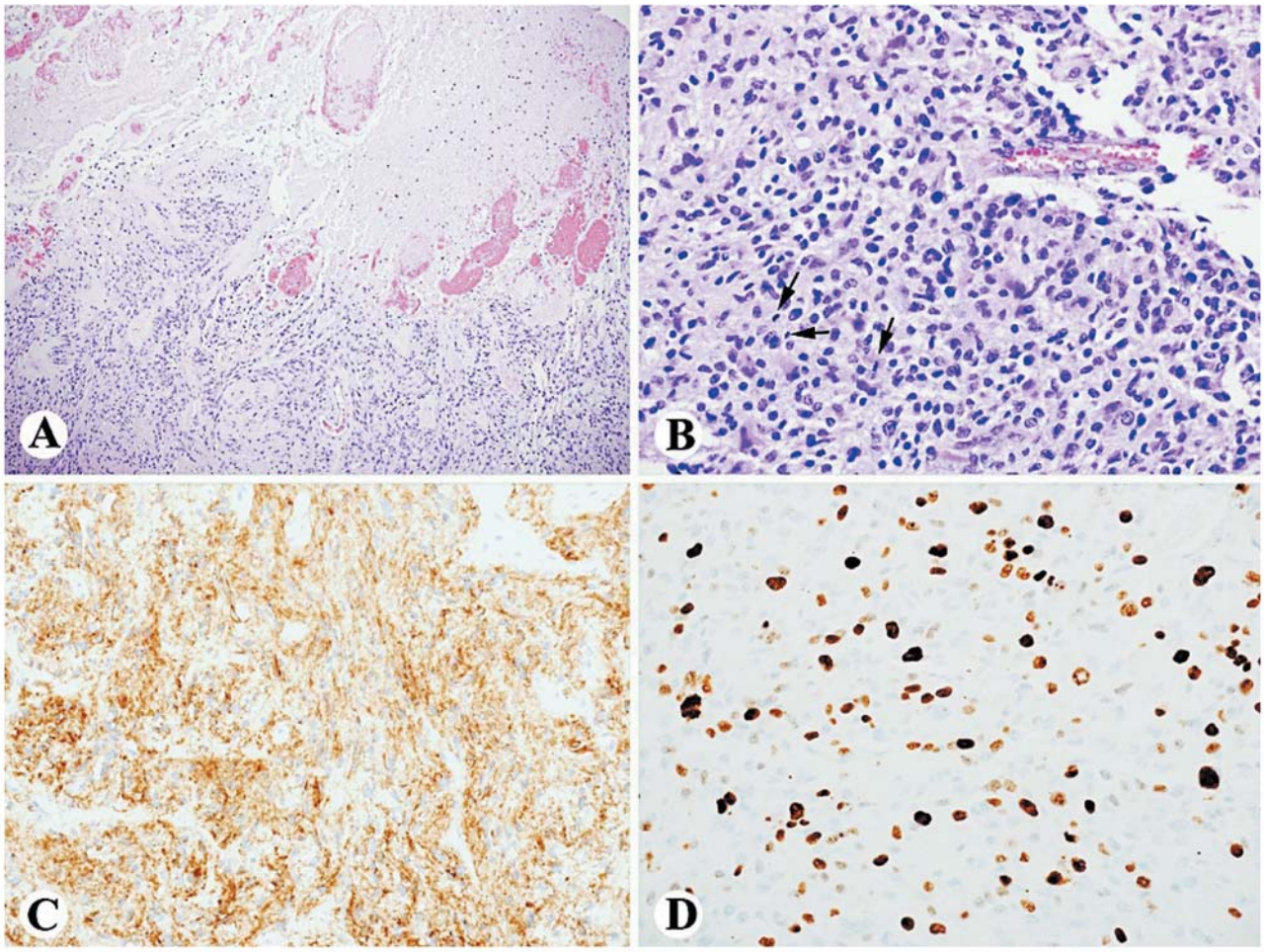

Figure 2. *Glioblastoma. (A) The left temporoparietal lesion shows high cellularity, vascular proliferation, necrosis (100X) and (B) numerous mitotic figures (black arrows, 400X); (C-D) The tumor cells stain strongly and diffusely positive for GFAP (C, 100X) with a Ki-67/MIB-1 proliferation index of approximately 47% (D, 400X).*

identified short segment intussusception at the ileocecal valve showed moderate FDG uptake with SUV_{max} 3.7 (Figure 1B). The previously identified inguinal soft tissue lesion was found to be intensely FDG avid with SUV_{max} 11.8, suspicious for malignancy (Figure 1C). Interestingly, marked metabolic activity was also seen in the appendix with SUV_{max} 7.1 (Figure 1D).

