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CASE REPORT

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An ultrasound-guided modified iliac fascia and sacral plexus block application in a critically ill patient undergoing artificial femoral head replacement surgery: a case report

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Abstract

Background Hip fractures have become a significant clinical concern on a global scale in recent years. The burgeoning aging population has exacerbated this issue, leading to a rise in the number of hip fracture cases coupled with concomitant geriatric ailments. Therefore, it poses a huge challenge to anesthesiologists with the increasing number of critically ill patients who are not suitable for general anesthesia and intrathecal anesthesia. Ultrasound-guided nerve blocks combined with sedation have not previously been documented in critically ill patients.

Case presentation We administered an ultrasound-guided modified iliac fascia block combined with sacral plexus block to an 88-year-old male patient with a left femoral fracture suffering from severe multi-systemic diseases. Concurrently, the patient received intravenous anesthesia via propofol and dexmedetomidine, with monitoring conducted through bispectral index. Subsequently, the surgery was completed smoothly and the patient demonstrated accelerated postoperative recovery without significant discomfort and a successful discharge.

Conclusions This innovative approach significantly contributed to achieving successful surgical anesthesia and postoperative analgesia, thereby facilitating early recovery and discharge from the hospital. We propose that ultrasound-guided nerve blocks with sedation show promise for critically ill patients.

Keywords Nerve block, Pain management, Ultrasonography, Analgesia, Case report

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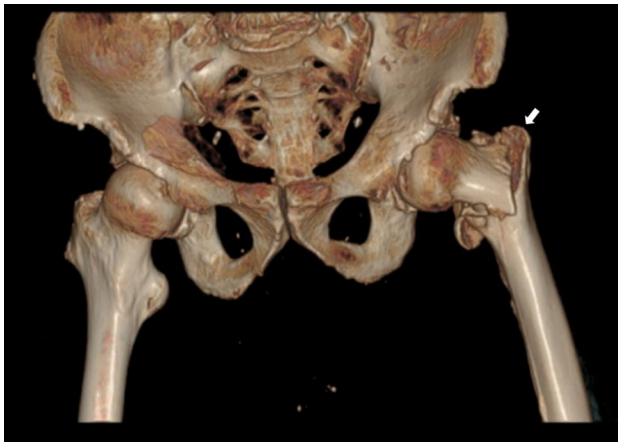

Fig. 1 CT 3-D reconstruction of hip joint for left femoral neck fracture

Table 1 List of drugs before hospitalization

	Drugs	Dose	Frequency	Route
Medication	Losartan Potassium Tablets	50 mg	Q.D.	Orally
	Levofloxacin Tablets	0.5 g	Q.D.	Orally

Background

General anesthesia and intrathecal anesthesia are the two main anesthetic options for artificial femoral head replacement surgery [1]. While ultrasound-guided nerve block [2] has emerged as a well-established technique for postoperative analgesia [3], its efficacy as a sole anesthetic for the entire procedure remains to be fully explored through clinical practice.

In comparison to general anesthesia, ultrasound-guided nerve block ensures stable hemodynamics during surgery owing to its minimal impact on the circulatory and respiratory systems. Furthermore, when juxtaposed with intrathecal anesthesia, ultrasound-guided nerve block diminishes the necessity for coagulation management [4, 5]. Additionally, nerve blocks offer superior analgesic effects, heightened patient satisfaction [6], fewer hemodynamic fluctuations [7], and reduced perioperative complications [6]. Considering these advantages, ultrasound-guided nerve block emerges as a compelling alternative anesthetic technique, especially for patients confronting challenging circumstances, such as severe underlying conditions and multiple comorbidities.

