J Anesth (2010) 24:134–138
DOI 10.1007/s00540-009-0835-3

CLINICAL REPORT

# Successful use of spinal anesthesia in a patient with severe Klippel–Trénaunay syndrome associated with upper airway abnormalities and chronic Kasabach–Merritt coagulopathy

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Received: 2 July 2009 / Accepted: 20 August 2009 / Published online: 7 January 2010


**Abstract** Klippel–Trénaunay syndrome is a rare disorder characterized by the triad of capillary or cavernous hemangiomas, venous varicosities or malformations, and soft tissue or bone hypertrophy. Neuraxial anesthesia in patients with Klippel–Trénaunay syndrome has been infrequently described and has not been previously reported when accompanied by consumptive coagulopathy with thrombocytopenia (Kasabach–Merritt syndrome). The authors describe their clinical management of a 23 year-old woman with Klippel–Trénaunay syndrome who presented for elective total knee arthroplasty. Her past medical history was notable for chronic Kasabach–Merritt syndrome, hypersplenism with pancytopenia, and intermittent lower gastrointestinal bleeding resulting from colonic hemangiomas. The physical examination revealed several large cavernous hemangiomas located on her right face, neck, chest, arm, and leg. No hemangiomas were noted within the dermatomal levels innervated by the upper lumbar spine. The neck hemangioma was very large and filled with blood when the patient assumed a supine position, making it almost impossible for her to breathe. The oropharynx revealed markedly hypertrophied soft tissue, pharyngeal, and hypopharyngeal hemangiomas, and a Mallampati class IV airway. Spinal and epidural hemangiomas were excluded based on a magnetic resonance imaging study before surgery. Kasabach–Merritt coagulopathy was corrected preoperatively by administration of cryoprecipitate. These interventions allowed the authors to safely perform a spinal anesthetic for the operation. The current case illustrates that major conduction anesthesia may be safely performed in patients with Klippel–Trénaunay disease provided that preoperative imaging studies exclude neurovascular involvement and coexisting coagulopathy is appropriately corrected.

**Keywords** Klippel–Trénaunay syndrome · Kasabach–Merritt syndrome · Disseminated intravascular coagulation · Cavernous hemangioma · Spinal anesthesia

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## Introduction

Klippel–Trénaunay syndrome is a rare vascular disorder characterized by the triad of capillary abnormalities (e.g., flat or cavernous hemangioma, "port wine" staining), venous varicosities or malformations, and soft tissue or bone hypertrophy [1–6]. Klippel–Trénaunay syndrome is most often unilateral and confined to a lower extremity, but a small minority of severelyaffected patients may have widely disseminated, bilateral disease [3]. The incidence of Klippel–Trénaunay syndrome has been estimated to range between 0.0025% and 0.005% of live births [5]. The absence of major arterial-venous malformations and shunting with or without congestive heart failure differentiates Klippel–Trénaunay syndrome from Parkes-Weber syndrome [7]. Imprecise clinical definitions of these two related, yet distinct, disorders previously led to their strictly incorrect combined description as "Klippel–Trénaunay–Weber" syndrome [6]. The vascular manifestations of Klippel–Trénaunay syndrome are remarkably diverse and may include mixed capillary, lymphatic, and venous malformations [4], deep venous abnormalities (e.g., venous

hypoplasia, valvular insufficiency, aneurysmal dilation), arterial-venous microfistulas [2], and facial or visceral hemangiomas [3] concomitant with thrombosis, Kasabach–Merritt syndrome (consumptive coagulopathy with thrombocytopenia), or frank disseminated intravascular coagulation [4]. Visceral hemangiomas may produce life-threatening hemorrhage from the gastrointestinal tract [8] or the genitourinary system [9], especially in the presence of coagulation abnormalities. Important neurovascular consequences of Klippel–Trénaunay syndrome have also been reported [10], and the possibility of needle trauma to hemangiomas within or adjacent to the spinal canal, combined with the potential for coagulopathy, has substantially limited the use of neuraxial anesthesia and analgesia in patients with this disorder [11, 12]. In the present report, the authors describe the successful use of spinal anesthesia in a young woman with severe Klippel–Trénaunay syndrome complicated by upper airway abnormalities and Kasabach–Merritt coagulopathy undergoing orthopedic surgery. Spinal and epidural hemangiomas were excluded based on a magnetic resonance imaging (MRI) study before surgery, and Kasabach–Merritt coagulopathy was corrected preoperatively by administration of cryoprecipitate. These diagnostic and therapeutic interventions allowed the authors to safely perform major conduction anesthesia for the operation.