The patient underwent stereotactic craniotomy for gross total resection of the left temporoparietal mass. Gross examination of the resection specimen demonstrated extensive tumor necrosis. Microscopic examination of the resection specimen revealed a hypercellular, high-grade glial neoplasm with microvascular proliferation and necrosis (Figure 2A). The tumor was composed of pleomorphic cells with hyperchromatic nuclei and numerous mitotic figures (Figure 2B). Immunoperoxidase staining for glial fibrillary acid protein (GFAP; Cell Marque, CA) was strongly and diffusely-positive in the tumor cells (Figure 2C). Ki-67/MIB-1 monoclonal antibody (Ventana, AZ) staining revealed a proliferation index of approximately 47%, consistent with glioblastoma - World Health Organization (WHO) Grade IV astrocytoma, previously known as glioblastoma multiforme (Figure 2D).

The patient's glioblastoma tumor tissue was submitted for cytogenetic study. Array comparative genomic hybridization (array CGH) (8) was performed on the glioblastoma tumor tissue and showed trisomy 7, amplification of the epidermal growth factor (*EGFR*) gene, biallelic interstitial deletion at 9p21 including the cyclin-dependent kinase inhibitor 2A/2B (*CDKN2A/2B*) genes, and loss or monosomy of chromosome 10 including the phosphatase and tensin homolog (*PTEN*) gene. Isocitrate dehydrogenase enzyme 1/2 (*IDH1/2*) mutational analysis and O^6-methylguanine-DNA methyltransferase (*MGMT*) promoter methylation analysis were performed and showed no abnormalities.