Case presentation

An 88-year-old male patient presented with a left femoral fracture (Fig. 1), requiring an artificial femoral head replacement surgery. It took more than 20 days until the patient was admitted to a hospital, due to initial rejection by other hospitals. In the setting of an extensive medical history including controlled hypertension, coronary artery disease, old cerebral infarction, and Alzheimer's disease (medication before hospitalization in Table 1), the delayed hospitalization exacerbated the patient's

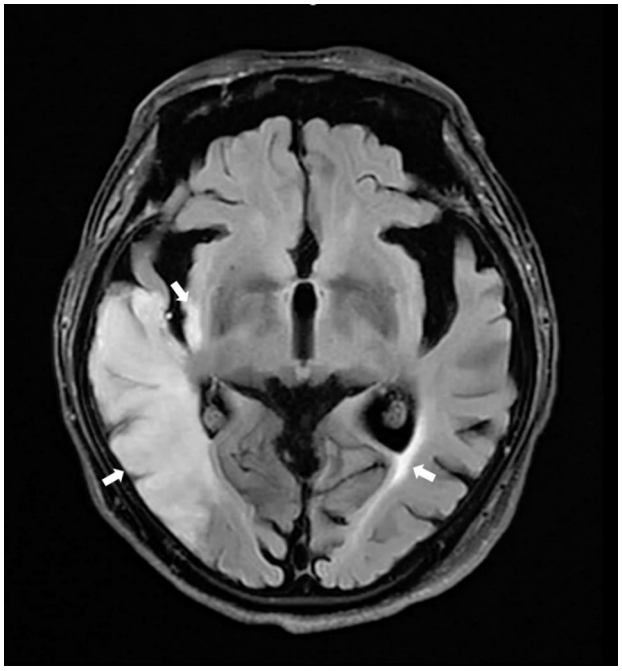

Fig. 2 Cranial MRI: Acute phase infarction of the right parietal, occipital, and temporal lobes with multiple intracranial infarctions

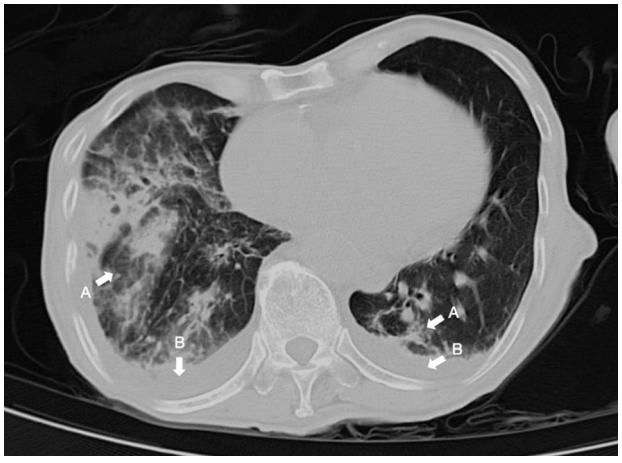

Fig. 3 Chest CT: A: Scattered exudation in both lungs; B: Bilateral pleural effusion

condition significantly. Upon presentation, the patient exhibited signs of heart failure, with an elevated brain natriuretic peptide (BNP) level of 878.0 pg/mL, as well as severe hypoalbuminemia with an albumin level of 27.2 g/L. Meanwhile, imaging revealed a new large area cerebral infarction (Fig. 2), severe pulmonary infection (Fig. 3), bilateral pleural effusion (Fig. 3), and coagulation disorder, characterized by an activated partial thromboplastin time (APTT) of 36.9s and a D-Dimer level of 2.97ug/ml. Notably, the patient failed to recover from pneumonia, progressing rapidly to acute respiratory distress syndrome with a peripheral capillary oxygen

saturation (SpO2) of 88% despite that the elder patient used a regular nasal cannula receiving oxygen therapy through the hospital's central oxygen supply system at a flow rate of 3 ml/min. Prolonged immobilization due to the fracture contributed to the development of hypostatic pneumonia and other complications, impeding his overall recovery. Following a comprehensive assessment, the patient was classified as frail according to the Fatigue, Resistance, Ambulation, Illness, and Loss of Weight (FRAIL) Index [8], and was assigned New York Heart Association (NYHA) functional class IV status.

Surgical treatment was the best choice for the patient after multidisciplinary consultations. Upon admission into the operating room, the elderly patient was applied standard monitoring [9]. His anthropometric measurements revealed a height of 165 cm and a weight of 65 kg, resulting in a body mass index (BMI) of 23.87 kg/cm^2. Baseline vitals were as follows: a heart rate of 72 beats per minute (bpm), arterial blood pressure reading at 239/76 mmHg, and a SpO2 of 93% on ambient air. Supplemental oxygen at a rate of 5 L per minute via nasal catheter was subsequently administered, resulting in the attainment of a SpO_2 level of 100%. Following initial stabilization, central intravenous and radial arterial lines were established, followed by a comprehensive blood gas analysis which revealed arterial partial pressure of oxygen (PO_2) at 132 mmHg, partial pressure of carbon dioxide (PCO_2) at 45.6 mmHg, and hemoglobin (Hb) concentration of 98 g/L, with no other significant abnormalities noted.