## Case report

A 23 year-old, 150 cm, 57 kg woman with a history of Klippel–Trénaunay syndrome presented to our institution for an elective right total knee arthroplasty. The patient's surgeon reported that cavernous hemangiomas within the knee joint had caused repeated episodes of intraarticular hemorrhage and contributed to the development of severe degenerative arthritis accompanied by intractable pain. Soft tissue and bone hypertrophy, as well as venous varicosities and stasis in the right lower extremity, also contributed to a loss of joint mobility. The patient described a history of mild residual left hemiparesis (which put additional chronic stress on her right knee) and a seizure disorder (treated with carbamazepine) because of a large, right hemispheric, neonatal cerebrovascular accident. As a result of these infirmities, she was no longer able to ambulate and was confined to a wheelchair. The past medical history was notable for the presence of Kasabach–Merritt syndrome, hypersplenism with pancytopenia, and intermittent lower gastrointestinal bleeding resulting from colonic hemangiomas. The physical examination revealed several large, well-demarcated cavernous hemangiomas located on her right face, neck, chest, arm, and leg. There were no hemangiomas adjacent to, overlying, or located within the dermatomal levels innervated by the upper lumbar spine. The neck hemangioma was very large, extended across the midline, substantially limited flexion and extension of the neck in the upright position, and prevented quantification of thyromental distance. The patient reported that she slept in a semirecumbent position because the face and neck hemangiomas filled with blood when she assumed a supine position, making it almost impossible for her to breathe. Inspection of the oropharynx revealed markedly hypertrophied soft tissue, hemangiomas in the pharynx and hypopharynx, and a Mallampati class IV view of the airway. Examination of the heart and lungs was unremarkable.

Laboratory analysis revealed anemia (hemoglobin concentration = 10.8 g/dL), leukopenia (white blood cell count = 3.2 K/μL; normal 4.5–11.0 K/μL), and thrombocytopenia (platelet count = 122 K/μL; normal 150–450 K/μL;). The prothrombin time was mildly elevated (14.1 s; normal 11.5–13.5 s), the plasma fibrinogen concentration was substantially reduced (72 mg/dL; normal 190–320 mg/dL), and fibrin degradation products were present (>40 μg/mL; normal < 10 μg/mL) concomitant with D-dimer formation (>4 μg/mL; normal < 1 μg/mL). Plasma concentrations of factors V and VII were 77% and 80% of normal values, respectively. A chest radiograph demonstrated multiple calcific densities in the right neck, axilla, and upper thorax consistent with overlying hemangiomas. A computed tomographic (CT) scan of the head revealed marked right cerebral hemiatrophy and porencephaly resulting from the neonatal cerebrovascular accident. An MRI study of the lumbosacral spine showed osseous hypertrophy of the vertebrae, but hemangiomas within the spinal canal or the soft tissues of the back were absent.

The patient received 10 U of cryoprecipitate before surgery, which corrected the prothrombin time (13.4 s) and increased the plasma fibrinogen concentration (133 mg/dL). She was then transported to the operating room. A left radial arterial catheter was inserted, using local anesthesia and intravenous conscious sedation (midazolam 1 mg and fentanyl 50 μg). After the patient's coagulation status had been improved, the authors proceeded with a spinal anesthetic in lieu of providing general endotracheal anesthesia, because of the aforementioned airway concerns. If spinal anesthesia had become insufficient due to prolonged operative time, the authors planned to convert to general anesthesia using a carefully inserted laryngeal mask airway (LMA) with or without fiberoptic endotracheal intubation through the device. The presence of osseous hypertrophy of the lumbar vertebrae made entry into the subarachnoid space somewhat difficult, but this task was accomplished in the midline $L_2$–$L_3$ interspace using a 25 g Quincke needle with the patient in sitting position. Clear cerebral spinal fluid was obtained, hyperbaric tetracaine (10 mg) was administered, and a $T_8$ subarachnoid block was established. The patient was placed in a semirecumbent position for the