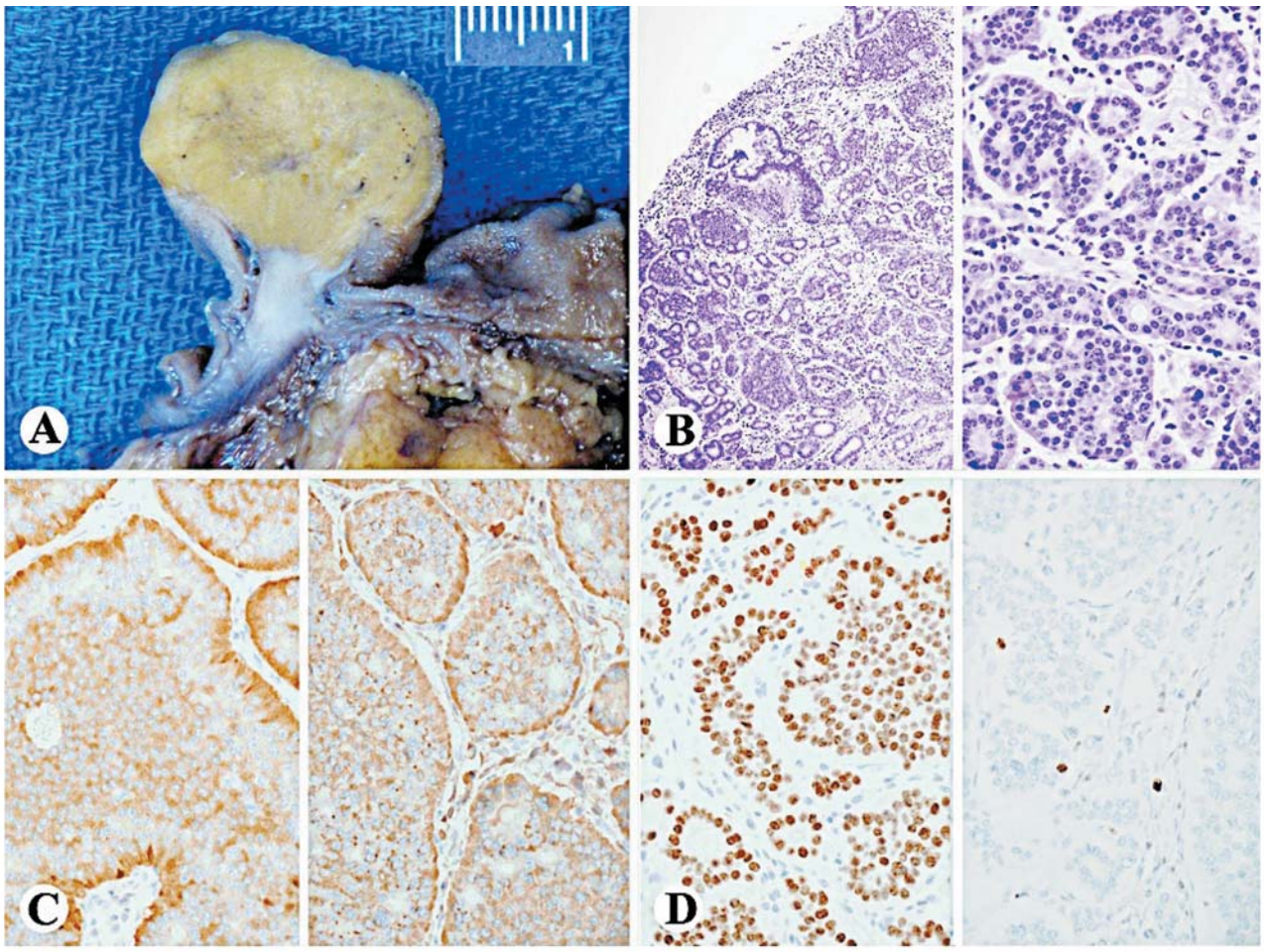

Figure 3. *Well-differentiated neuroendocrine tumor (NET) of the terminal ileum. (A) Grossly, the tumor is a 2.5×2.3×2.3-cm pedunculated mass arising near the ileocecal valve with yellow homogeneous cut surface; (B) Histologically, the tumor cells have monotonous nuclei and acinar architecture (left, 100X) with "salt and pepper" chromatin (right, 400X); (C) The tumor cells are positive for synaptophysin (left, 400X), chromogranin (right, 400X) and (D) CDX-2 (left, 400X) with a Ki-67/MIB-1 proliferation index of less than 2% (right, 400X).*

The patient then underwent a right hemicolectomy for intermittent obstructive bowel symptoms and intussusception due to the ileocecal mass. Gross dissection of the hemicolectomy specimen demonstrated a 2.5×2.3×2.3-cm pedunculated mass lesion arising from the mucosal surface of the terminal ileum (Figure 3A). Histologic evaluation of the mass revealed a well-differentiated neuroendocrine tumor (NET) (Figure 3B) with invasion into the muscularis propria. The tumor cells stained positive for synaptophysin, chromogranin and CDX-2 with a Ki-67/MIB-1 proliferation index of less than 2% (Figure 3C-D), consistent with a WHO low-grade, well-differentiated NET of the terminal ileum.

The patient's enlarged 3.5-cm inguinal soft tissue lesion suspected to be lymph node metastasis was also biopsied. Microscopic examination of the biopsy specimen showed a moderately cellular, low-grade spindle cell neoplasm with characteristic Verocay bodies, no mitoses and absent necrosis (Figure 4A-B). The tumor cells stained uniformly and strongly positive for S100 (Figure 4C) and Bcl-2 and negative for desmin and CD-34. Ki-67/MIB-1 staining showed a proliferation index of less than 5% (Figure 4D), consistent with a benign schwannoma.

Incidentally, sections from the appendix within the hemicolectomy specimen demonstrated circumferential sessile serrated adenoma/polyp (SSA/P) (Figure 5) located 1.4-cm from the appediceal tip, consistent with the FDG avidity (SUV_{max} 7.1) seen on FDG-PET (Figure 1D).