After adequate preparations, we decided to implement a modified iliac fascia and sacral plexus block directly under ultrasound vision (Mindray Bio-medical electronics Co., Ltd., Model: ME 8P). The patient was positioned supine with the affected lower limb slightly abducted. High-frequency (11.0 MHz) linear ultrasound probe was placed parallel to the inguinal ligament, and high echogenicity of the fascia lata, iliac fascia, and iliopsoas muscle could be seen under ultrasound (Fig. 4). Subsequently, a mixture of 0.25% ropivacaine and 1% lidocaine (including 50 mg ropivacaine and 200 mg lidocaine) totaling 20 mL was injected into the designated anatomical gap using a short-axis out-of-plane technique, targeting the femoral nerve within the lateral sheath under the iliac fascia, with injection directed cephalad. Following this, the patient was repositioned laterally. The convex array probe (6.0 MHz) was placed at the level of the lower edge of the medial 1/2 part of the line between the midpoint of the greater trochanter of the femur and the posterior superior iliac spine and the line of the posterior superior iliac spine, at which point the ultrasound image was linear and hyperechoic (for the iliac bone) (Fig. 5). We could gradually see the greater sciatic foramen in which the sacral plexus nerve was highlighted with the probe sliding inward and downward. The injection point was on the tail side near the greater sciatic foramen above the iliac bone, with the needle inserted out of the short axis plane and the needle tip beveled downwards. The same concentration and dosage of local anesthetics were