operation. Intravenous midazolam and fentanyl were used to provide conscious sedation. A lower extremity tourniquet was not used during surgery to avoid injury to the cavernous hemangiomas of the right thigh. The surgeon reported that the knee joint contained several invaginating soft tissue hemangiomas that extended into the articular surfaces. Substantial bleeding was encountered (approximately 1600 ml during the 2 h procedure) and frequent use of electrocautery and topical thrombin was required for hemostasis, but the patient remained hemodynamically stable during the procedure. Intraoperative coagulation studies were obtained at regular intervals. Prothrombin time increased to a maximum of 15.7 s and fibrinogen decreased to a nadir of 108 mg/dL, but the platelet count remained unchanged (120 K/μL). The patient was transfused with three units of packed red blood cells and 10 units of cryoprecipitate during surgery. The surgeon completed the arthroplasty without difficulty, and the patient was transferred to the recovery room in stable condition. Her postoperative course was uneventful.

## Discussion

The causes and pathogenesis of Klippel–Trénaunay syndrome are unclear despite extensive study. Several potential mechanisms have been proposed, but, to date, none of these hypotheses is able to explain all of the clinical and histopathological features of Klippel–Trénaunay syndrome [6]. Early theories focused on active or passive hyperemia to affected areas as causative factors for Klippel–Trénaunay syndrome through reduced congenital autonomic nervous system regulation of capillary blood flow in the dermatomal distribution of spinal nerves, enhanced vasculogenesis during embryonic development, or abnormal deep vein development or function. A sporadically expressed, congenital defect of mesoderm that contributes to abnormal angiogenesis, microscopic arterial-venous malformations, and chronically enhanced blood flow has also been postulated [2]. More recently, polygenic theories of Klippel–Trénaunay syndrome characterized by paradominant inheritance or somatic mosaicism have also been proposed [13, 14].

Regardless of the precise mechanism(s) responsible for the present patient's Klippel–Trénaunay syndrome, it was very clear, based on her history and clinical presentation, that she was severely affected by the disease. Two major issues affected her anesthetic management. The presence of soft tissue hypertrophy and hemangiomatous disease in the mouth and hypopharynx concomitant with a large neck cavernous hemangioma that produced near-total airway collapse in the supine position strongly suggested that direct laryngoscopy and endotracheal intubation may be very difficult. However, the authors were confident that her airway could be safely secured using fiberoptic laryngoscopy, a videolaryngoscope, or an intubating LMA. The history of chronic Kasabach–Merritt coagulopathy provided an additional anesthetic challenge because of its potential implications for the use of neuraxial anesthesia. In fact, the use of major conduction anesthesia in patients with Klippel–Trénaunay syndrome has been infrequently described independent of coagulopathy. A dermatomal relationship between cutaneous hemangiomas and neuraxial vascular anomalies has been previously reported in patients with Klippel–Trénaunay syndrome [10, 15]. As a result, de Leon-Casasola and Lema initially recommended against the use of spinal or epidural anesthesia because the resultant trauma may precipitate the formation of a hematoma concomitant with cord compression and acute neurological deficits [11]. Indeed, Eastwood [16] reported such an unfortunate complication in a patient with suspected Klippel–Trénaunay syndrome who developed a hematoma after an epidural anesthetic [17]. In contrast, Gaiser et al. [12] first described the successful use of combined spinal-epidural anesthesia for a woman with Klippel–Trénaunay syndrome undergoing a Cesarean section after a lumbosacral MRI study excluded arterial-venous malformations or hemangiomas immediately adjacent to and within the spinal canal. Neuraxial anesthesia was expressly avoided in another parturient with Klippel–Trénaunay syndrome undergoing Cesarean delivery because preoperative imaging of the spine had not been performed [18]. Dobbs et al. [19] reported the use of epidural analgesia in a laboring parturient with Klippel–Trénaunay syndrome in whom serial MRI scans had been performed in the months before the induction of labor. Further, Christie et al. [20] described the use of combined spinal-epidural in a Klippel–Trénaunay patient undergoing reconstructive lower extremity surgery after a contrast-enhanced CT scan excluded hemangiomatous disease and major arterial-venous malformations within the lumbosacral spine.