Discussion

Multiple primary cancer (MPC) occurring in a single patient is rare. The exact prevalence of patients diagnosed with at least two, non-metastatic, primary cancers remains unknown as reported prevalence rates vary considerably. Demandante

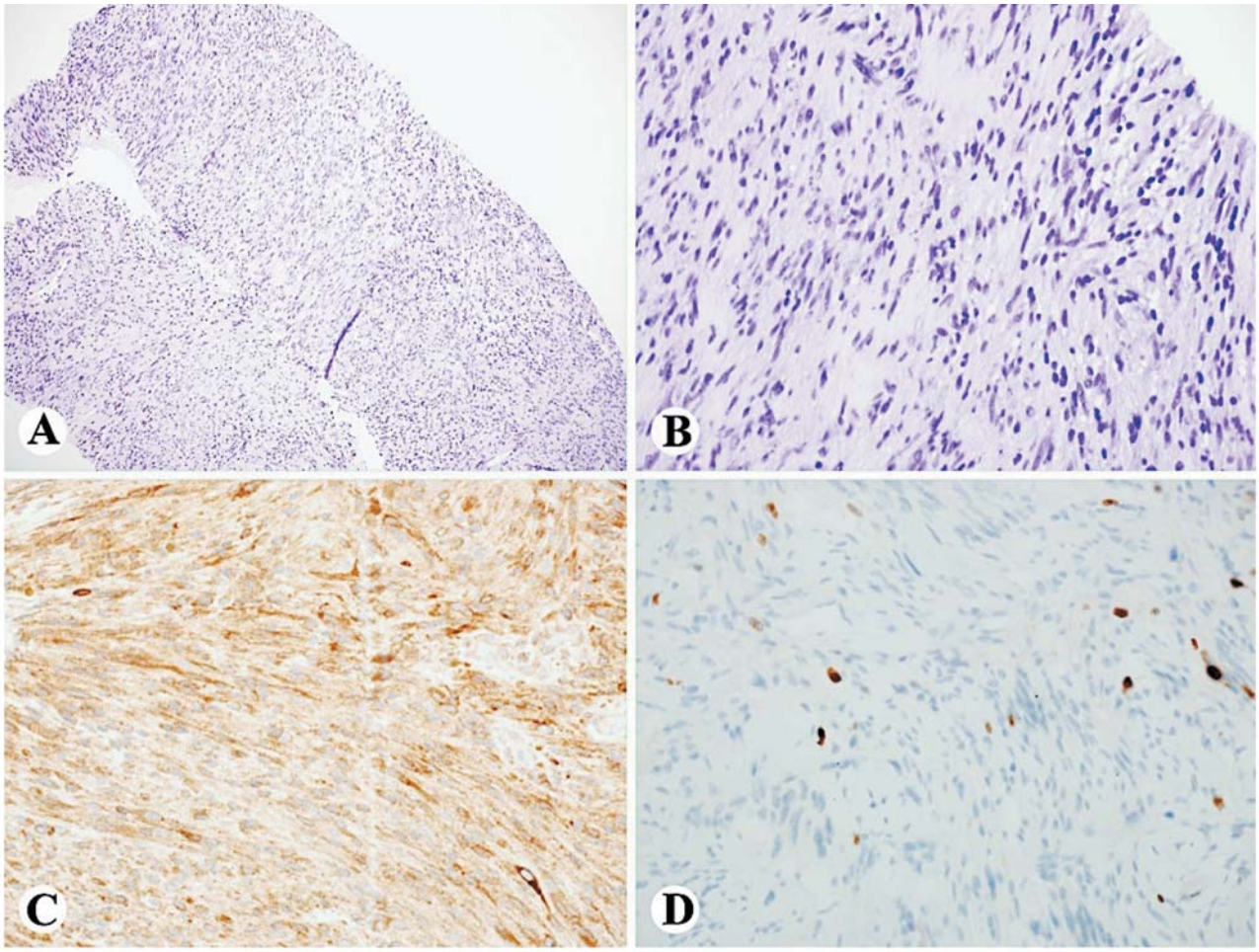

Figure 4. *Inguinal schwannoma. (A-B) The needle-core biopsy specimen shows a low-grade spindle cell neoplasm without necrosis (A, 100X) that contains bland, elongated spindle cells palisading around Verocay bodies with absent mitoses (B, 400X); (C) The tumor cells show diffuse and strong positivity for S100 (400X) with a (D) Ki-67/MIB-1 proliferation index of less than 5% (400X).*