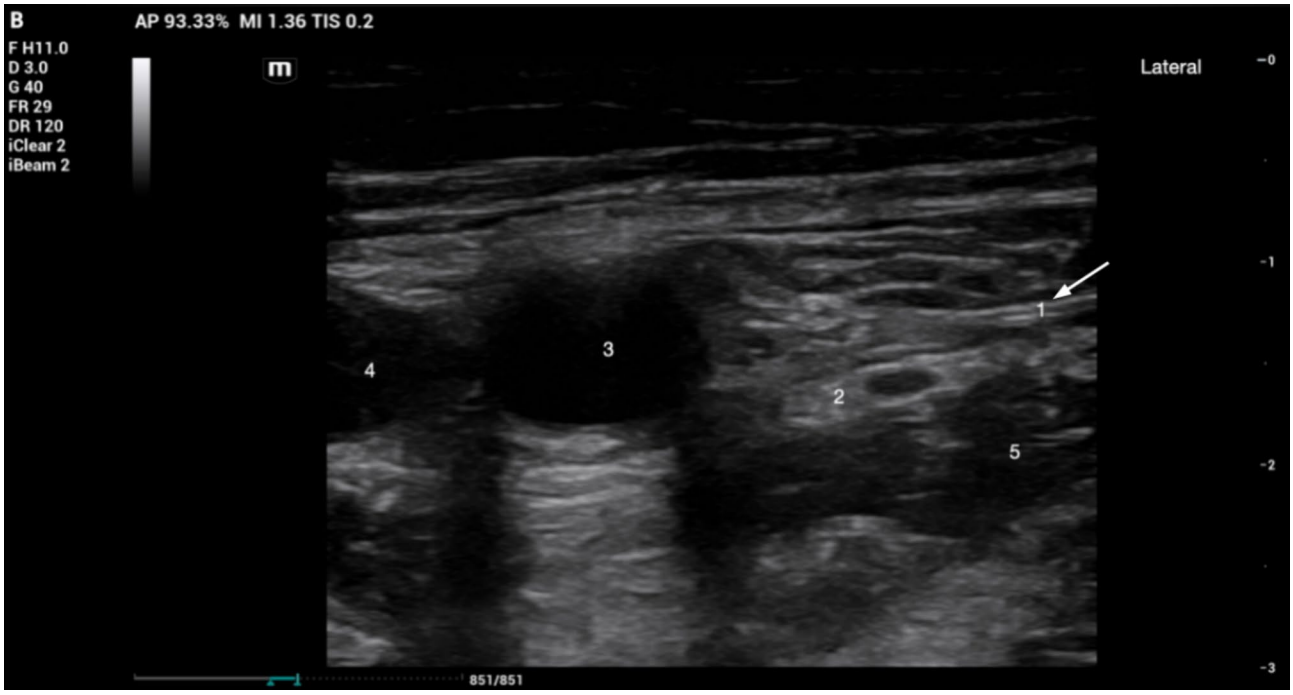

Fig. 4 Modified iliac fascia block. The block needle was advanced in the direction of the arrow and reached the tip. 1-Iliac fascia; 2-Femoral nerve; 3-Femoral artery; 4-Femoral vein; 5-Iliopsoas muscle

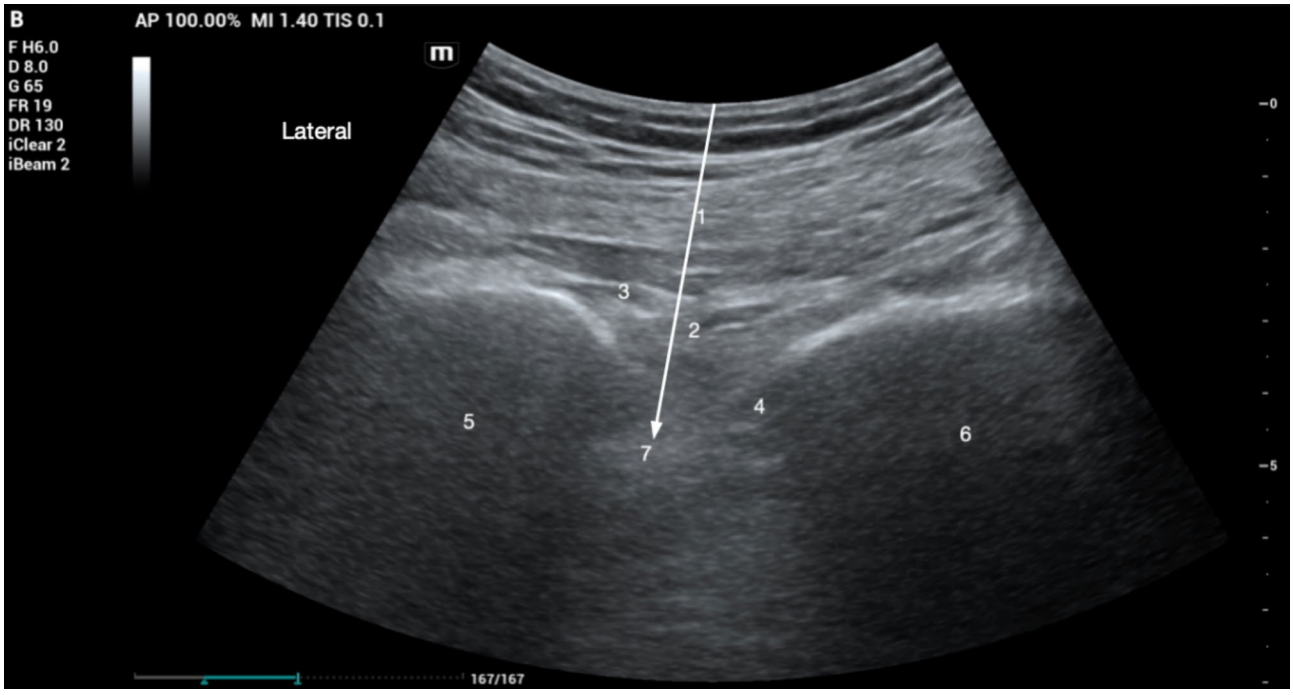

Fig. 5 Sacaral plexus block via short axis approach. The block needle was advanced in the direction of the arrow and reached the tip. 1-Gluteus maximus muscle; 2-Piriform muscle; 3-Superior gluteal artery; 4-Inferior gluteal artery; 5-Iliac bone; 6-Sacrum; 7-Lumbosacral plexus

administered via the described technique. Fifteen minutes post-administration, sensory and motor blockade of the targeted nerve territories were confirmed through cutaneous stimulation, without observed adverse effects. Subsequently, the elderly patient was induced into a state of sedoanalgesia with a loading dose of dexmedetomidine (1 μg/kg) administered for 10 min, followed by a maintenance infusion at a rate of 0.4 μg/kg/h, in conjunction with propofol at 1 mg/kg/h to maintain bispectral index (BIS) at approximately 60. Surgical intervention commenced five minutes after the attainment of unconsciousness.