Similar to the findings in these previous reports [12, 19, 20], an MRI study of the present patient's spine demonstrated the absence of neurovascular abnormalities, thereby suggesting that major conduction anesthesia was a feasible option in this patient with an anticipated difficult airway. However, unlike the previously described patients [12, 18–20], Kasabach–Merritt syndrome was also observed in the present patient. Thus, the use of a neuraxial anesthetic technique may have been relatively contraindicated if the coagulation defects had not been substantially corrected before surgery. The authors chose to perform a spinal, and not an epidural, anesthetic to minimize potential injury to small, occult hemangiomas within the soft tissue or spinal canal that had not been previously identified in the MRI study. Kasabach–Merritt

coagulopathy occurs in fewer than 0.3% of neonates with hemangiomatous disease, but the disorder may be associated with a mortality rate approaching 40% from uncontrollable bleeding [21]. Notably, the development of Kasabach–Merritt coagulopathy cannot be reliably predicted based on the relative size and location of neonatal hemangiomas during the neonatal period [21, 22]. As many as 45% of patients with Klippel–Trénaunay syndrome may be afflicted by Kasabach–Merritt syndrome [3], and episodes of acute [23] or chronic [22] disseminated intravascular coagulation have been described in the literature. Indeed, the present patient with Klippel–Trénaunay syndrome and multiple cutaneous and visceral cavernous hemangiomas demonstrated convincing laboratory evidence of a chronic consumptive coagulopathy. She had previously sustained an intracerebral hemorrhage during infancy and also suffered from intermittent lower gastrointestinal bleeding as a result of cerebral and colonic hemangiomas, respectively.

The pathophysiology responsible for Kasabach–Merritt syndrome remains unclear, but proliferating vascular endothelium has been proposed to "trap" platelets, thereby aggregating and activating platelets within the hemangioma [24]. Platelets may also be exposed to subendothelial collagen between abnormal hemangioma endothelial cells, further contributing to this platelet activation and producing secondary consumption of coagulation factors [22]. Kaposiform hemangioendothelioma (a malignant neoplasm) and tufted angioma (a benign tumor) are the most common histopathological vascular anomalies associated with Kasabach–Merritt syndrome, but these abnormalities were absent in the present patient with Klippel–Trénaunay syndrome and cavernous hemangiomatous disease. Replacement of depleted clotting factors using fresh-frozen plasma has been recommended in patients with Kasabach–Merritt coagulopathy and elevated prothrombin or partial thromboplastin time before surgery [22]. As observed in the present patient, marked hypofibrinogenemia may necessitate the administration of cryoprecipitate in lieu of fresh-frozen plasma to correct the underlying coagulopathy. The administration of recombinant activated factor VII in a child with Kasabach–Merritt syndrome undergoing major surgery was also recently reported [25], but the plasma concentration of factor VII was only modestly reduced and this strategy was not required in the present patient.

In summary, the authors describe the successful use of spinal anesthesia in a patient with severe Klippel–Trénaunay syndrome with upper airway involvement and a chronic consumptive coagulopathy. The management of this patient required careful consideration of the risks of hemangiomatous disease and soft tissue hypertrophy in the mouth, hypopharynx, and neck, the potential for neuraxial hemangiomas, and the presence of relatively refractory hypofibrinogenemia. The present case illustrates that major conduction anesthesia may be safely performed in patients with Klippel–Trénaunay disease provided that preoperative imaging studies exclude neurovascular involvement and coexisting coagulopathy is appropriately corrected.

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