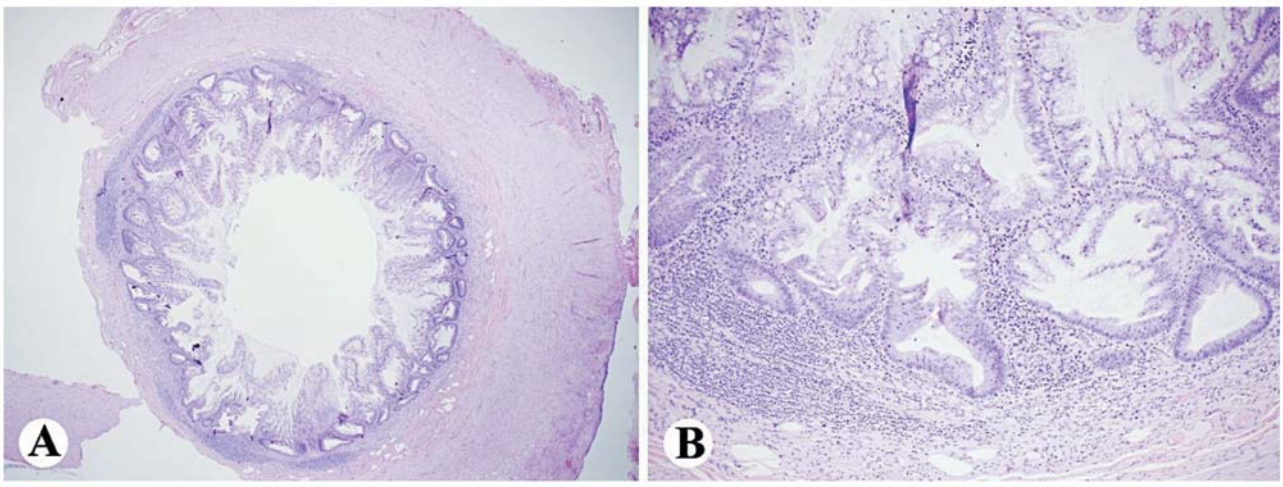

Figure 5. *Sessile serrated adenoma/polyp (SSA/P) of the appendix. (A) The appendiceal resection specimen shows a circumferential lesion located in the mid-appendix, 1.4-cm from the appendiceal tip (100X), which demonstrated (B) characteristic 'boot-shaped', horizontally branching basal crypt architecture (400X).*

et al. (4) performed a retrospective literature review of 1,104,229 cancer patients diagnosed from 1966-2000, which demonstrated the overall prevalence of multiple primary malignancies to be between 0.73% and 11.7%. Rosso *et al*. (9) performed an extensive analysis of 69 European cancer registries and discovered that of 2,919,023 patients diagnosed with one cancer, only 183,683 (6.3%) were diagnosed with at least one additional cancer. Moreover, other retrospective analyses found the prevalence of patients diagnosed with three or more primary tumors to be between 0.10-0.16% (9-10). The diagnosis of MPC in a single patient will likely become more common due to more sensitive diagnostic techniques, better access to care and an aging population.

MPC can be synchronous or metachronous depending on the time interval between their diagnoses. Synchronous tumors are defined as two or more primary neoplasms that are diagnosed simultaneously (3) or within 6 months of one another, while metachronous tumors are two or more primary neoplasms that are diagnosed at least 6 months apart (4). Epidemiologic data on synchronous cancers is scarce and based on small sample sizes. A retrospective analysis performed from 1981-2010 at a Turkish oncology center revealed that out of 130 MPC cases, 24 (18.4%) were synchronous, while 106 (81.6%) were metachronous (5). In the study, the authors investigated risk factor association with synchronous tumors. Their study revealed that patients with synchronous tumors were more often male, were more likely to be smokers and use alcohol and were more likely to have aerodigestive tumors of the head, neck, lung and upper esophagus. Other risk factors for MPC, whether metachronous or synchronous, include chemotherapy, radiation exposure, immunosuppression and undiagnosed hereditary cancer predisposition (11-12). Additionally, an analysis of 4,449 patients in the Minneapolis Veterans Affairs tumor registry from 2005-2009 showed that out of 506 patients diagnosed with two or more malignant cancers, 124 (24.3%) had synchronous malignancies (6).