Throughout the whole surgical procedure, the patient received intravenous fluids totaling 600mL of crystalloid solution, including 500mL of sodium lactate Ringer's solution (Baxter, Baxter Healthcare Co., Ltd.) and 100mL of 0.9% Sodium Chloride, 500 ml of hydroxyethyl starch (Voluven, Fresenius Kabi Pharmaceutical Co., Ltd.), 2 units of plasma, and 50 ml of autologous blood transfusion based on the patient's preoperative debility. Intraoperative vital signs remained within satisfactory limits, with the heart rate predominantly ranging between 70 and 80 bpm, invasive blood pressure averaging around 180/80mmHg, SpO_2 maintained between 99 and 100% with supplemental oxygen and respiratory rate recorded at 10–12 breaths per minute. Overall, intraoperative hemodynamic stability was achieved. The surgical procedure concluded successfully after approximately 1.5 h under the aforementioned stable conditions, following which the patient was transferred to the post-anesthesia care unit (PACU). Within three minutes in PACU, the patient regained consciousness in a calm and orderly manner facilitated by reasonable pharmacological management during the surgical intervention. Postoperative blood gas analysis demonstrated arterial PO_2 at 228mmHg, PCO_2 at 38.7mmHg, and Hb concentration at 77 g/L. Furthermore, the patient was provided with a patient-controlled analgesia pump delivering a solution comprising 100 μg of sufentanil and 10 mg of tropisetron, with a background infusion rate of 1.5mL, a single bolus dose of 1.5mL, and a 15-minute lockout interval. The elder patient's consciousness level could basically restore to the preoperative state, with the GCS score measured as 3 points for Eye opening, 4 points for Verbal response, 5 points for Motor response, totaling 12 points, classified as mild, based on which a postoperative Visual Analog Scale (VAS) score of 2 points was recorded eight hours after the surgical procedure. Ultimately, the patient demonstrated accelerated postoperative recovery without significant discomfort, leading to a successful discharge.

Discussion and conclusions

With the trend of aging population leading to a significant increase in elderly critically ill patients, anesthesiologists will face unprecedented challenges. Traditional general anesthesia or intrathecal anesthesia is often not the optimal anesthesia strategy for such patients. Therefore, it is necessary to achieve diversification of anesthesia

technology to adapt to the continuous increase in critically ill patients and the increasing maturity of surgical techniques.

In this case, the elderly patient presented with pronounced frailty compounded by a spectrum of comorbidities including hypertension, coronary artery disease, acute heart failure, old cerebral infarction, Alzheimer's disease, and coagulopathy. Traditional anesthetics and analgesics frequently utilized in general anesthesia possess potent cardiodepressive properties, potentially leading to significant hemodynamic fluctuations. Additionally, tracheal intubation inherently elicits airway irritation, exacerbating pre-existing pulmonary conditions and complicating extubation maneuvers. Moreover, intrathecal anesthesia was contraindicated due to his coagulation disorder. These collective factors directly or indirectly imperil the lives of elderly patients. Fortunately, nerve block anesthesia offers a viable alternative, circumventing such risks adeptly. Nerve block facilitates profound and prolonged anesthesia with minimal doses of local anesthetics, ensuring preserved spontaneous respiration. Furthermore, its analgesic efficacy may endure for up to 8–10 h postoperatively [2], markedly reducing reliance on opioid analgesia and its associated adverse effects. A retrospective study has highlighted that regional anesthesia was associated with a modestly shorter length-of-stay compared with general anesthesia [10]. Employing ultrasound-guided technology in nerve blockade substantially mitigates the potential for tissue trauma and local anesthetic mistakenly entering blood vessels, thus enhancing procedural reliability and safety [2]. Previously, nerve block was used more intraoperatively combined with general anesthesia, aimed at dose reduction of opioid medications [3, 7] or postoperative analgesia [3, 11, 12]. However, emerging literature suggests the feasibility of employing simple nerve blocks for selected procedures [7, 13].