Rare cases of triple synchronous primary neoplasms have been reported and often involve one organ system and have identifiable risk factors (13-19). However, only one case of synchronous quadruple primary cancer has been reported in the English literature. Kim *et al*. (20) described a novel case of synchronous quadruple primary cancers: papillary thyroid carcinoma, adenocarcinoma of the breast and pancreas and gastrointestinal stromal tumor (GIST) of the stomach.

Radiologic detection of synchronous neoplasms typically occurs when staging a biopsy-proven malignancy. Chen *et al*. (21) found FDG-PET/CT to have higher sensitivity (88.2%) in detecting synchronous cancers in patients with head and neck squamous cell carcinoma than conventional work-up (52.9%) with CT, barium swallow esophagram and panendoscopy. Kondo *et al*. (22) retrospectively reviewed 230 biopsy-proven head and neck cancer patient charts and found the diagnostic sensitivity of PET for detecting synchronous primary cancers varied with anatomic location of the non-index tumor: esophagus, 7.6%; stomach, 25.0%; lung, 66.7%; head and neck, 75.0%; colon, 0%; kidney, 0%; and subcutaneous, 100%. Several other studies have concluded the diagnostic sensitivity of FDG-PET or FDG-PET/CT is limited in detecting synchronous cancers and depends on anatomic site and histologic characteristics of the synchronous cancer (23-27).

FDG can accumulate at sites other than those with malignancies, such as salivary glands, lymphoid tissue, sites of local inflammation and within benign tumors (28). Interestingly, our patient's benign schwannoma had a discrepancy between the SUV_{max} 11.8 on FDG-PET (Figure 1C) and the Ki-67/MIB-1 proliferation index of less than 5%. Multiple studies concluded that increased FDG accumulation can be seen in schwannoma and is positively correlated with the age and size of the lesion, glucose transporter and vascular endothelial growth factor (VEGF) expression, microvascular density, vascular permeability and histologic cellularity (26, 29). Beaulieu *et al*. (29) found that, because schwannomas have a wide range of FDG uptake, there is no correlation between SUV_{max} and Ki-67 proliferation index.

SSA/Ps are high-risk, rapidly progressing, pre-malignant lesions that comprise 1.0-3.0% of all colorectal polyps (30) and 22% of serrated colorectal polyps (31) that have a predilection for the proximal colon (32). Appendiceal SSA/Ps are very rare. Yuyucu *et al*. (33) retrospectively reviewed 960 appendectomy specimens that demonstrated serrated morphology and found that 33 (3.4%) were classified as SSA/Ps according to WHO criteria. FDG-PET data has not previously been reported in SSA/P. Our patient's SSA/P demonstrated intense FDG uptake with SUV_{max} 7.1 (Figure 1D), likely attributable to its pre-malignant nature.

In conclusion, we report a unique cluster of synchronous tumors and possible association of glioblastoma, NET, schwannoma and SSA/P in a 70-year-old Arabic male with a history of prostate cancer and no identifiable environmental risk factors. Histologic, cytogenetic and immunohistochemical analyses confirmed each neoplastic lesion to be distinct from one another. When a patient is diagnosed with one malignancy, further radiologic work-up is strongly recommended not only for staging purposes but also to look for additional primary cancers. This is the first reported case of a quadruple synchronous presentation of glioblastoma, neuroendocrine tumor, schwannoma and sessile serrated adenoma.

References

1 Billroth T: Handbuch fur Studierende and Artze. Auflage;Die allgemeine chirurgische pathologie und therapie, 1889.

2 Warren S and Gates O: Multiple primary malignant tumors: a survey of the literature and a statistical study. Am J Cancer *16*: 1358-1414, 1932.

3 Koutsopoulos AV, Dambaki KI, Datseris G, Giannikaki E, Froudarakis M and Stathopoulos E: A novel combination of multiple primary carcinomas: urinary bladder transitional cell carcinoma, prostate adenocarcinoma and small cell lung carcinoma-a report of a case and review of the literature. World J Surg Oncol *3*: 51, 2005.
4 Demandante CG, Troyer DA and Miles TP: Multiple primary malignant neoplasms: case report and a comprehensive review of the literature. Am J Clin Oncol *26*: 79-83, 2003.
5 Arpaci E, Tokluoglu S, Yetigyigit T and Alkis N: Multiple primary malignancies-a retrospective analysis at a single center in Turkey. Asian Pac J Cancer Prev *14*: 769-773, 2013.
6 Powell S, Tarchand G, Rector T and Klein M: Synchronous and metachronous malignancies: analysis of the Minneapolis Veterans Affairs (VA) tumor registry. Cancer Causes Control *24*: 1565-1573, 2013.
7 Feyerabend T, Richter E and Brandt A: Multiple malignomas-an analysis of 352 patients. Strahlenther Onkol *167*: 214-219, 1991. Article in German.
8 Pinkel D and Albertson DG: Array comparative genomic hybridization and its applications in cancer. Nat Genet *37*. S11-S17. 2005.
9 Rosso S, De Angelis R, Ciccolallo L, Carrani E, Soerjomataram I, Grande E, Zigon G and Brenner H: Multiple primary malignancies: an epidemiological and pedigree analysis of 57 patients with at least three tumours. Eur J Surg Oncol *27(3)*: 302-313, 2001.
10 Salem A, Abu-Hijlih R, Abdelrahman F, Turfa R, Amarin R, Farah N, Sughayer M, Almousa A and Khader J: Multiple primary malignancies: analysis of 23 patients with at least three tumors. J Gastrointest Cancer *43*: 437-443, 2012.
11 Zorica M, Nikola T, Jasna B,Tijana S, Marko B, Dragana L, Zorka M, Gordana P, Sonja S, Vedrana M, Yasuhiro I and Radan D: Genetic alterations in quadruple malignancies of a patient with multiple sclerosis: their role in malignancy development and response to therapy. Int J Clin Exp Pathol *7(4)*: 1826-1833. 2014.
12 Angurana SL, Kapoor R, Kumar P, Khosla D, Kumar N, Sharma SC and Patel FD: Quadruple malignancy in a single patient: A case report and comprehensive review of literature. J Cancer Res Ther *6(2)*: 230-232. 2010.
13 Gatto A, Falvo L, Sebastiani S, Roncolini G and Pinna G: Triple synchronous tumours of the urinary system with different histologies: a case report. Chir Ital *61*: 381-385, 2009.
14 Chong VH, Idros A and Telisinghe PU: Triple synchronous gastrointestinal malignancies: a rare occurrence. Singapore Med J *51*: 176-177, 2010.
15 Hale CS, Lee L and Mittal K: Triple synchronous primary gynecologic carcinomas: a case report and review of the literature. Int J Surg Pathol *19*: 552-555, 2011.
16 Schottenfeld D, Gantt RC, and Wyner EL: The role of alcohol and tobacco in multiple primary cancers of the upper digestive system, larynx and lung: a prospective study. Prev Med *3*: 277-293, 1974.
17 Fukaya M, Abe T, Yokoyama Y, Itatsu K and Nagino M: Two-stage operation for synchronous triple primary cancer of the esophagus, stomach, and ampulla of Vater: report of a case. Surg Today *44*: 967-971, 2014.
18 Yeh CC, Hsi SC, Chuu CP and Kao YH: Synchronous triple carcinoma of the colon and rectum. World J Surg Oncol *11*: 66, 2013.
19 Yoon HJ, Lee HY, Han J and Choi YL: Synchronous triple primary lung cancers: a case report. Korean J Radiol *15*: 646-650, 2014.