We implemented an ultrasound-guided modified iliac fascia block combined with sacral plexus instead of traditional iliac fascia block [14, 15], which is firstly reported to apply in such elder critically ill patients. The innervation of the hip joint primarily stems from the ventral rami of the lower lumbar plexus (L2-L4) and upper sacral plexus (L4-S1) spinal nerve roots [16]. Key nerves supplying the hip joint include the femoral and obturator nerves from the lumbar plexus, and the lumbosacral trunk (via the sciatic and superior gluteal nerves) from the sacral plexus [16, 17]. Traditional iliac fascia block is comprised of high and low iliac fascia block. The high iliac fascia block targets nerves above the inguinal ligament, effectively blocking the femoral, obturator, and external cutaneous nerves. Conversely, the low iliac fascia block, directed below the inguinal ligament, often yields incomplete blockade, affecting solely the femoral and obturator nerves. In our approach, we placed high-frequency linear ultrasound probe parallel to the inguinal ligament to see high echogenicity of the fascia lata, iliac fascia, and iliopsoas muscle with the patient supine position and the lower limb on the operated side slightly abducted. Subsequently, we administered a 20 ml combination of 0.25% ropivacaine and 1% lidocaine into the designated gap using a short-axis out-of-plane technique. The needle insertion was directed under the iliac fascia within the lateral sheath of the femoral nerve, with injection directed cephalad. Diverging from the traditional method, we positioned the injection lower and employed a lower concentration (0.25% ropivacaine combined with 1% lidocaine vs. 0.35% ropivacaine) and reduced dosage (20 mL vs. 40 mL). A randomized controlled trial [18] summarized that local anesthetics with lower concentrations may has distinct advantages. Considering the critical condition of the elderly patient, the adoption of such low-concentration local anesthetics ensures anesthesia safety while affording effective pain relief [19]. Therefore, the approach in our case, marked by lower concentration and dosage, holds better promise for expediting recovery and aligning with Enhanced Recovery After Surgery (ERAS) principles. This nuanced approach underscores the imperative of tailoring anesthesia protocols to suit individual patient profiles, particularly in the context of complex medical comorbidities.

In this case, we successfully implemented an ultrasound-guided modified iliac fascia combined sacral plexus block with sedation to facilitate surgical completion in a critically ill patient. The utilization of the modified iliac fascia block yielded comparable anesthesia and analgesic outcomes to the traditional iliac fascia block on a safer basis. Notably, ultrasound-guided nerve blocks offer a promising avenue for critically ill individuals unsuited for general or intrathecal anesthesia, thereby extending newfound therapeutic potential to this patient cohort.

Abbreviations

BNP	Brain Natriuretic Peptide
APTT	Activated Partial Thromboplastin Time
SpO_2	Peripheral Capillary Oxygen Saturation
FRAIL	Fatigue, Resistance, Ambulation, Illness, and Loss of Weight
NYHA	New York Heart Association
BMI	Body Mass Index
Bpm	Beats per minute
PO_2	Partial Pressure of Oxygen
PCO_2	Partial Pressure of Carbon Dioxide
Hb	Hemoglobin
BIS	Bispectral Index
PACU	Post-Anesthesia Care Unit
VAS	Visual Analog Scale
ERAS	Enhanced Recovery After Surgery

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Author contributions
Collection and compilation of the case and pictures: Muyan Shi, Ping Huang, Qiuyue Lian.Literature search: Muyan Shi, Ping Huang, Qiuyue Lian.Drafting the article and revising it critically for important intellectual content: Muyan Shi, Zhenling Huang, Jie Tian, Ruixin Lin.Final approval of the article: Zhenling Huang.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Not applicable to ethics approval as the case described above is not an experimental study.

Consent for publication
We include a statement on informed consent from the participant and his guardian for his individual data.

Competing interests
The authors declare no competing interests.

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