20 Kim JS, Chung CY, Park HC, Myung DS, Cho SB, Lee WS, Min JJ and Joo YE: Synchronous quadruple primary tumors of thyroid, breast, pancreas and stomach: a case report. Anticancer Res *33*: 2135-2138, 2014.
21 Chen SH, Chan SC, Chao YK and Yen TC: Detection of synchronous cancers by fluorodeoxyglucose positron emission tomography/computed tomography during primary staging workup for esophageal squamous cell carcinoma in Taiwan. PLoS One *8*: e82812, 2013.
22 Kondo N, Tsukuda M and Nishimura G: Diagnostic sensitivity of 18fluorodeoxyglucose positron emission tomography for detecting synchronous multiple primary cancers in head and neck cancer patients. Eur Arch Otorhinolaryngol *269*: 1503-1507, 2012.
23 Stokkel MP, Moons KG, ten Broek FW, van Rijk PP and Hordijk GJ: 18F-fluorodeoxyglucose dual-head positron emission tomography as a procedure for detecting simultaneous primary tumors in cases of head and neck cancer. Cancer *86(11)*: 2370- 2377, 1999.
24 Nishiyama Y, Yamamoto Y and Yokoe K: FDG PET as a procedure for detecting simultaneous tumours in head and neck cancer patients. Nucl Med Commun *26(3)*: 239- 244, 2005.
25 Suzuki H, Hasegawa Y, Terada A, Ogawa T, Hyodo I, Suzuki M, Nakashima T, Tamaki T and Nishio M: Limitations of FDG-PET and FDG-PET with computed tomography for detecting synchronous cancer in pharyngeal cancer. Arch Otolaryngol Head Neck Surg *134*: 1191-1195, 2008.
26 Hamada K, Tomita Y, Qiu Y, Tomoeda M, Ueda T, Tamai N, Hashimoto N, Yoshikawa H, Aozasa K and Hatazawa J: (18)F-FDG PET analysis of schwannoma: increase of SUV_{max} in the delayed scan is correlated with elevated VEGF/VPF expression in the tumors. Skeletal Radiol 38(3): 261-266, 2009.
27 Yabuki K, Kubota A, Horiuchi C, Taguchi T, Nishimura G and Inamori M: Limitations of PET and PET/CT in detecting upper gastrointestinal synchronous cancer in patients with head and neck carcinoma. Eur Arch Otorhinolaryngol *270(2)*: 727-733, 2013.
28 Fletcher JW, Djulbegovic B, Soares HP, Siegel BA, Lowe VJ, Lyman GH, Coleman RE, Wahl R, Paschold JC, Avril N, Einhorn LH, Suh WW, Samson D, Delbeke D, Gorman M and Shields AF: Recommendations on the use of 18F-FDG PET in oncology. J Nucl Med *49*: 480-508, 2008.
29 Beaulieu S, Rubin B, Djang D, Conrad E, Turcotte E and Eary JF: Positron emission tomography of schwannomas: emphasizing its potential in preoperative planning. Am J Roentgenol *182*: 971-974, 2004.
30 Qiu Y, Fu X, Zhang W, Xu Y, Xiao L, Chen X, Shi L, Zhou X, Xia G, Peng Y and Deng M: Prevalence and molecular characterization of the sessile serrated adenoma in a subset of the Chinese population. J Clin Pathol *67(6)*: 491-498, 2014.
31 Spring KJ, Zhao ZZ, Karamatic R, Walsh MD, Whitehall VL, Pike T, Simms LA, Young J, James M, Montgomery GW, Appleyard M, Hewett D, Togashi K, Jass JR and Leggett BA: High prevalence of sessile serrated adenomas with BRAF mutations: a prospective study of patients undergoing colonoscopy. Gastroenterology *131(5)*: 1400-1407, 2006.
32 Fu X, Qiu Y and Zhang Y: Screening, management and surveillance for the sessile serrated adenomas/polyps. Int J Clin Exp Pathol *7(4)*: 1275-1285, 2014.
33 Yuyucu Y, Savaş B, Kurşun N and Ensar A: Serrated lesions of the appendix: do they differ from their colorectal counterparts? Turk J Gastroenterol *25(1)*: 29-34. 2014.

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